

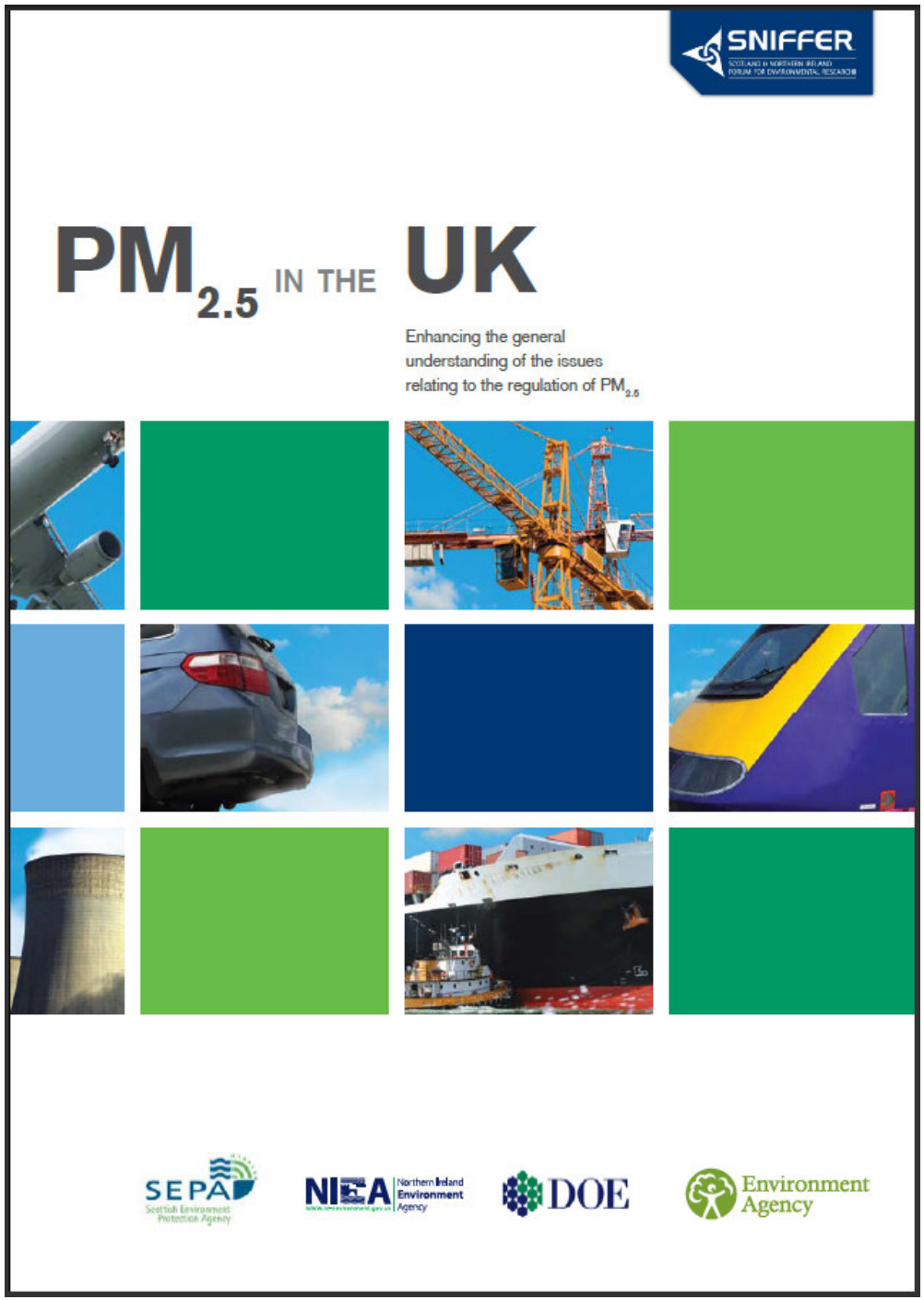




Air Quality CONSULTANTS

SNIFFER '*$PM_{2.5}$ in the UK*' Study

Prof Duncan Laxen



A 193 page report prepared for SNIFFER

Scotland and Northern Ireland Forum for Environmental Research

Available at:
www.sniffer.org.uk/Default.aspx

and at:
www.aqconsultants.co.uk/download-reports.aspx

Air Quality CONSULTANTS

Prepared by

Air Quality CONSULTANTS

Prof. Duncan Laxen, Stephen Moorcroft, Dr Ben Marner and Kieran Laxen

TRL

Dr Paul Boulter and Dr Tim Barlow

UNIVERSITY OF BIRMINGHAM

Prof. Roy Harrison

THE UNIVERSITY OF EDINBURGH

Dr Mat Heal

Air Quality CONSULTANTS

Sponsored by

Report Covers

- Characteristics & behaviour of PM in the atmosphere
- Sources of $PM_{2.5}$
- Exposure to $PM_{2.5}$ in the UK
- Health effects of $PM_{2.5}$
- Legislation to control exposure
- Monitoring for $PM_{2.5}$
- Modelling for $PM_{2.5}$
- Policy implications, recommendations and delivery

Air Quality CONSULTANTS

Why $PM_{2.5}$?

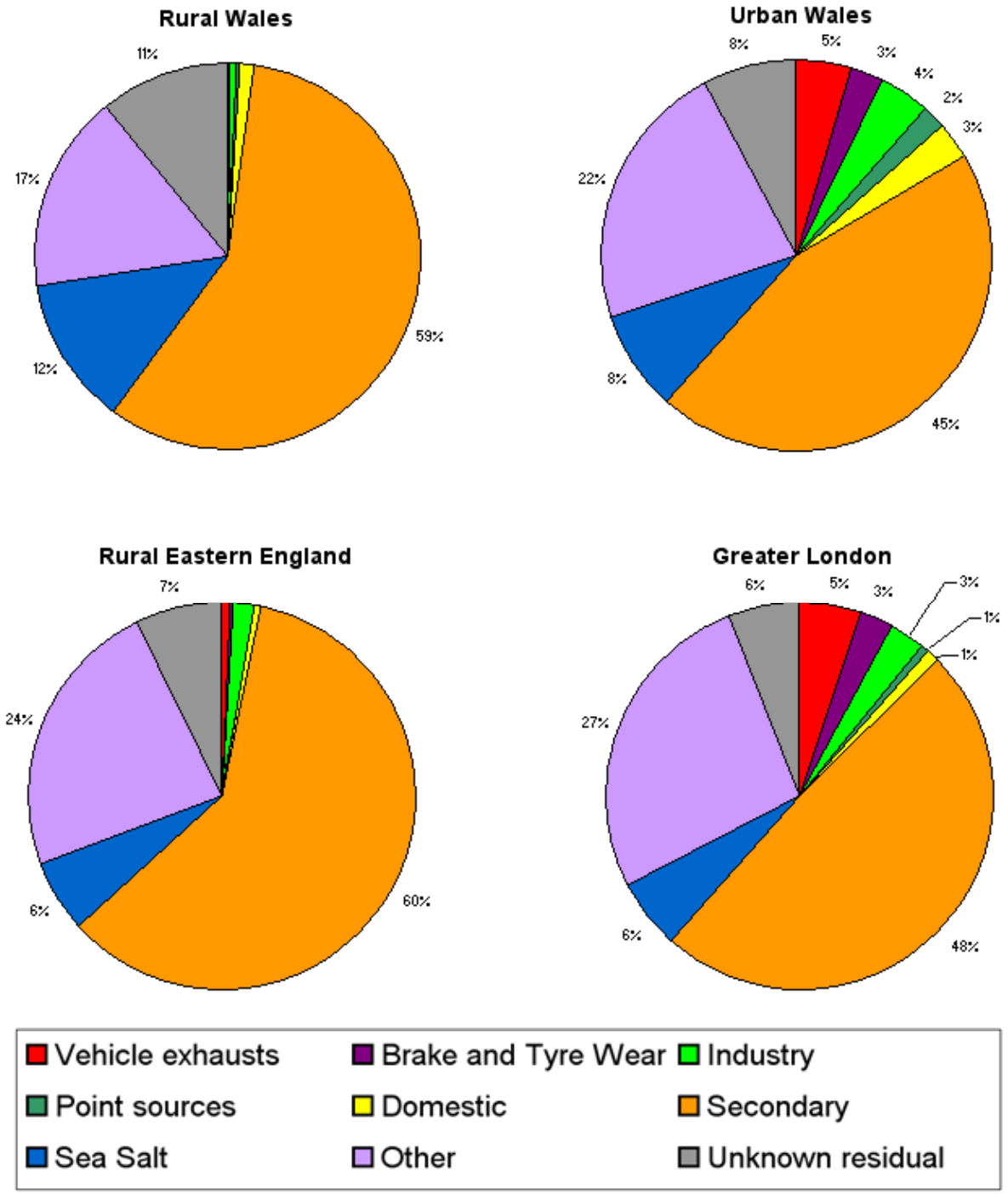
- $PM_{2.5}$ is the pollutant most clearly associated with adverse health outcomes, including death
- There is no known threshold for effects, i.e. no safe level
- There are new UK and EU standards that will have to be met

Air Quality CONSULTANTS

Important distinction

- Important distinction between primary and secondary particles
- Primary particles are particles emitted directly into the atmosphere
- Secondary particles are formed in the atmosphere through atmospheric reactions, e.g. SO_2 > sulphates
  - The formation of secondary particles is relatively slow (hours to days) so secondary $PM_{2.5}$ is found well downwind of the sources of the precursor gases
  - As a consequence secondary particles are evenly distributed in the atmosphere

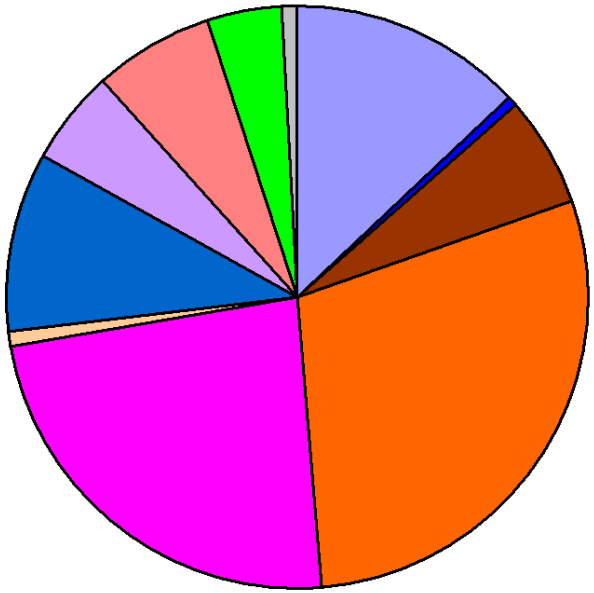
Air Quality CONSULTANTS



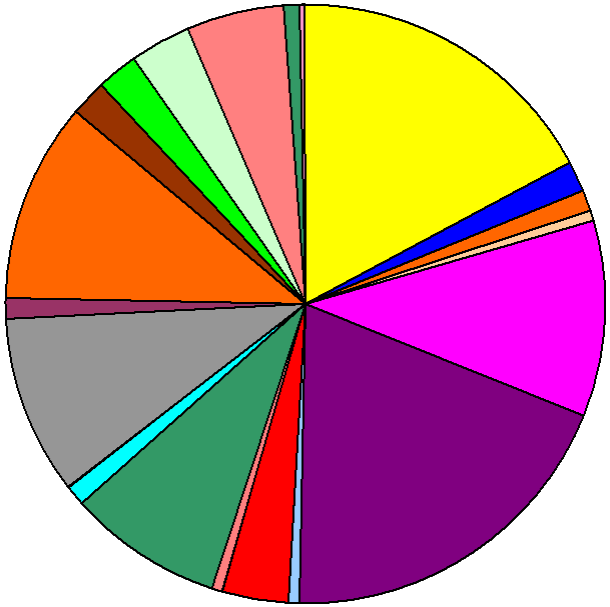
Sources of $PM_{2.5}$ in 2010

Air Quality CONSULTANTS

Sources of Primary $PM_{2.5}$ in the UK



- Residential (13.0%)
- Commercial/institutional (0.7%)
- Power stations (6.0%)
- Industrial operations (28.9%)
- Road transport (23.5%)
- Rail (0.8%)
- Shipping (10.1%)
- Off-road mobile (5.3%)
- Aviation (0.1%)
- Waste (6.6%)
- Agriculture (4.2%)
- Other (0.8%)



- Power Stations (17.2%)
- Petroleum refining (1.7%)
- Manufacture solid ruels & other energy industries (1.0%)
- Combustion for iron & steel (0.5%)
- Stationary combustion manufacturing industries & construction (10.5%)
- Mobile combustion manufacturing industries & construction (19.4%)
- Solid-fuel transformation (0.4%)
- Venting & flaring (3.6%)
- Cement production (0.1%)
- Road paving with asphalt (0.5%)
- Quarrying & mining of minerals (other than coal) (8.4%)
- Construction & demolition (1.0%)
- Storage, handling & transport of mineral products (0.2%)
- Other mineral products (9.5%)
- Other chemical industry (1.2%)
- Iron & steel production (10.7%)
- Other metal production (2.0%)
- Wood processing (2.3%)
- Refrigerants & air conditioning equipment (3.3%)
- Industrial coating application (5.4%)
- Other coating application (0.8%)
- Chemical products, manufacture & processing (0.2%)

Air Quality CONSULTANTS

$PM_{2.5}$ Standards

- Key change has been the introduction of exposure-reduction target, with a backstop standard to ensure concentrations are not too high at any location
- Exposure-reduction is based on it being more effective to reduce the exposure of a large number of people by a small amount, than to reduce exposure of a small number of people by a large amount.
  - The health benefits of reducing average exposure of 10 million people by 1 $\mu g/m^3$, are one hundred times greater than reducing the exposure of 10,000 people by 10 $\mu g/m^3$.

Air Quality CONSULTANTS

$PM_{2.5}$ Standards

- Need to consider EU, UK and Scottish standards
- UK and Scottish standards came first 2007 Strategy

	Time Period	Standard	Timescale
UK	Annual	Objective 25 µg/m^3	By 2020
	3 Year running mean	Objective 15% reduction across urban background sites	Over period 2010 to 2020
Scotland	Annual	Objective 12 µg/m^3	By 2020
	3 Year running mean	Objective 15% reduction across urban background sites	Over period 2010 to 2020

Air Quality CONSULTANTS

$PM_{2.5}$ Standards

- EU standards 2008 CAFE Directive implemented 2010

Time Period	Standard	Value	Timescale
Annual	Target value	25 µg/m^3	2010
Annual	Limit value	25 µg/m^3	By 2015
Annual	Stage 2 indicative limit value	20 µg/m^3	By 2020
3 Year Average Exposure Indicator (AEI)	Exposure-reduction target	0% - 20% depending on initial AEI	Over period 2010 to 2020
3 Year Average Exposure Indicator (AEI)	Exposure-concentration obligation	20 µg/m^3	2015

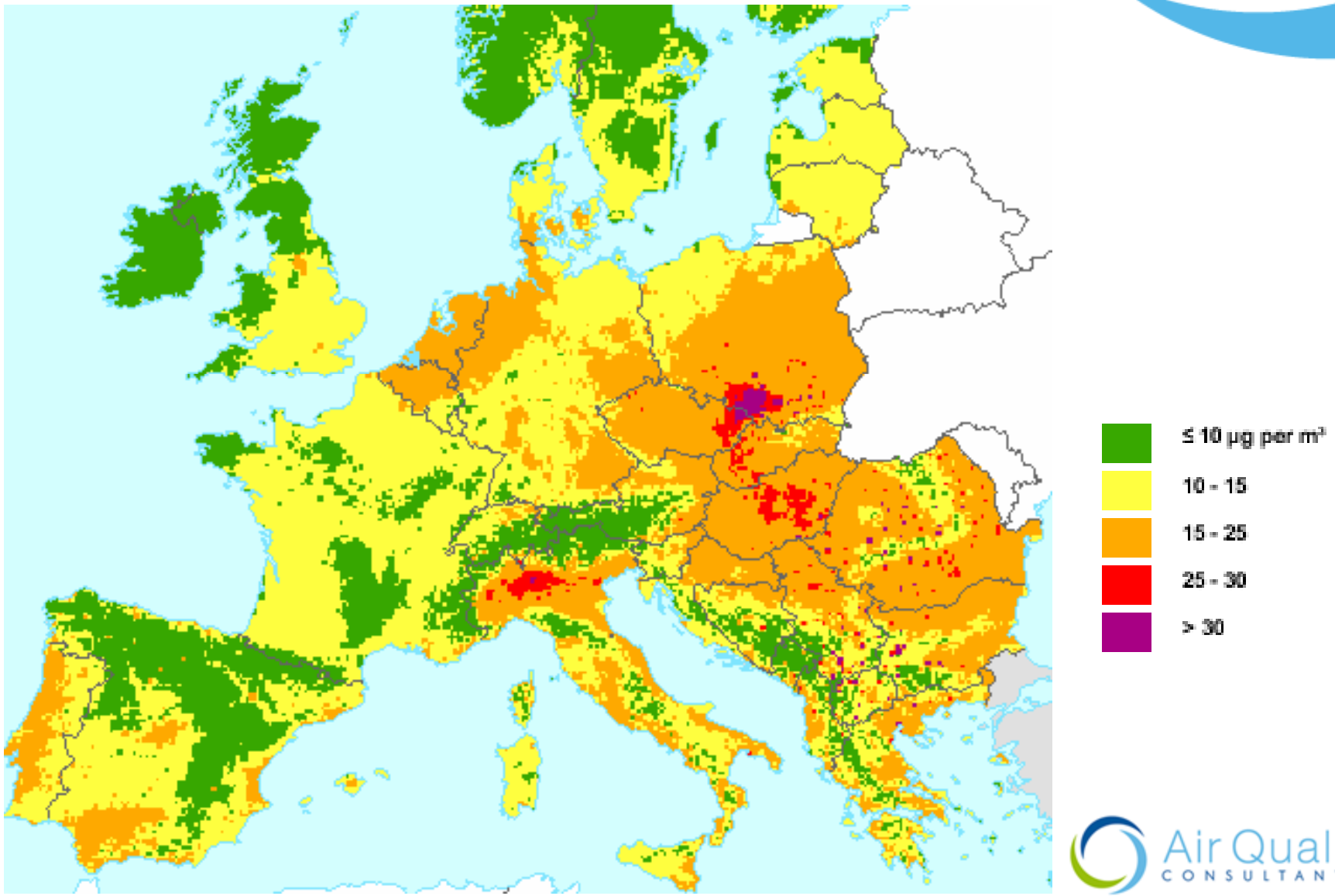
Air Quality CONSULTANTS

$PM_{2.5}$ Exposure Reduction

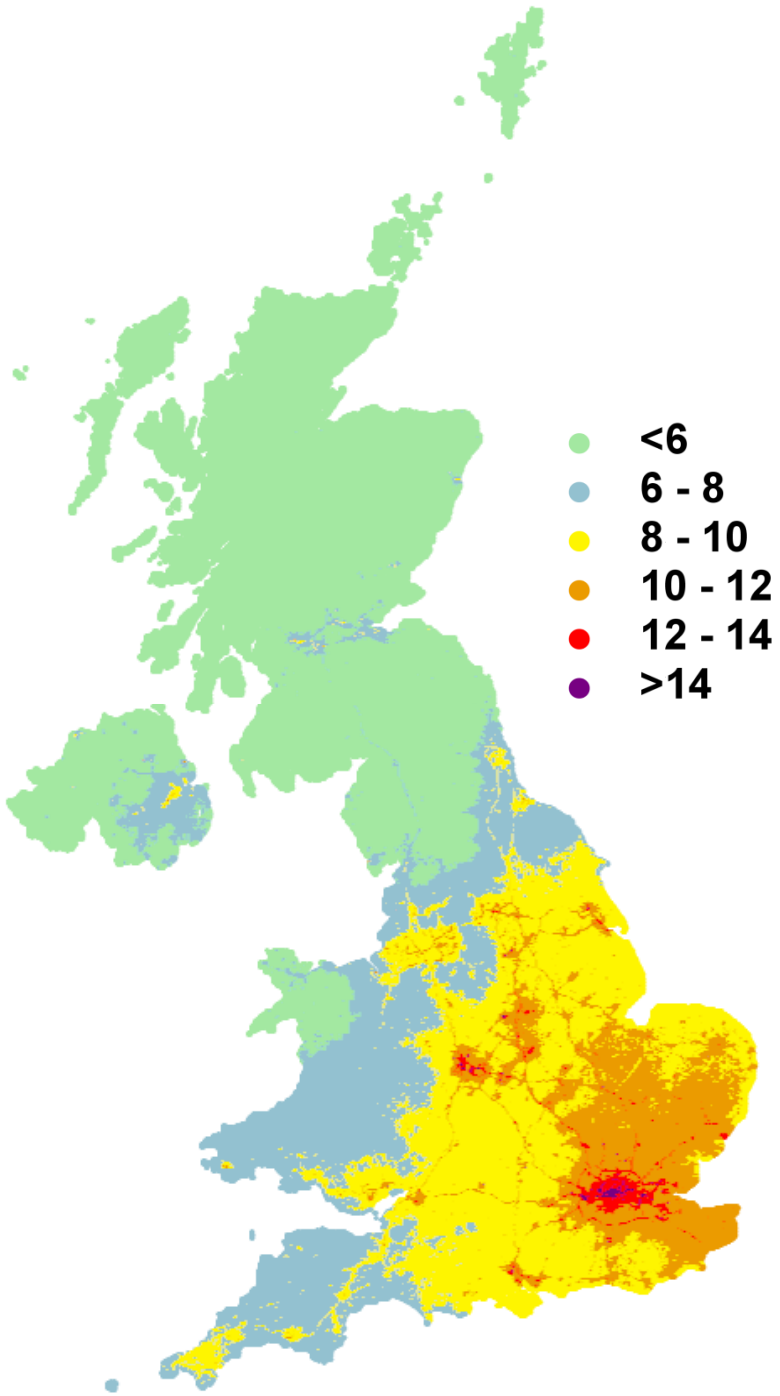
- The Average Exposure Indicator (AEI) is being based on measurements at 50 urban background sites across the UK, with 3 in Scotland (Aberdeen, Edinburgh, Glasgow)
- Start year will be 2009 – 2011 (not 2008-2010)
- Boundary between 10% and 15% reduction for EU target is 13 µg/m^3
- In 2009 UK average was 13.2 µg/m^3
- Exposure-reduction target is obligation on Member State – has not been devolved down to Local Authorities (yet?)

Air Quality CONSULTANTS

$PM_{2.5}$ across Europe 2005

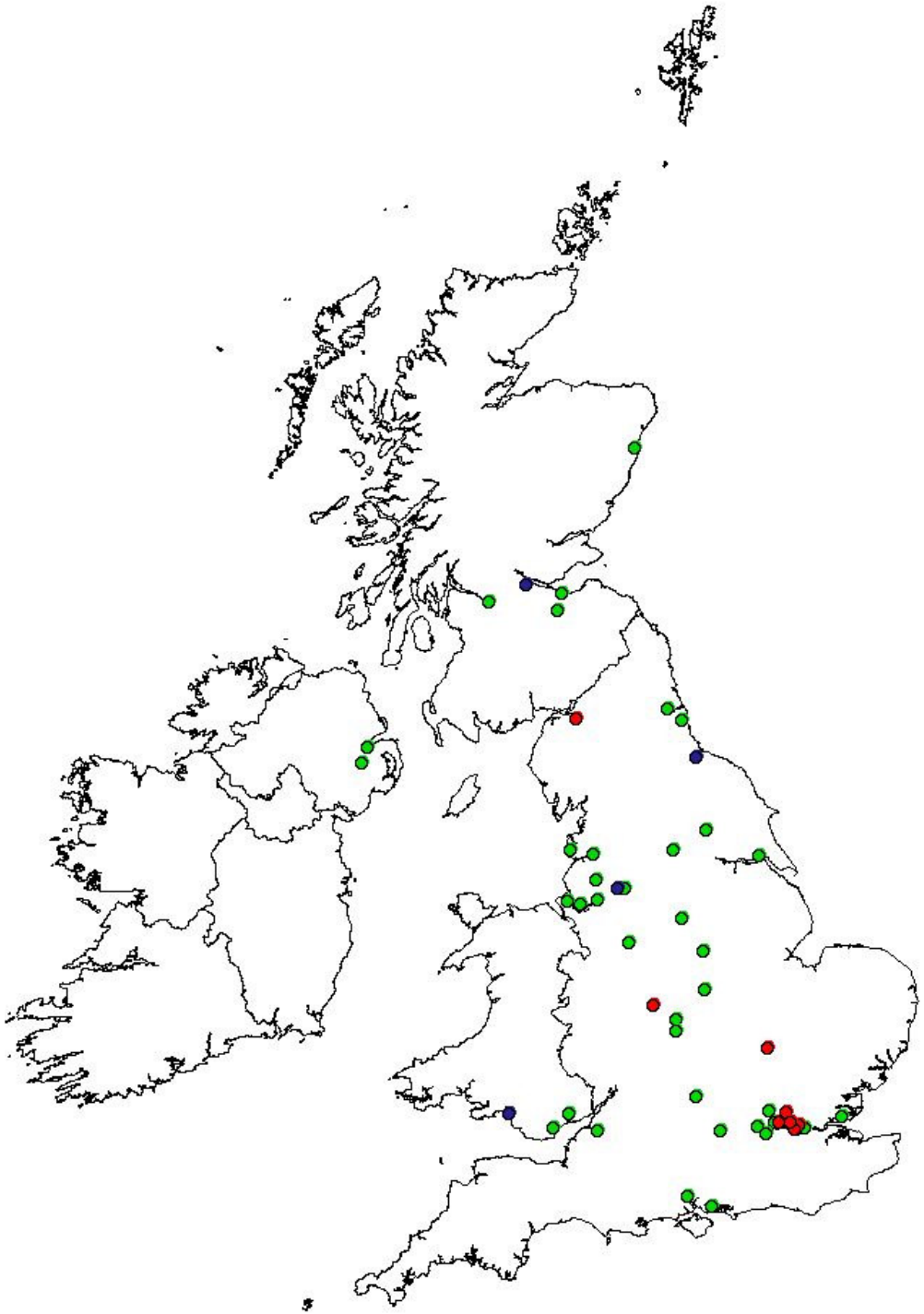


Air Quality CONSULTANTS



$PM_{2.5}$ across the UK in 2010

Air Quality CONSULTANTS



$PM_{2.5}$ AURN

(UK Monitoring Network)

67 sites:

- 43 urban background
- 17 roadside/kerbside
- 4 industrial
- 3 rural

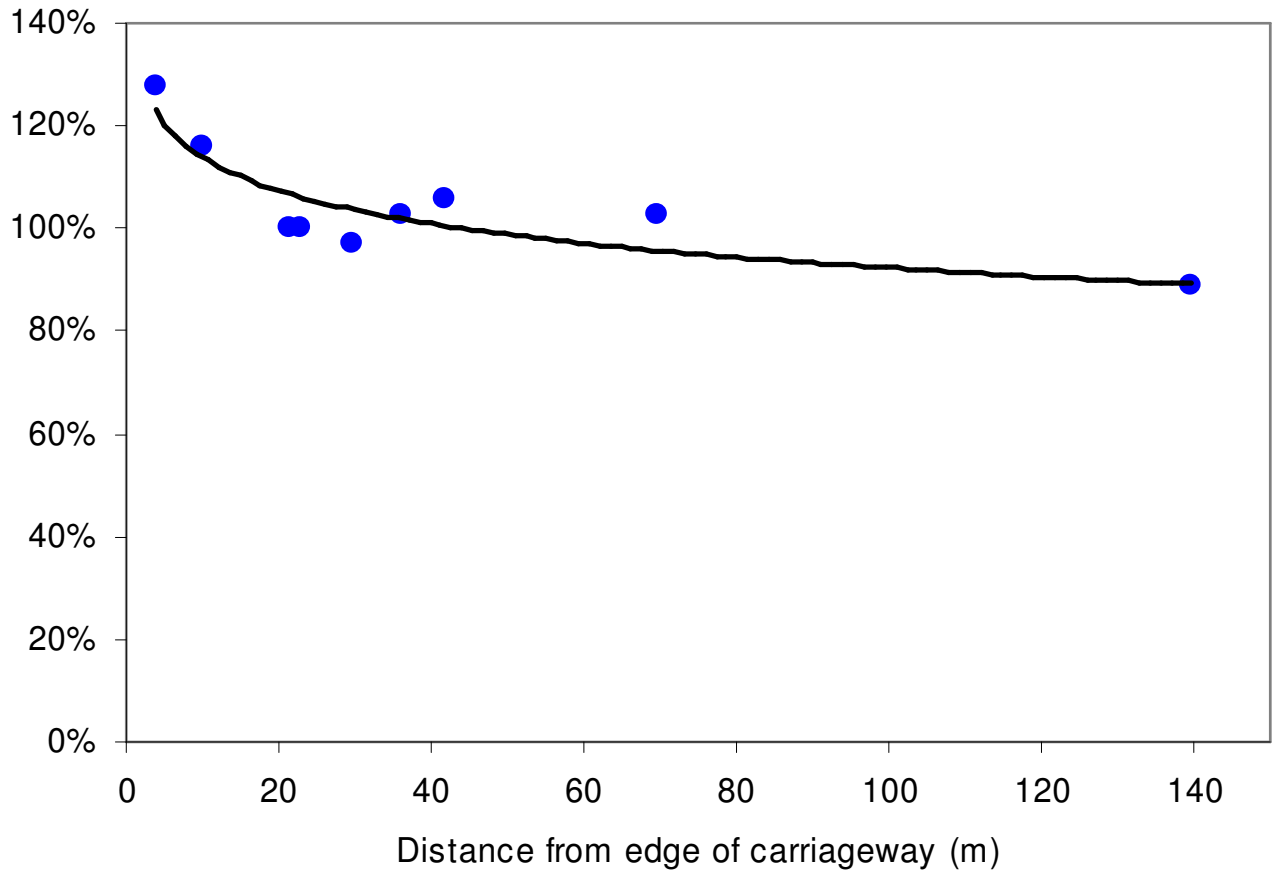
Air Quality CONSULTANTS

General Pattern of $PM_{2.5}$ Annual Mean Concentrations 2009

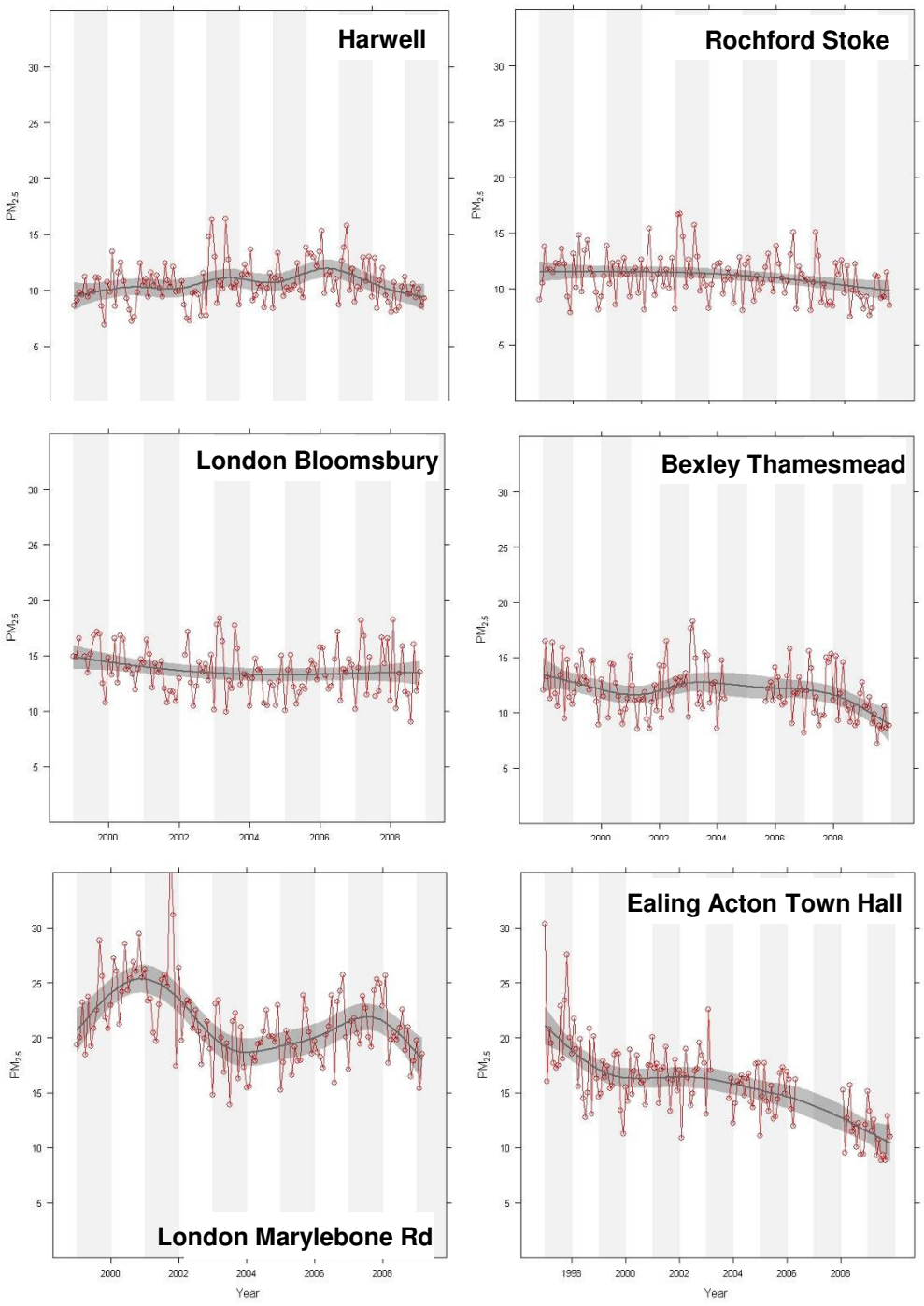
Rural Background	3 - 10 µg/m^3
Urban Background	+ 3 - 6 µg/m^3
Roadside	+ 1- 2 µg/m^3
Kerbside	+ 7 – 8 µg/m^3
Industrial	? Small

Air Quality CONSULTANTS

PM_{10} Fall-off with Distance from Road (M25) ($PM_{2.5}$ similar)



Air Quality CONSULTANTS



Rural

Urban Background

Roadside

$PM_{2.5}$ Trends 1998-2009

Air Quality CONSULTANTS

$PM_{2.5}$ vs PM_{10} as Control on PM

- PM_{10} daily mean limit value (approx. annual mean of 31.5 µg/m^3) will be more stringent than $PM_{2.5}$ annual mean limit value of 25 µg/m^3
  - 31.5 µg/m^3 PM_{10} equates to ~17 µg/m^3 $PM_{2.5}$ in the north of UK to ~24 µg/m^3 in the southeast
- PM_{10} annual mean objective in Scotland will be more stringent than $PM_{2.5}$ annual mean objective of 12 µg/m^3
  - 18 µg/m^3 PM_{10} equates to ~10 µg/m^3 $PM_{2.5}$
- So PM_{10} objectives and limit values will drive controls at hotspots

Air Quality CONSULTANTS

Exposure reduction target is challenging

- 10-15% reduction will require ~1.5-2 µg/m^3 reduction in urban background $PM_{2.5}$ across the UK over 10 years
  - If to be achieved by reducing local sources then need to reduce urban background contribution by this amount, i.e. 1.5-2 µg/m^3 reduction out of 3-6 µg/m^3 which is 25-67% reduction
  - If to be achieved by reducing secondary sources then need to reduce secondary $PM_{2.5}$contribution by this amount, i.e. 1.5-2 µg/m^3 reduction out of 4-6 µg/m^3 which is 25-50% reduction
- These reductions are substantial and will be challenging to deliver

Air Quality CONSULTANTS

Key Points

- Significant health benefits from reducing exposure to $PM_{2.5}$
- Sources are many and diverse with different attributes, making control more challenging
- Key role played by secondary PM
- Exposure varies across UK but dominated by background
- Meeting the Exposure-Reduction target will be challenging

Air Quality CONSULTANTS







Air Quality CONSULTANTS

Head Office
23 Coldharbour Road, Bristol BS6 7JT
Tel: 0117 974 1086

London Office
12 Airedale Road, London SW12 8SF
Tel/Fax: 020 8673 4313

Air Quality CONSULTANTS