

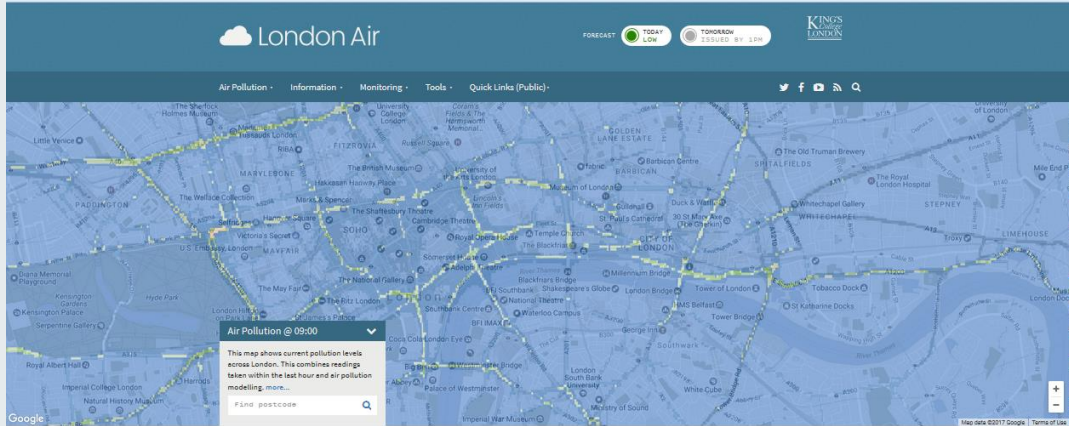
# London Air at 25 – a look back at the early days

Hima Chouhan

**KING'S**  
*College*  
**LONDON**



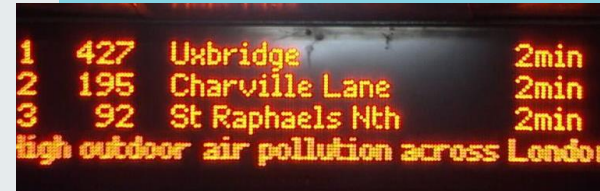
# Who are we?




Pollutants	London	Health effects	Health advice	Actions	Reduce exposure
Air pollution	Epidemiology	Health effects	Air quality bands	Can I monitor?	From Breathe London.
Carbon monoxide	How bad is London?	Increased risk effects	Avoiding pollution	Climate change Government action	At home
Nitrogen dioxide	LAQN	Long term effects	Busy roads	Information	On my walk or run
Ozone	London history	Objectives and health	Short term effects	What can I do?	Senior Citizens
Particulates	Monitoring	Why monitor?	Worst place	Can what can be done?	At school
Sulphur dioxide	Wood Burning				Cycling
					My

Choose the lowest pollution route from A to B anywhere in the City.

- Receive alerts the day before pollution events
- High resolution pollution map updated every hour
- Bus stops, stations and bike hire locations to help you get across town
- The latest news from City of London



View The Northbank Air Quality Widgets

Get in touch to find out more

THE NORTHBANK

# Where did it all start?

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- South East Institute of Public Health (SEIPH) formed in 1991.
- In Tunbridge Wells in Kent



# Why SEIPH?

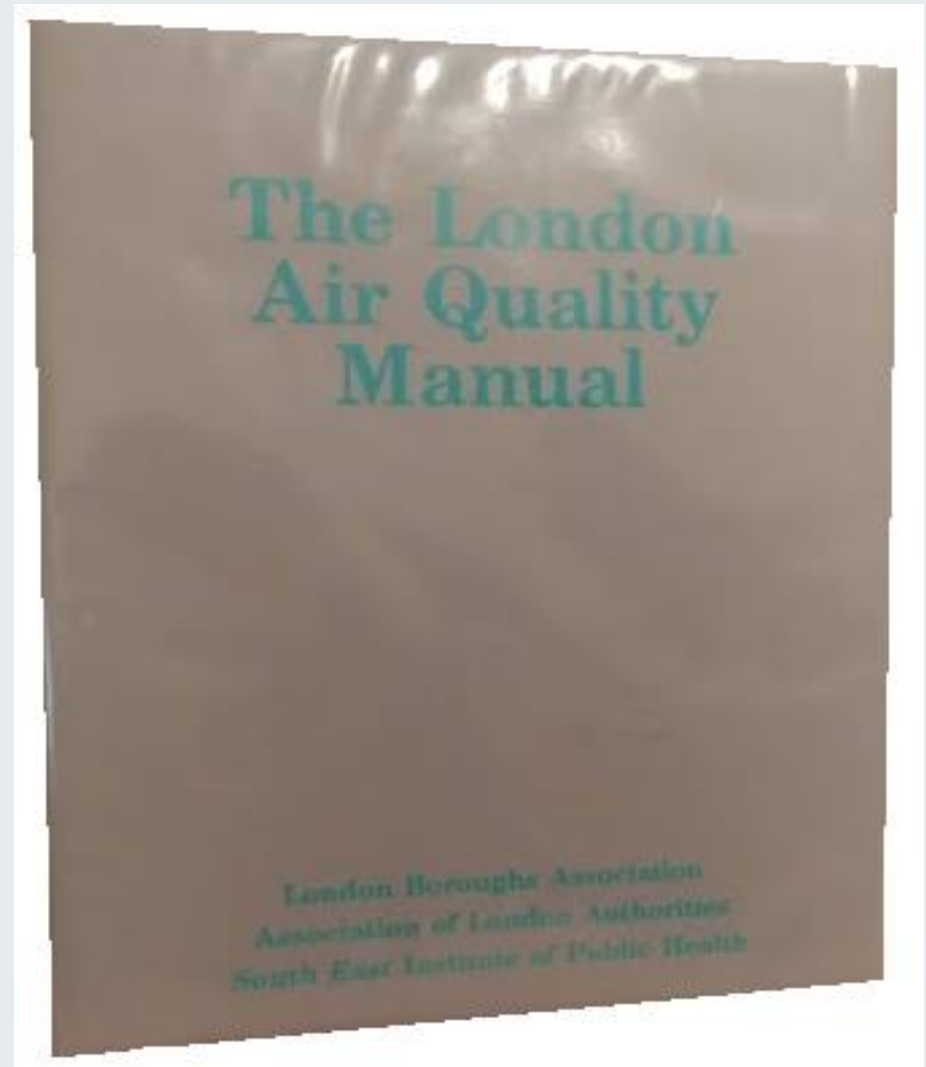
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- South East Thames Regional Health authorities
- Closer links between health disciplines: Public Health Medicine, Environmental Health and Social care
- Questions on public health about air pollution in East Thames area
- Not enough good pollution data / no QC



# Where did the London Air Quality Network come from?

- London local authorities agreed in 1993 to create the London air quality network
- Funding by the four regional Health authorities and SEIPH (us!)
- London Air Quality Manual
- Consistency and quality of data
- Guide on health effects, measurement methods, QA, calibrations, maintenance, data handling



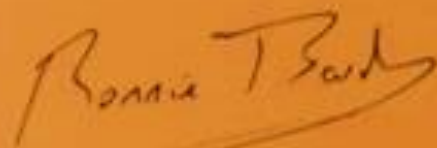
# The London Air Quality Manual

Few of us can choose the air we breathe. Pollution does not respect borough boundaries. It is all too evident that traffic congestion and other factors are having an effect on the health and well being of Londoners.

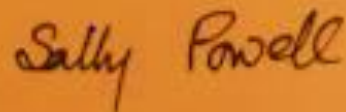
Local authorities have a responsibility to monitor the air and a role in advising the local community about its quality. It is essential that the boroughs have similar standards and are able to share data to build our knowledge of air quality in London.

That is why our work with the South East Institute of Public Health and this manual are so important. For the first time it will be possible to measure air quality in a co-ordinated way and develop our knowledge of, patterns and trends of air quality and pollution in the capital. It should be an invaluable guide to officers responsible for monitoring air quality and help us inform the community. The manual will assist in ensuring that there is a consistent and reliable approach. No doubt the lead shown in London will be taken up by other cities.

With this data, London boroughs will be able to develop the policies needed to ensure that everyone can breathe more easily.



Councillor Ronnie Barden  
London Boroughs Association



Councillor Sally Powell  
Association of London Authorities

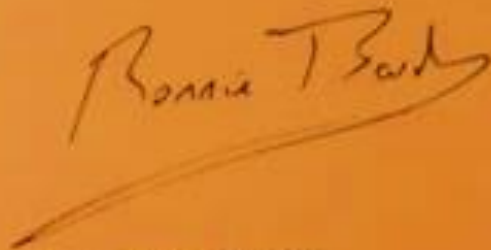
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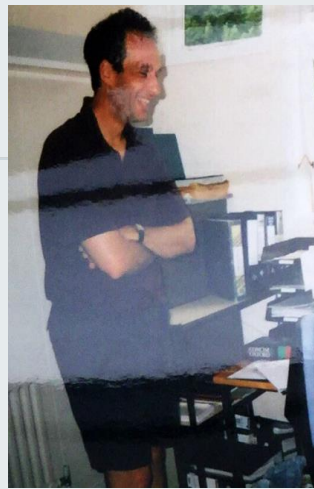


Councillor Ronnie Barden  
London Boroughs Association



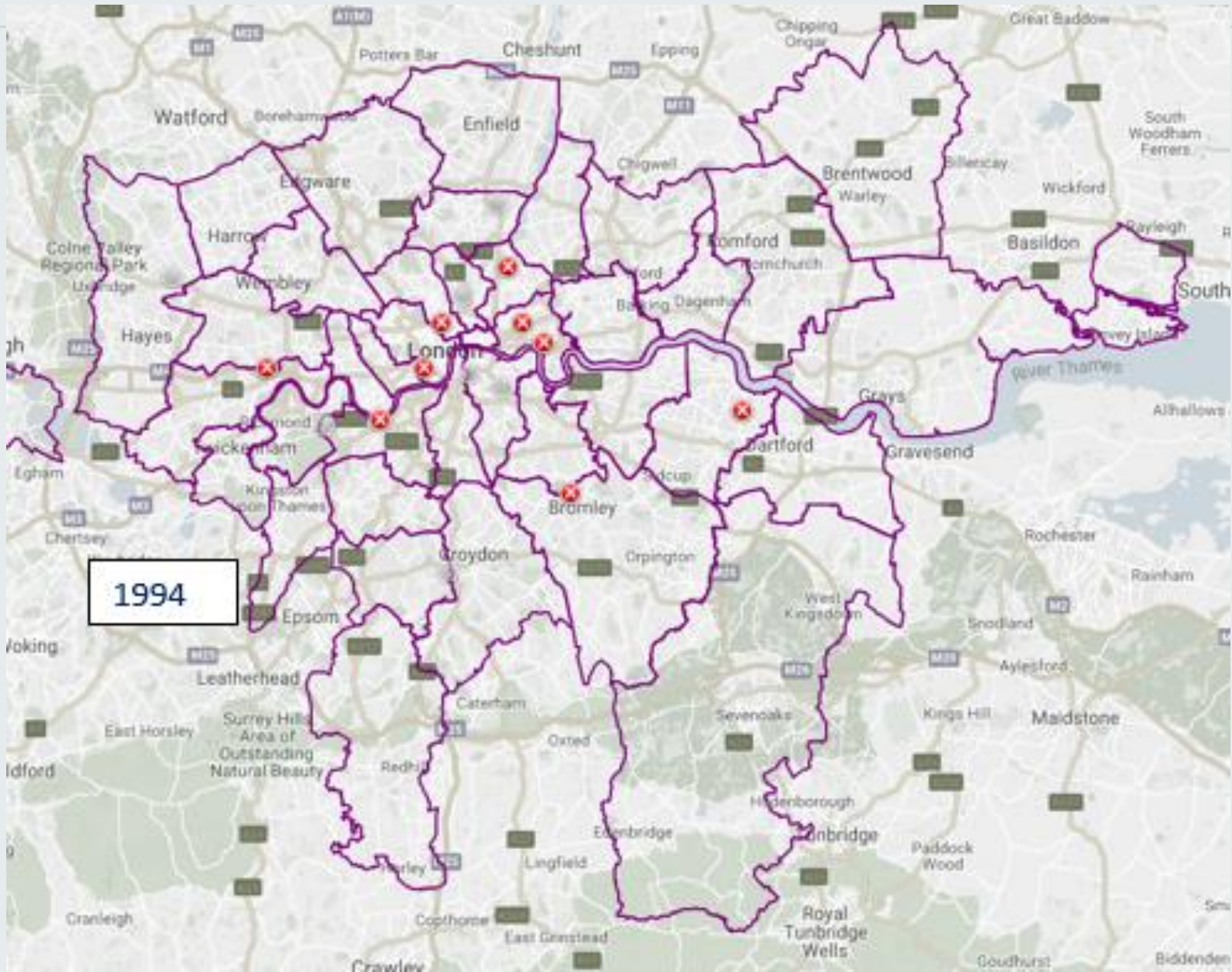
Councillor Sally Powell  
Association of London Authorities

# Monitoring Team

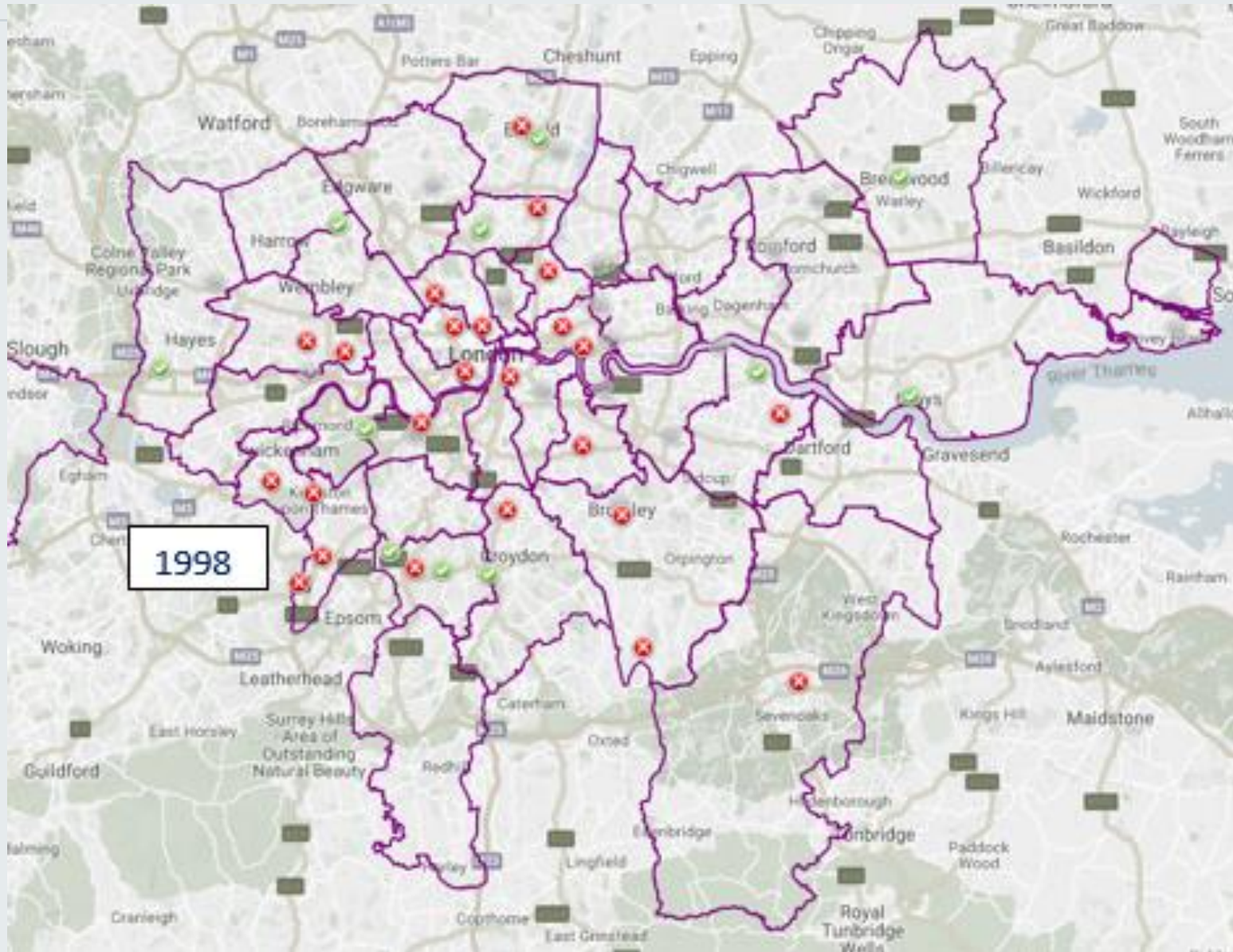




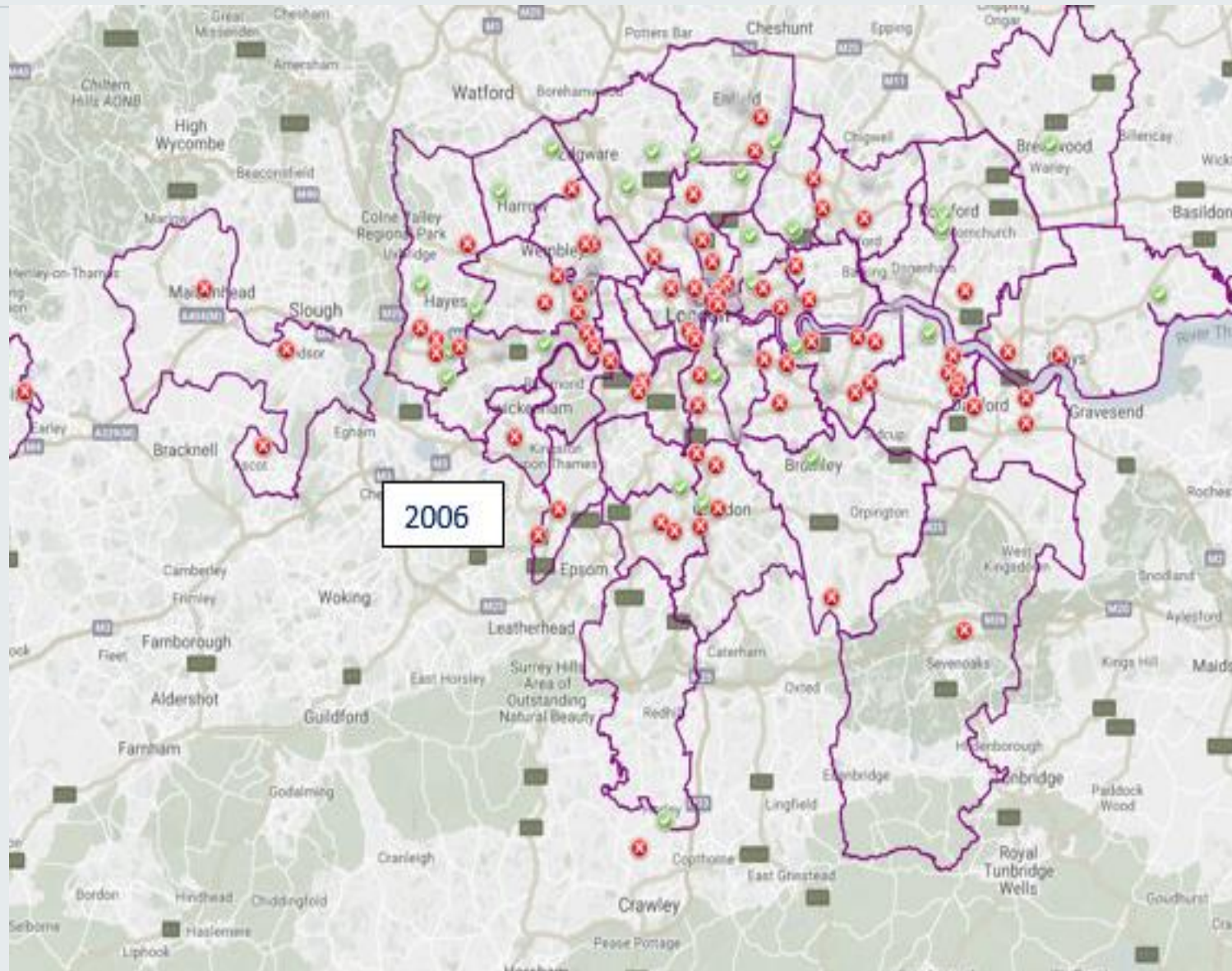
# Network Growth



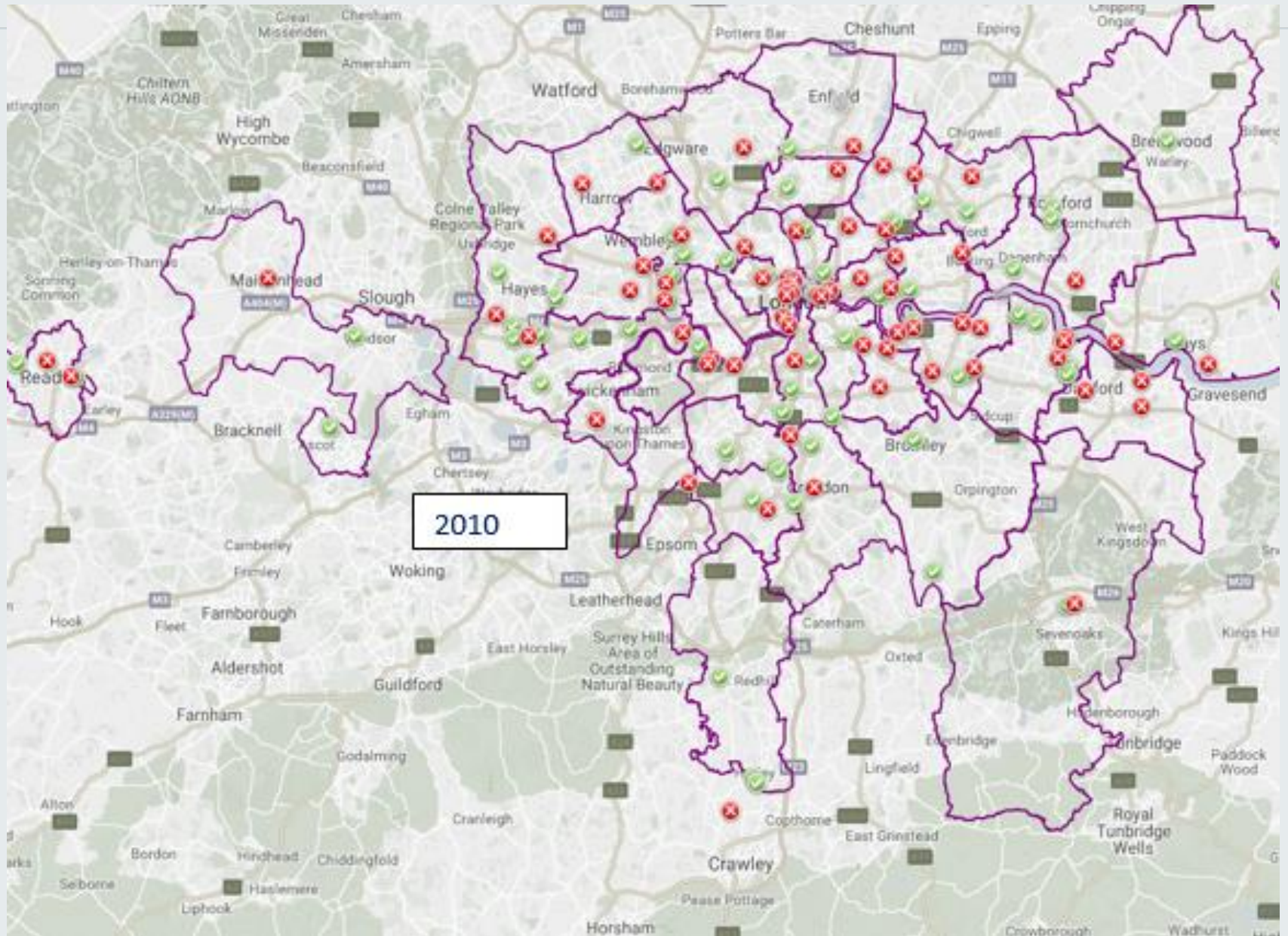
# Network sites in 1998



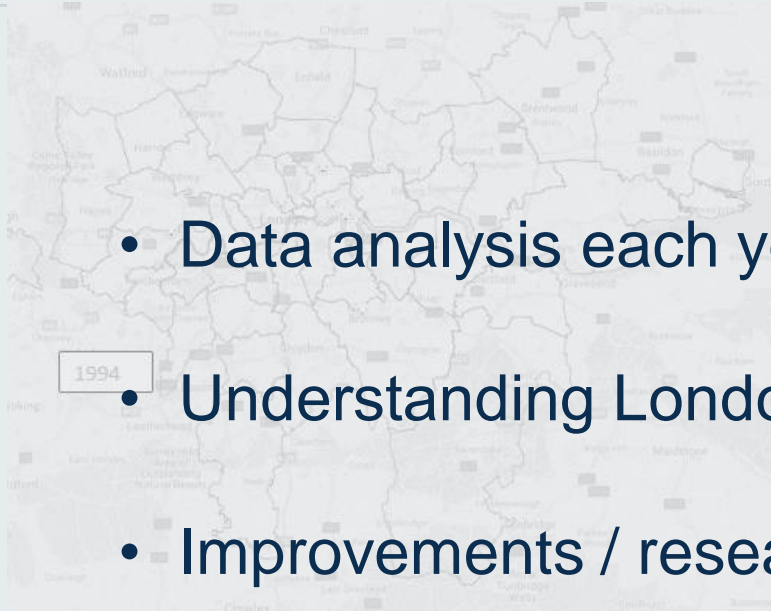
# Network sites in 2006



# Network sites in 2010



# Network Growth



- Data analysis each year

- Understanding London's pollution

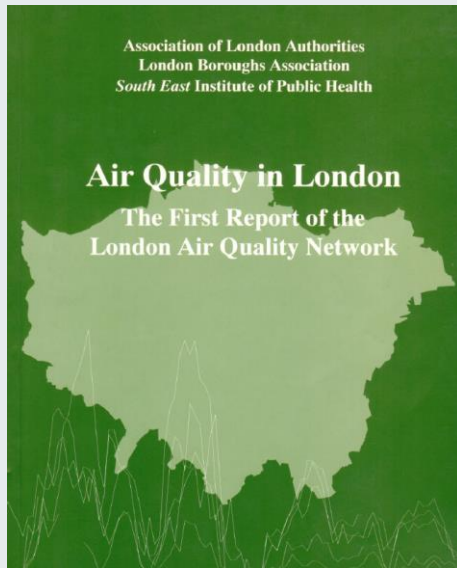
- Improvements / research



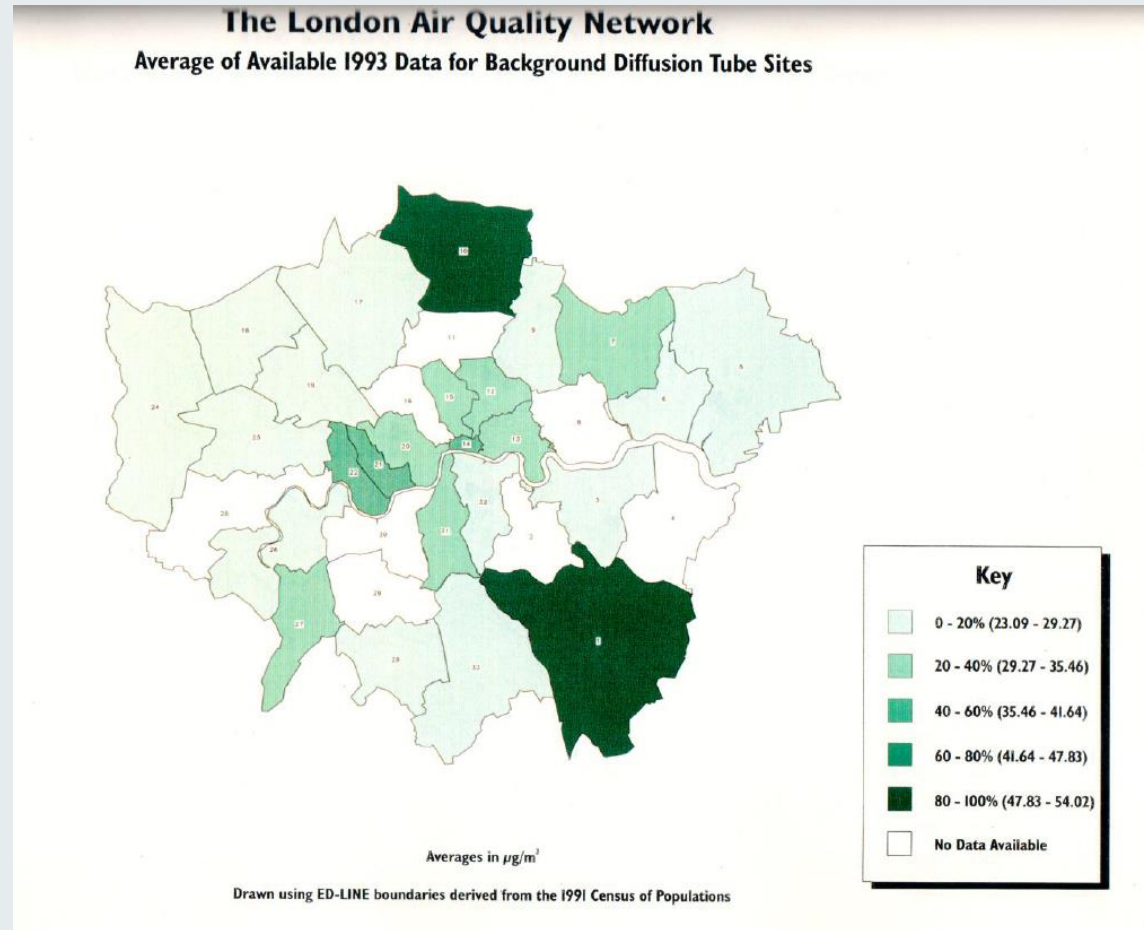
- Enhanced Network



# 1993 (the first) report findings

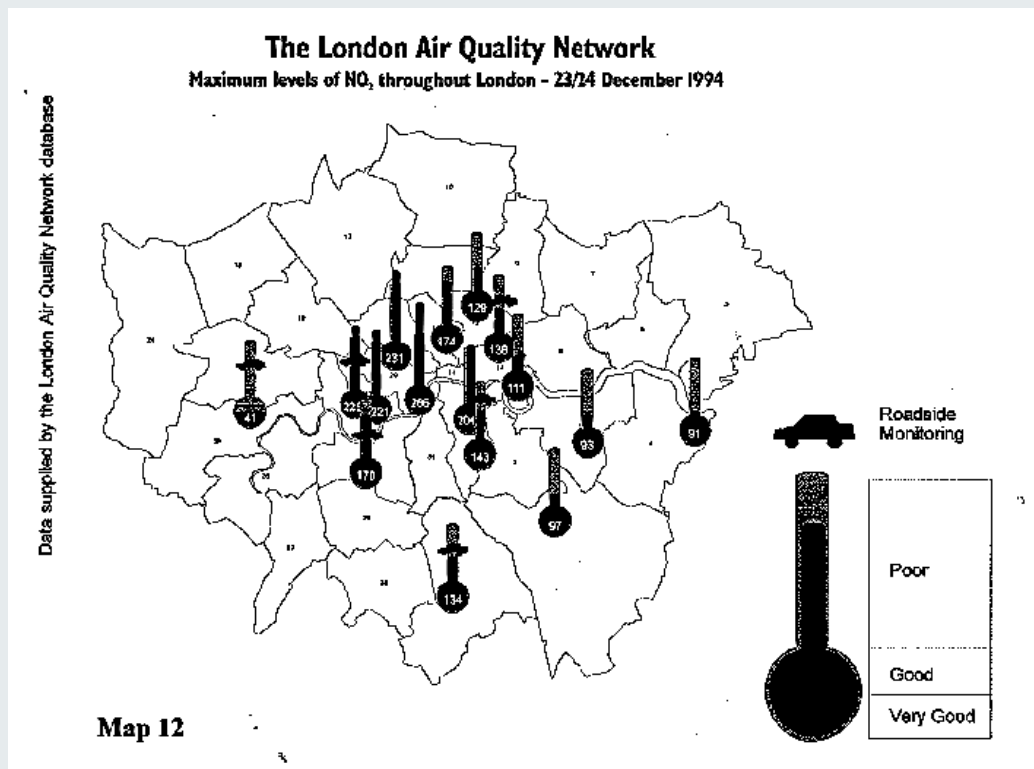


- Diffusion tube analysis
- Results dependant on lab
- Not suitable for mapping
- Bias correction
- Spatial distribution / particulates



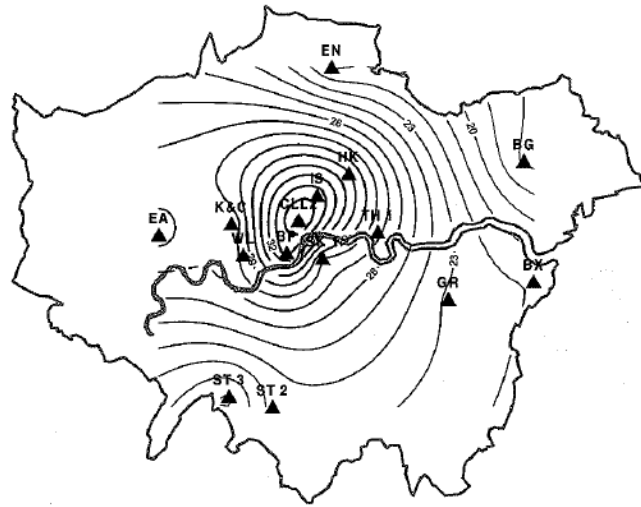
# 1994

- Worst NO<sub>2</sub> episode since 1991 (> 100 premature deaths)
- > 400µgm<sup>-3</sup>
- Pollution definitely a concern!
- Asthma epidemic June
- Research into air pollution and health links needed
- Monitoring even more essential

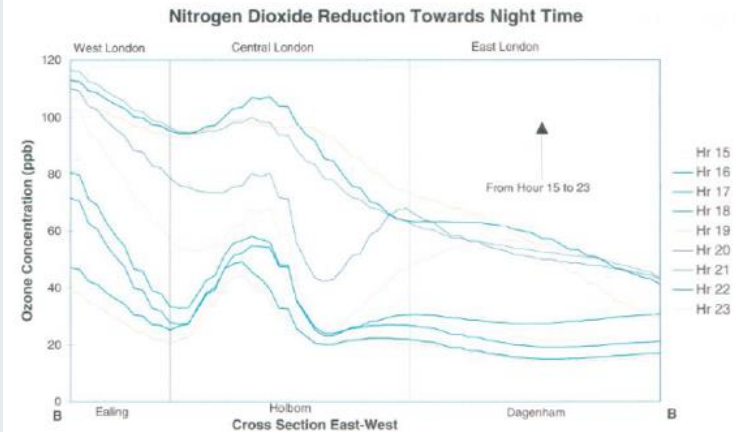
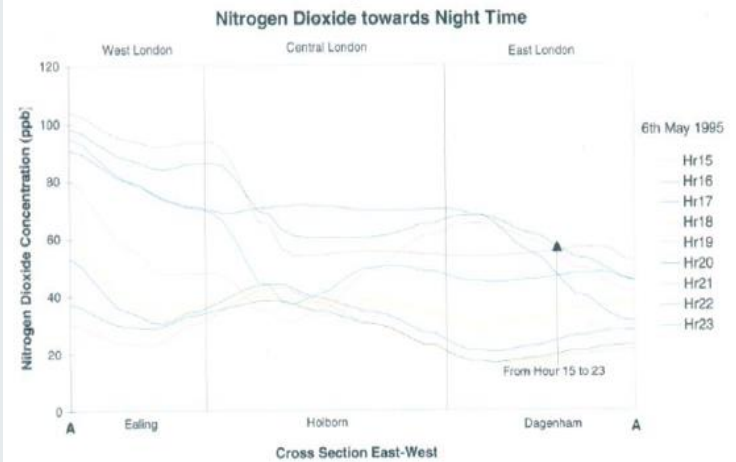
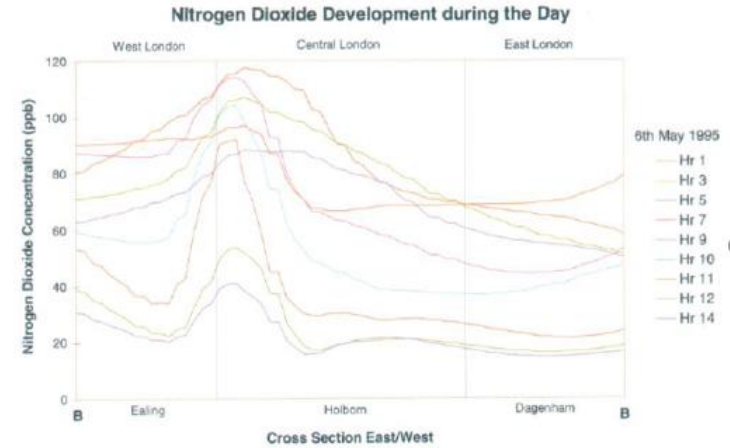


# 1995

Nitrogen Dioxide Annual Average for 1995 (ppb)



- First NO<sub>2</sub> mapping (by Sean Beevers)
- Cross section graphs
- Herts & Beds, Kent, Essex (Sussex later) enhanced understanding of London pollution
- LAQN was the largest continuous automated air quality monitoring network in the UK





# Affiliation to National network

- 16 sites affiliated to UK Automatic Urban Air Quality Network (AUN)
- SEIPH appointed CMCU
- Data reported on CEEFAX, Teletext, internet and UK Data archive

P416 CEEFAX 416 Thu 15 Aug 15:38/47

**BBC AIR**

OZONE Southern England 1pm Thu 15 Aug

Air Quality	Level (ppb)
URBAN sites	
Bristol Centre	Very Good 13
5'hampton Centre	Very Good 23
Exeter Roadside	Very Good 43
RURAL sites	
East Anglia	- -
	Very Good 39
	Very Good 22
	Good 54
	Good 55
	Good 60

Weather Travel

P106 Teletext 106 Oct 8 00:33:51

**Air Pollution**

S. EAST ENGLAND

**NEW IMPROVED SERVICE**

Teletext's air quality service has been updated and expanded. Every hour the Environment Dept gives out readings for seven air pollutants in your region.

High levels of ozone, nitrogen dioxide (NO2), sulphur dioxide (SO2) can affect the elderly, asthmatic and very young. This is true of new readings for carbon monoxide (CO) and emission particles which come from vehicle exhausts etc.

For detailed readings, Air Pollution line FREI

Check out the Green

**TELETEXT A-Z p199**

Shipping Inshore Holiday

P106 Teletext 106 Oct 8 00:35:49

**Air Pollution**

S. EAST ENGLAND

Forecast until 15:00 Thu Oct 8

Regions with VERY HIGH pollutant levels  
None

Regions with HIGH pollutant levels  
None

Forecast for all other regions is MODERATE or LOW air pollution.

2/5

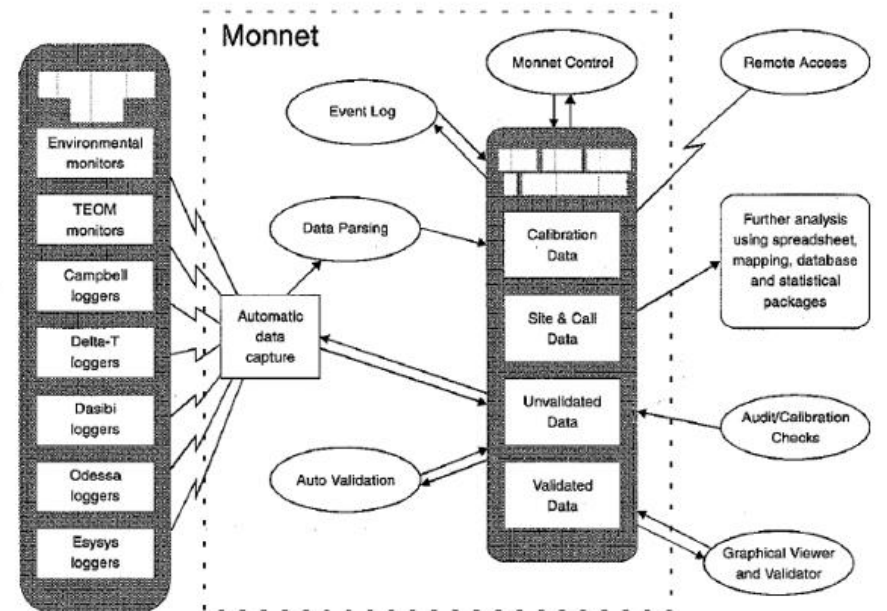
Check out the Green Scene 160 C4

ALL THE LATEST TELETEXT HOLIDAY OFFERS - BY FAX! p384

Shipping Inshore Holiday weather TVPlus

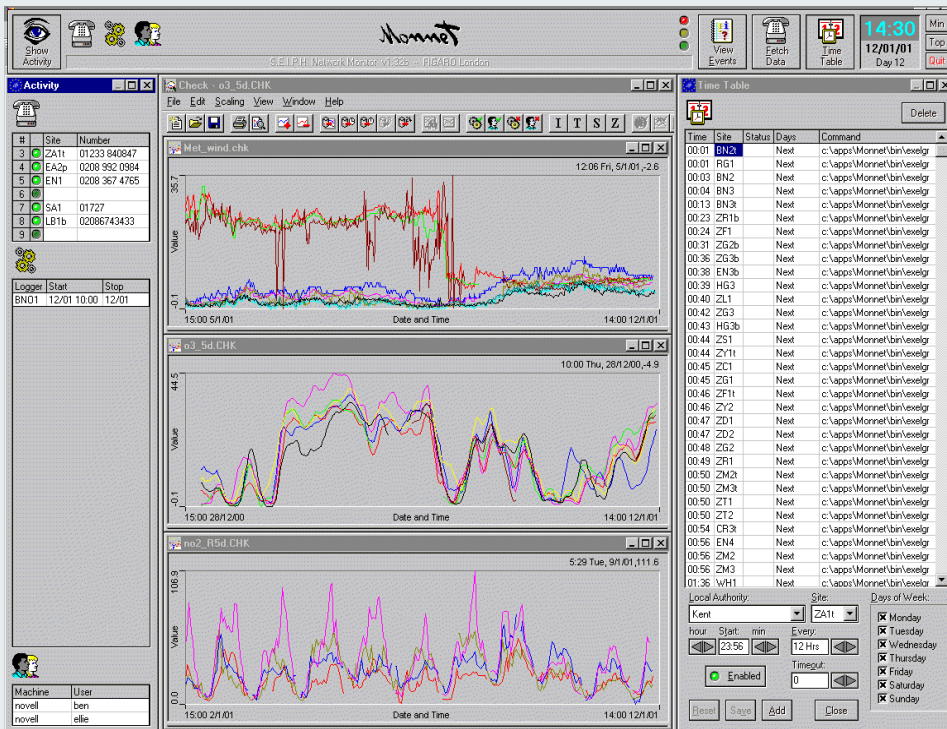
# 1996 - Monnet

- Monnet automatic data collection
- Tailor made and in house
- UNIQUE ability for variety of logger / analyser combinations



Schematic of MONNET Data Handling System

- No longer a need for same instruments across whole network
- Automatic entry to database
- Improved analysis capabilities



# Web pages

SEIPH Daily Data

London Air Quality Network

Current Air Quality Information

This report was generated on 27 June 1997 at 12:50 GMT.

Please note that this data will have to go through a number of validation steps and may subsequently be altered. The latest information in the table below is the hourly reading for the hour prior to the generation of this page. The peak reading is the peak hourly average from midnight. This number is used for the allocation of the AQI band.

We have a report which updates daily showing the previous day's air quality across London.

This table below is only intended to give a general impression of what the air quality is like. For more information, please visit our website.

Information from London Air Quality Network and affiliated Continuous Monitoring Sites

Local Authority Site	Today's peak concentration and latest reading by pollutant					AQI Band
	CO ppm	NO <sub>2</sub> ppb	O <sub>3</sub> ppb	SO <sub>2</sub> ppb	PM <sub>10</sub> µg/m <sup>3</sup>	
<b>ROADSIDE SITES</b>	Let on Peak	Let on Peak	Let on Peak	Let on Peak	Let on Peak	
Bromley 4	1					Good
London		49	44		36	70
Reading 2	0	0	21	22		10
Hatfield 1		26	30			13
Kingston 2					36	17
Southwark 2						
Sturton 1	1	7	30	33		3
Tower Hamlets 2	1	7	34	37		3
Watford 1		7	33		59	

1 of 3

switch to latest:

Sites outside of map areas

Key: ● ● ● ● ● ●

accessibility help links site map

Air Pollution Levels recorded on 15 January 2002

This map shows yesterday's maximum readings as recorded by each monitoring site.

Manually checked data from each operational monitoring site is included. You may be able to find more up to date information on current pollution levels in the hourly bulletin (click on the switch to latest tick)

Each site is shown by a coloured spot indicating pollution levels. The spot usually contains a number, representing the Government's Air Pollution Index value.

Click on a site to see a more detailed information.

Welcome to the London Air Quality Network

Home Nowcast Bulletins Sites Statistics Episodes Local Authorities Guide Tools Reports Download Data Contacts

You are on this page: Nowcast

Nowcast - Current Pollution Maps

Enter postcode or area:  Find

Map Satellite Hybrid

Estimated current PM10 air pollution index levels, based on measurements taken up to 09:00 on Tuesday 16th November.

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

What is a Nowcast?

This map shows a pollution 'nowcast', which is a pilot service to show current pollution levels in detail across London in comparison with the Government's Air Pollution Index. It is created by combining readings taken within the last hour and air pollution modelling in London. As you zoom into the map you will see which areas are currently experiencing higher pollution levels than others, usually those areas close to busy roads. More information about the Air Pollution Index and health advice associated with

London Air

FORECAST: TODAY LOW TOMORROW MODERATE TO HIGH

Air Pollution - Information - Monitoring - Tools - Quick Links (Public)

Air Pollution @ 09:00

London Air

pollution levels below readings for air and air pollution

You are on this page: Home > Air Pollution Guide

Pollutants London Health effects Health advice Actions Reduce exposure

air pollution episodes How bad is London? health effects increased risk effects London history Monitoring Why monitor? Wood burning Wood gas effects

Carbon monoxide Nitrogen dioxide Ozone Sulphur dioxide

LAQY London history Monitoring Why monitor? Wood burning Wood gas effects

Health effects increased risk effects London history Monitoring Why monitor? Wood burning Wood gas effects

Health advice Air quality bands Monitoring What can I do? On my walk or run Exercise Go for 30 seconds

Actions can't monitor? Climate change action Government action Information What can I do? Exercise Go for 30 seconds

Reduce exposure From breathe bands At home Address an COPD On my walk or run Sensor Cities At school Cycling My

11 June 2017

\*pollution watch series for the

News: Creating Liveable Cities for the Future

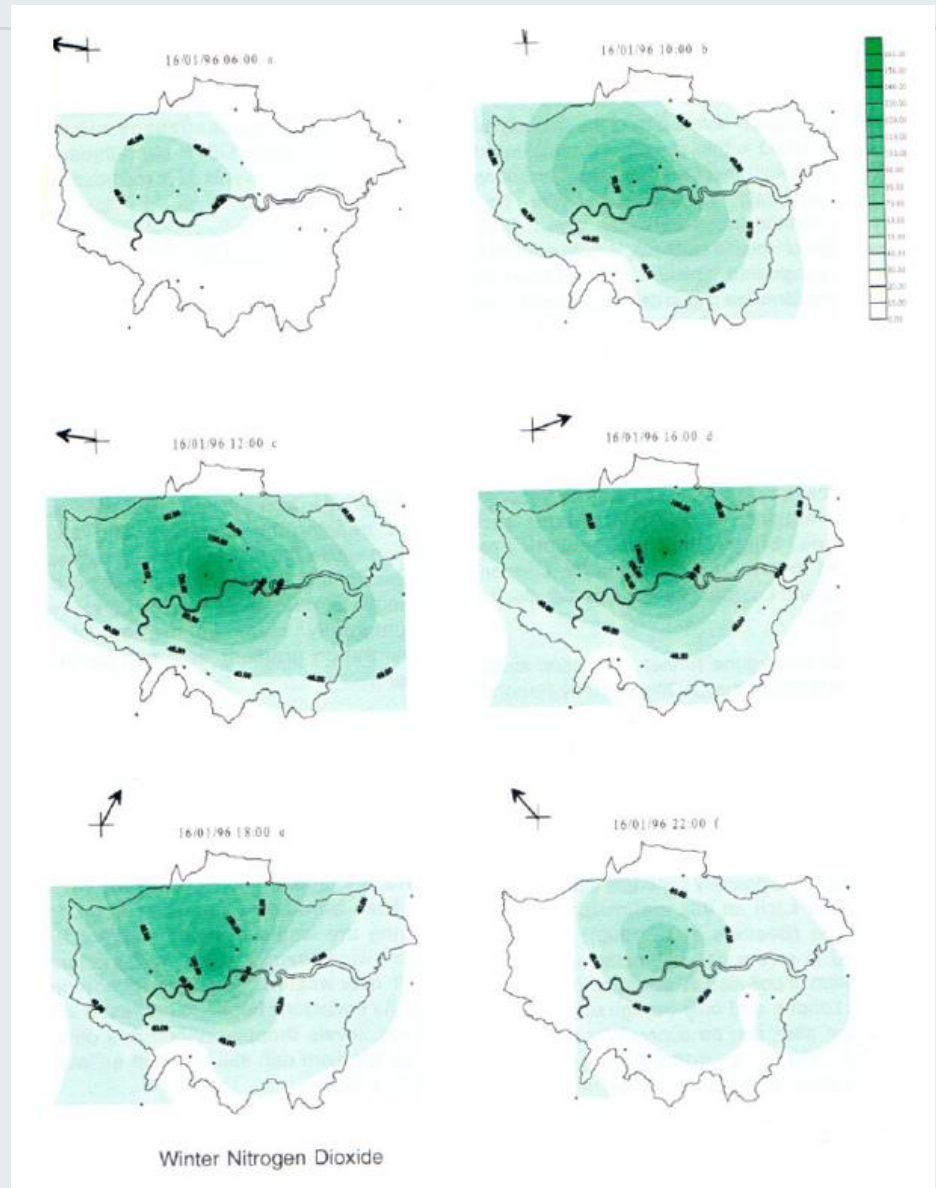
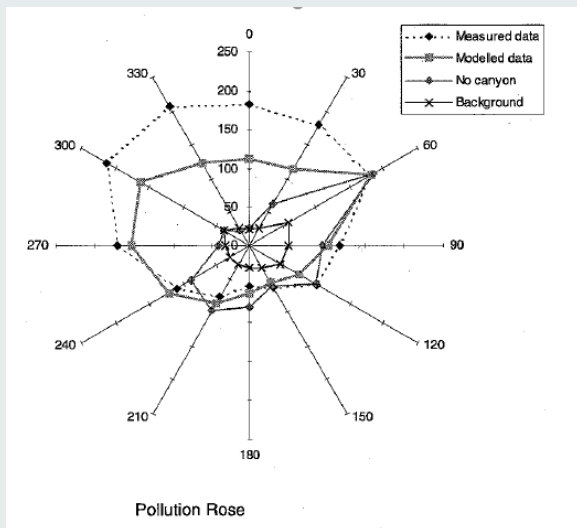
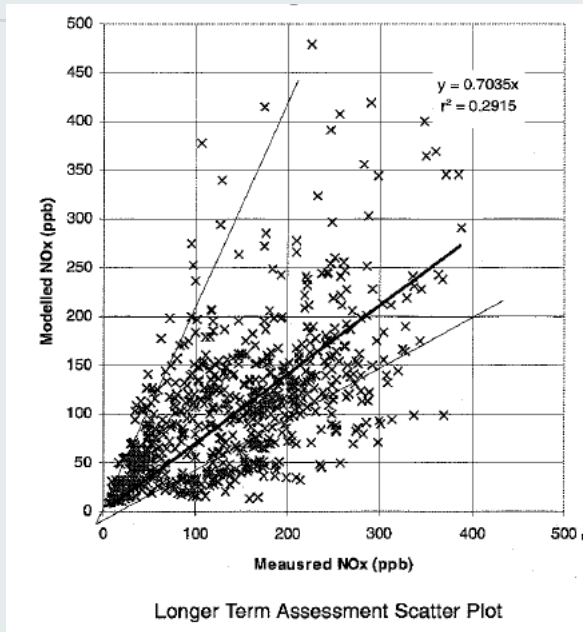
This year's Danish Embassy's programme for The Liveable City event features seven seminars on how we can create sustainable, healthy and thriving communities. Dr Gary Fuller from King's will be ...

News: The London Air Quality Network Conference 2017

London Air Quality Network Conference 6th July, King's College London

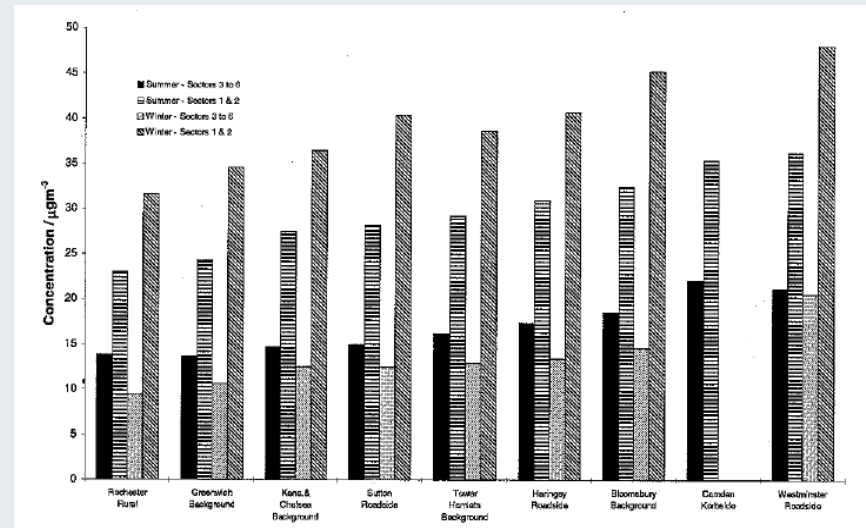
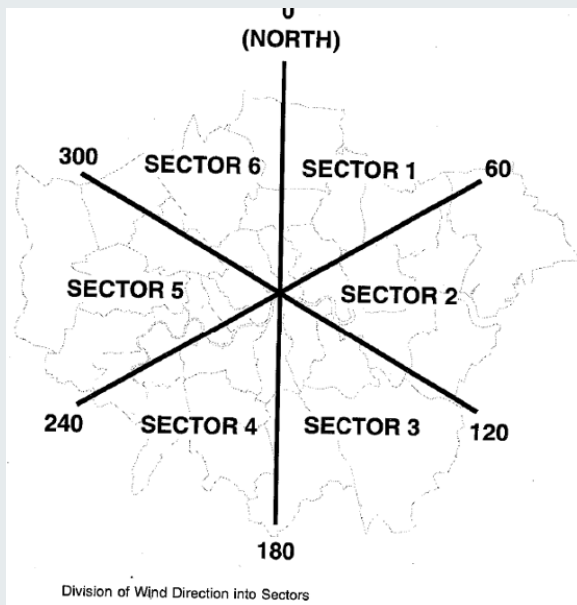
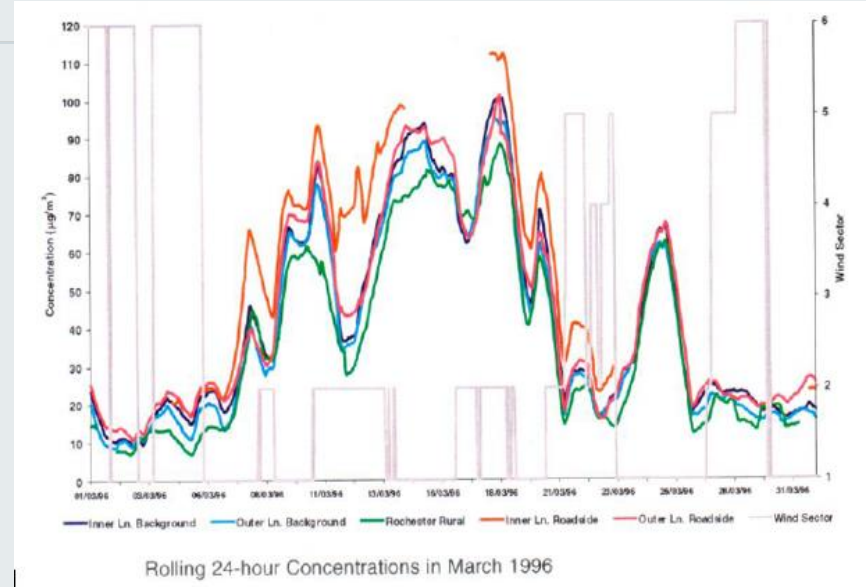
- First web page
- Previous day
- Upgraded to hourly
- Data plotting analysis tools in 2000
- Continual investment for improved info for Londoners

# NO2 modelling



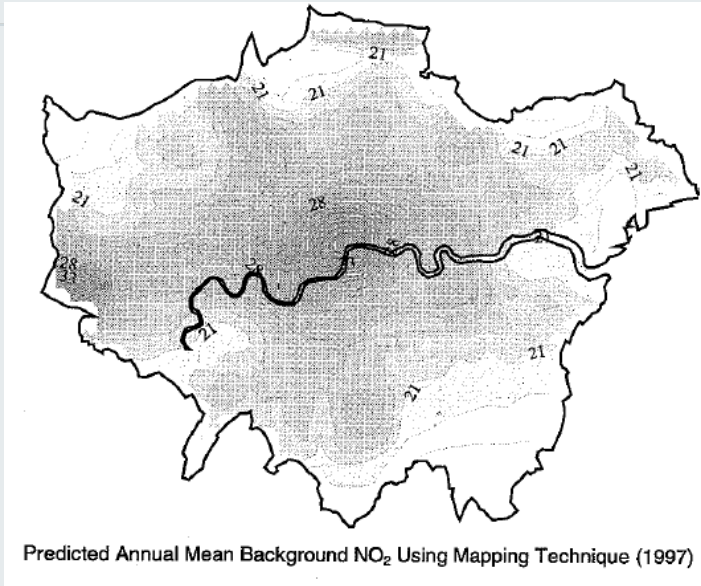
# Analysis of 1996 PM<sub>10</sub> episode

- March PM<sub>10</sub> episode – worst of modern times
- Investigation of wind sectors
- Evidence of transboundary PM<sub>10</sub> from East
- Look at wider area for monitoring and management

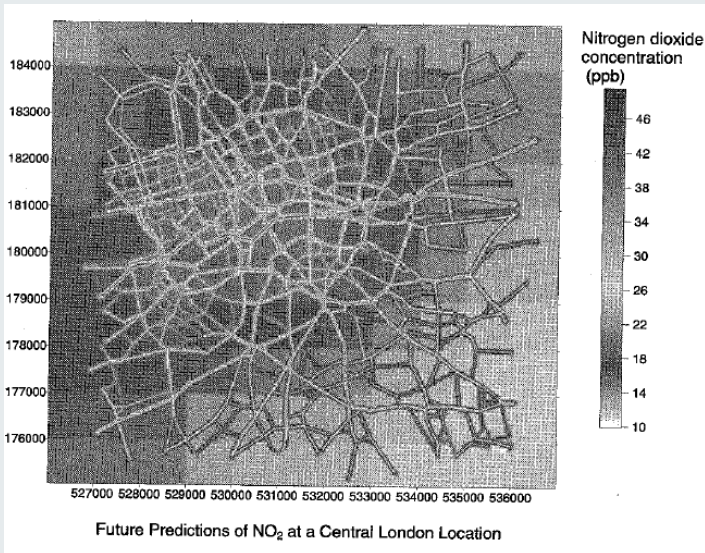


Notes: a: 'Summer' is 1/4/96 to 31/9.96, 'Winter' is 1/1/96 to 31/3/96 and 1/10/96 to 31/12/96  
 b: 'Sectors 1 & 2' is data gathered while prevailing wind is between 0 & 120 degrees from North  
 c: 'Sectors 3 to 6' is data gathered while prevailing wind is between 120 & 360 degrees from North

# 1997 Advances in Modelling



- Density of monitoring providing validation
- First background modelled maps (including Heathrow)
- First maps of roadside concentrations
- Overtook today's national model!



# Models got better...

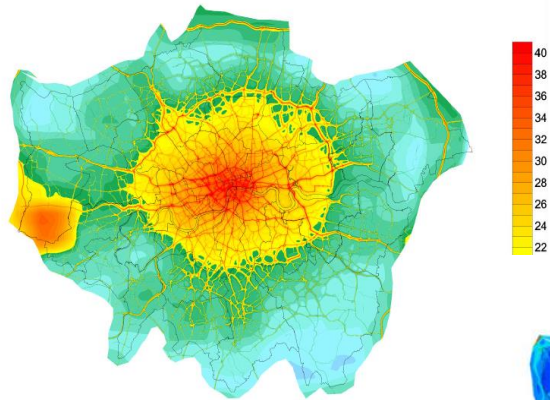
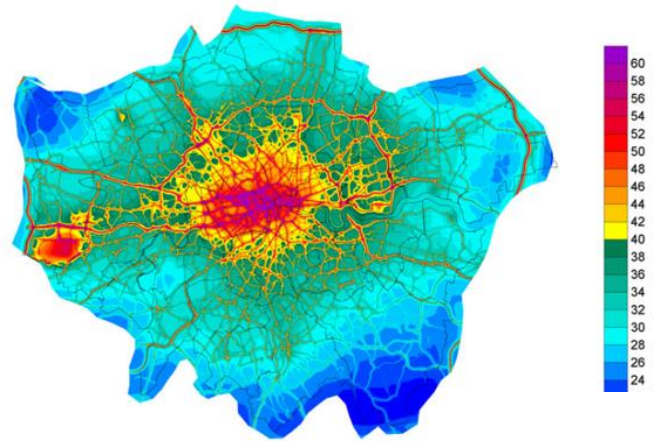
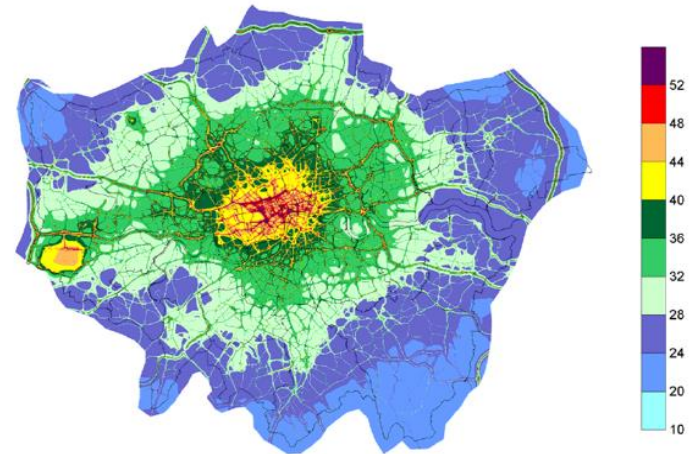


Figure 5 Predicted Annual Mean Background NO<sub>2</sub> Concentrations (ppb) (2000)



Provisional Annual Mean NO<sub>2</sub> Concentrations 2001 (μg m<sup>-3</sup>).



Provisional Annual Mean NO<sub>2</sub> Concentrations 2002 (μg m<sup>-3</sup>).

# 1997 - Marylebone Road



Image: GettyImages

- Installed wide range of equipment
- Variety of techniques
- Established early that research needed for equivalence of different methods for monitoring the same pollutant

## Monitoring Methods

Species	Method
PM10 (continuous)	Tapered Element Oscillating Microbalance (TEOM)
PM10 (non-continuous)	High or low volume with approved PM10 sampling head
Black Smoke (non-continuous)	British smoke stain method
NO <sub>x</sub>	Ozone chemiluminescence
NO <sub>2</sub> (non-continuous)	Passive diffusion tubes exposed in triplicate
CO	Infra-red absorption
SO <sub>2</sub>	UV fluorescence
SO <sub>2</sub> (non-continuous)	Bubbler method
O <sub>3</sub>	UV absorption
27 Hydrocarbons	Automatic gas chromatography
Benzene (non-continuous)	Passive diffusion tubes exposed in triplicate
Poly Aromatic Hydrocarbons	Filter method
Lead	Filter method



# National air quality Strategy - 1997

- Local air quality management
- Duty for local authorities to periodically review air quality in their local area and designate air quality management areas, with action plans.



# Move to London 1999

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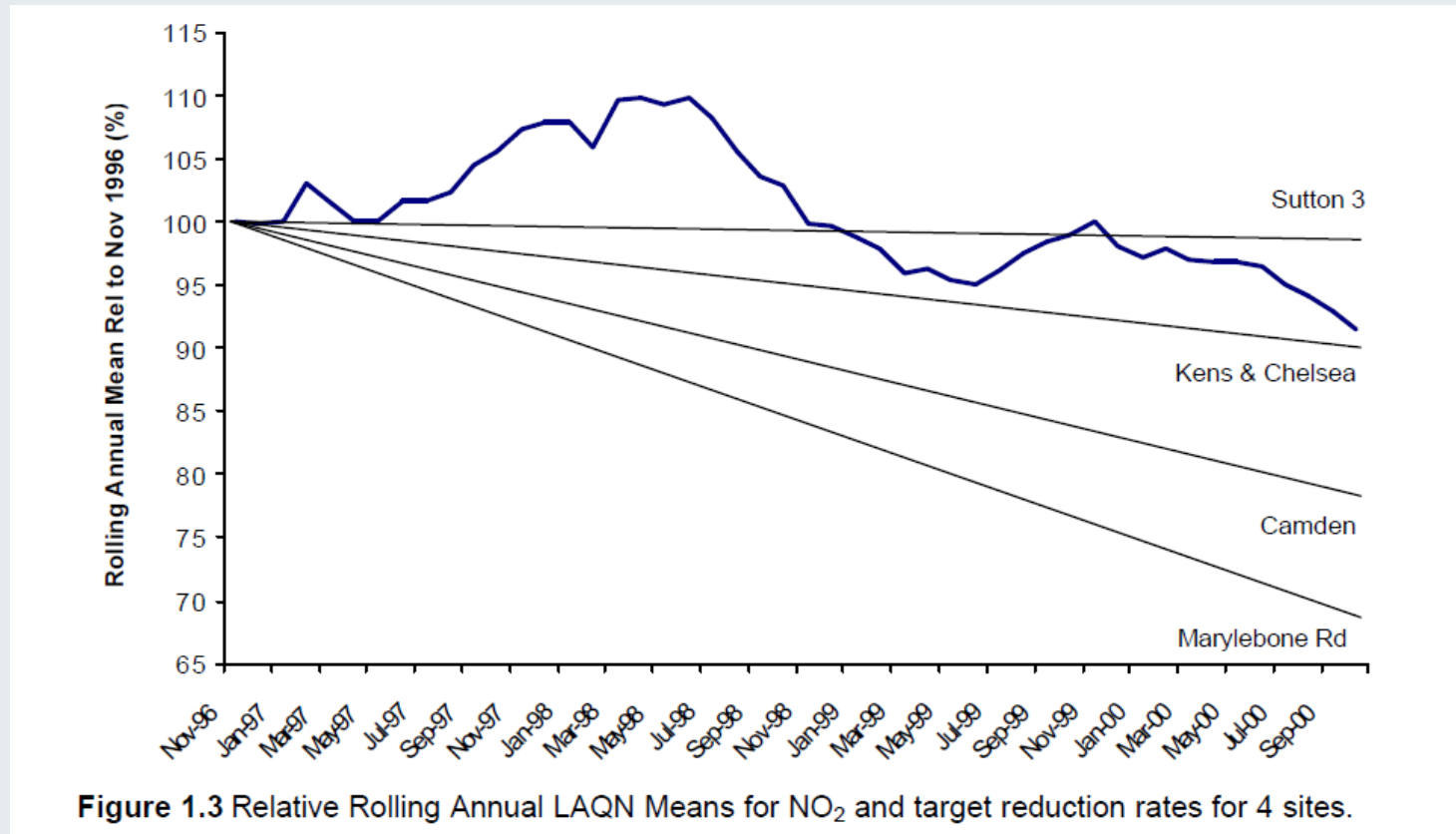


- ERG at SEIPH joined the School of Health and Life Sciences at King's College London
- Relocated to St.Thomas' Campus

- Closer to King's researchers
- Broader range of joint projects



# NO<sub>2</sub> trajectories 1999



- The first NO<sub>2</sub> alarm bells.
- NO<sub>2</sub> levels not reducing fast enough to meet the 2005 objectives

# Greater London Authority

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- Set up in 2000
- Mayor's air quality strategy published in 2002
- Measures to improve London's air quality
- LAQN set to evaluate how effective



# 2003 Pollution Trends – more alarm bells!

- NO<sub>2</sub>, O<sub>3</sub> and PM<sub>10</sub> increasing!
- Heatwave: O<sub>3</sub> highest measured in ten years of LAQN
- PM<sub>10</sub> deteriorated to 1998 levels

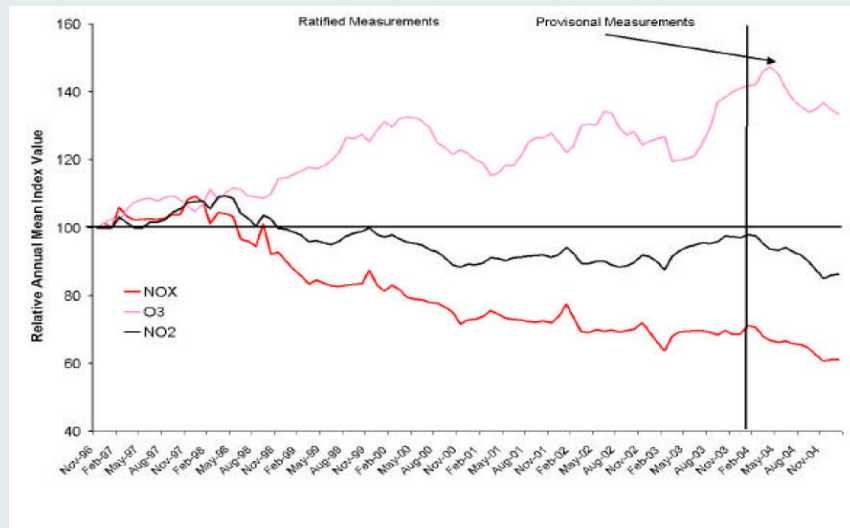


Figure 8 Relative Annual Mean Concentration of O<sub>3</sub>, NO<sub>x</sub> and NO<sub>2</sub>

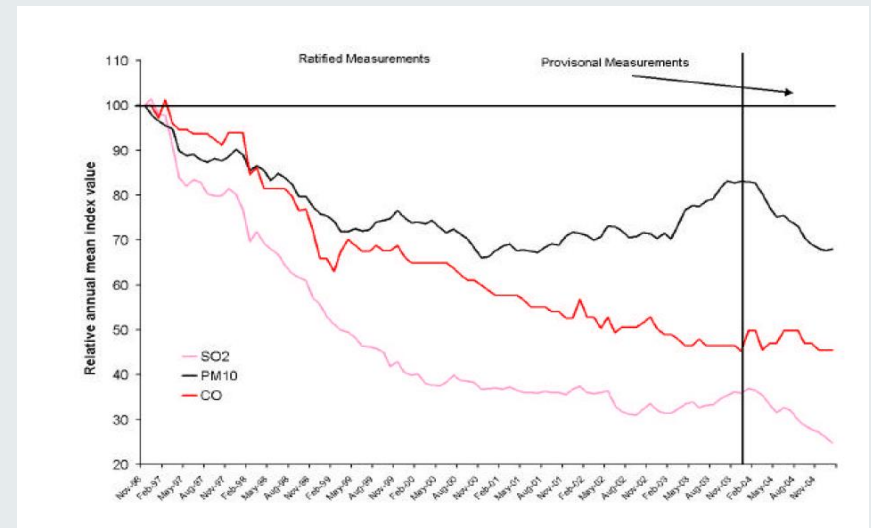


Figure 9 Relative Annual Mean Concentrations of CO, PM<sub>10</sub> and SO<sub>2</sub>

# 2003 secondary PM<sub>10</sub>

- First source apportionment – some episodes entirely from the outside, others amenable to control of London sources

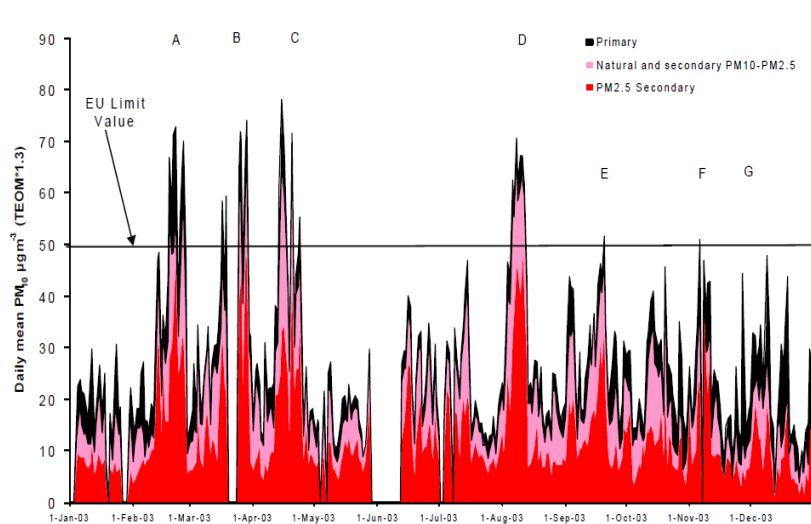


Figure 5 Source apportioned daily mean PM<sub>10</sub> at the inner London background site Kensington & Chelsea 1

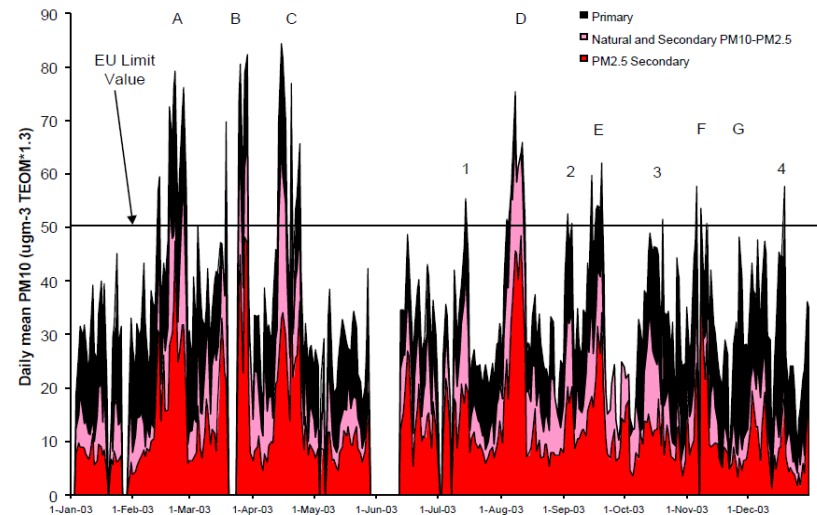


Figure 6 Source apportioned daily mean PM<sub>10</sub> at the inner London roadside site Kensington & Chelsea 2

# 2004

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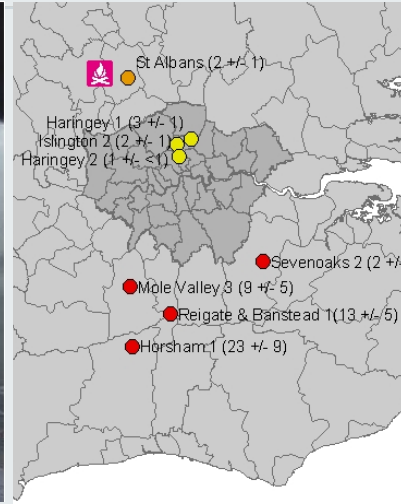
- NO<sub>2</sub> problems still
- Unexpected rise in primary NO<sub>2</sub>
- New PM<sub>10</sub> technology, Filter Dynamics measuring system (FDMS)
- Volatile PM<sub>10</sub> quantified
- Improved source apportionment
- KCL volatile correction model to allow old TEOM meet EU equivalence without costly replacement



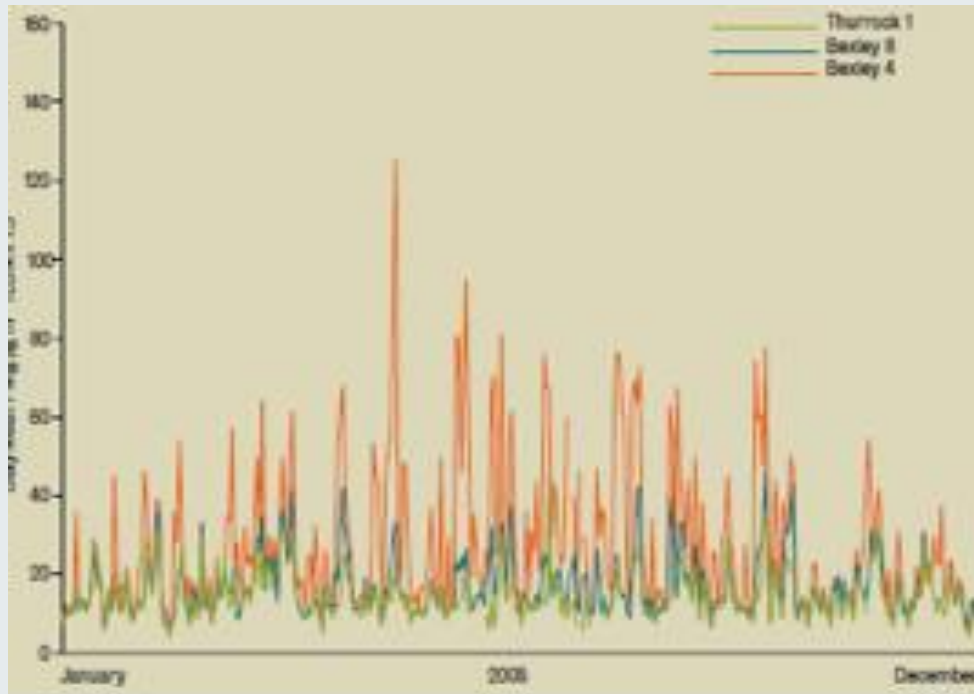
# 2005



Image: Chiltern Air Support Unit



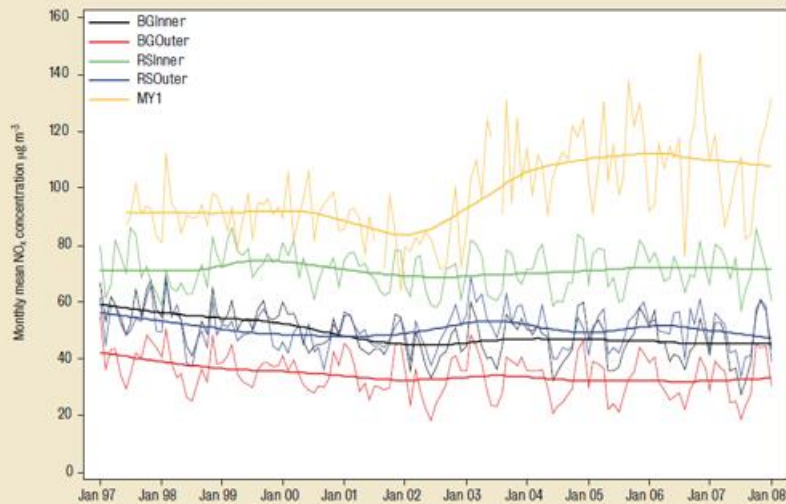
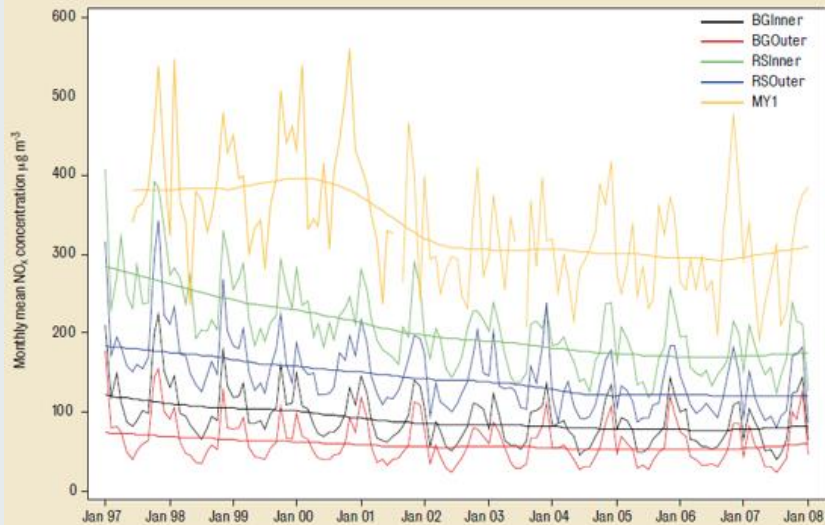
- Major explosion at Buncefield depot
- Closer links with Health Protection Agency (now PHE)
- Impact assessed at King's using  $PM_{10}$  source apportionment
- Continued collaboration around major fires and incidents



- Influence of industrial and waste transfer sites
- measure highest  $PM_{10}$



# 2006 more NO<sub>2</sub> warnings



- 2005 objective missed and poor progress towards 2010 limit value.
- Primary NO<sub>2</sub> still an issue
- NO<sub>2</sub> increase at Marylebone Road in 2003 and sustained
- NO<sub>x</sub> stable instead of downwards

# Research Projects

Atmospheric Environment 87 (2014) 87–94

Contents lists available at ScienceDirect

**Atmospheric Environment**

journal homepage: [www.elsevier.com/locate/atmosenv](http://www.elsevier.com/locate/atmosenv)

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**Contribution of wood burning to PM<sub>10</sub> in London<sup>☆</sup>**

Gary W. Fuller<sup>a,\*</sup>, Anja H. Tremper<sup>a</sup>, Timothy D. Baker<sup>a</sup>, Karl Espen Yttri<sup>b</sup>, David Butterfield<sup>c</sup>


<sup>a</sup>King's College London, MRC-PHE Centre for Environment and Health, 250 Stamford Street, London SE10 9NL, UK  
<sup>b</sup>Norwegian Institute for Air Research, Innturveien 18, P.O. Box 100, N-2007 Kjeller, Norway  
<sup>c</sup>National Physical Laboratory, Hampton Road, Sloughing, Middle TW7 0BZ, UK

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**HIGHLIGHTS**

- Aethalometer and levoglucosan methods used to estimate the contribution of wood smoke to PM<sub>10</sub> in London.
- Annual mean PM<sub>10</sub> from wood burning in London was 1.1 µg m<sup>-3</sup>.
- PM was most likely from a mixture of wood types burnt as decorative or secondary heating.

**GRAPHICAL ABSTRACT**



Journal of Exposure Science and Environmental Epidemiology (2016) 26, 125–132  
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[www.nature.com/jes](http://www.nature.com/jes)

- Development of VCM
- Contribution of wood burning to PM<sub>10</sub>
- Vehicle emission remote sensing (not large changes)

**ORIGINAL ARTICLE**

**Short-term exposure to traffic-related air pollution and daily mortality in London, UK**

Richard W. Atkinson<sup>1</sup>, Antonis Analtzi<sup>2</sup>, Evangelia Samoli<sup>2</sup>, Gary W. Fuller<sup>3</sup>, David C. Green<sup>3</sup>, Ian S. Mudway<sup>3</sup>, Hugh R. Anderson<sup>1,3</sup> and Frank J. Kelly<sup>3</sup>

<sup>1</sup>King's College London, Environmental Research Group, Franklin Wilkins Building, 250 Stamford Street, London SE1 9NL, UK  
<sup>2</sup>Department of Environmental Health, Faculty of Health Sciences, University of Ioannina, Ioannina, Greece  
<sup>3</sup>Imperial College London, School of Civil and Environmental Engineering, North Building, South Kensington, London SW7 2BX, UK

Atmospheric Environment 81 (2013) 339–347

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**Atmospheric Environment**

journal homepage: [www.elsevier.com/locate/atmosenv](http://www.elsevier.com/locate/atmosenv)

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**New insights from comprehensive on-road measurements of NO<sub>2</sub>, NO<sub>x</sub> and NH<sub>3</sub> from vehicle emission remote sensing in London, UK<sup>☆</sup>**

David C. Carslaw<sup>a,\*</sup>, Glyn Rhys-Tyler<sup>b,1</sup>

<sup>a</sup>King's College London, Environmental Research Group, Franklin Wilkins Building, 250 Stamford Street, London SE1 9NL, UK  
<sup>b</sup>Imperial College London, School of Civil and Environmental Engineering, North Building, South Kensington, London SW7 2BX, UK

- Impact of Congestion charging

Atmospheric Environment 87 (2014) 87–94

Contents lists available at ScienceDirect

**Atmospheric Environment**

journal homepage: [www.elsevier.com/locate/atmosenv](http://www.elsevier.com/locate/atmosenv)

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**Development and validation of the volatile correction model for PM<sub>10</sub> – An empirical method for adjusting TEOM measurements for their loss of volatile particulate matter**

David C. Green<sup>a</sup>, Gary W. Fuller<sup>a</sup>

<sup>a</sup>King's College London, Environmental Research Group, Franklin Wilkins Building, 250 Stamford Street, London SE1 9NL, UK

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**RESEARCH REPORT**

**The Impact of the Congestion Charging Scheme on Air Quality in London**

Part 1. Emissions Modeling and Analysis of Air Pollution Measurements  
 Part 2. Analysis of the Oxidative Potential of Particulate Matter (To Be Released in May 2011)

Frank Kelly, H. Ross Anderson, Ben Armstrong, Richard Atkinson, Ben Barratt, Sean Beavers, Dick Derwent, David Green, Ian Mudway, and Paul Wilkinson

Number 155  
April 2011

**RESEARCH REPORT**

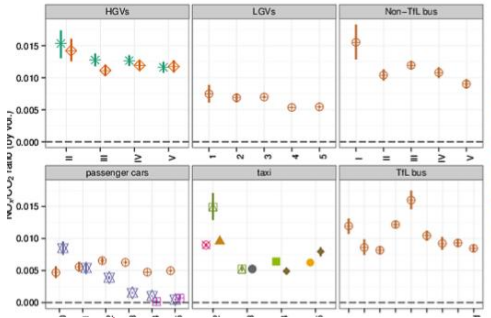
**The London Low Emission Zone Baseline Study**

Frank Kelly, Ben Armstrong, Richard Atkinson, H. Ross Anderson, Ben Barratt, Sean Beavers, Derek Cook, Dave Green, Dick Derwent, Ian Mudway, and Paul Wilkinson

Number 163  
November 2011

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**Figure: NO<sub>2</sub>/NO<sub>x</sub> ratio (µg vol<sup>-1</sup>) by vehicle type and Euro class.**



Key:

- >121
- 3.5–121
- Diesel
- Petrol
- Petrol\_Hybrid
- Taxi\_FX
- Taxi\_Met
- Taxi\_MV11
- Taxi\_MV13
- Taxi\_TX1
- Taxi\_TX4
- Taxi\_TXII

According to Euro classification,

# Formation of MRC-PHE Centre

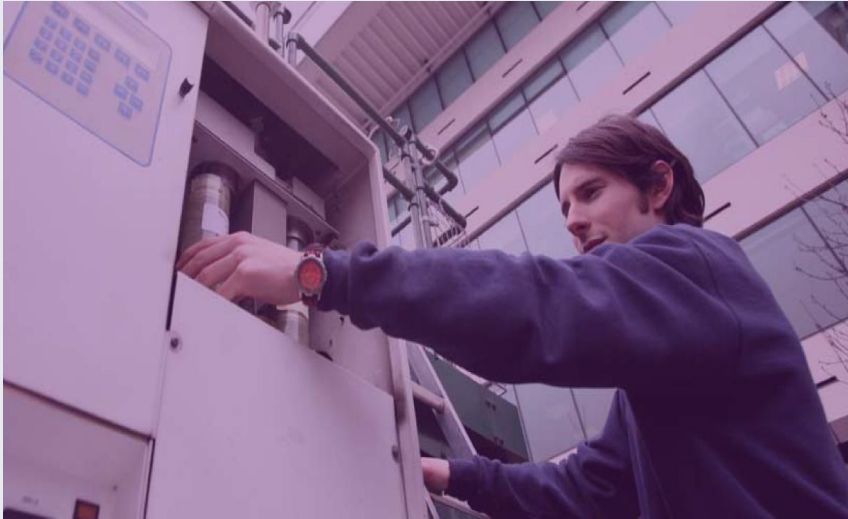
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- Formed in 2009
- Medical Research Centre, Public Health England for Environment and Health
- Interdisciplinary links between environment and health researchers
- Research studies to understand air quality and its impacts in London
- Projects have included evaluations on the low emission zone, ultra low emission zone, Clearflo, Traffic and Air Pollution in London (“Traffic”)



# London Air Quality Network today

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- Network and research
- Policy and awareness
- Working together with public health
- Driving forward with health research



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