1. Introduction

This is the third report to DEFRA and indicates the progress made to date, covering the period April to June 2002. It provides summary statistics and data capture rates. Where significant amounts of data are missing the reasons for these are given together with details of any remedial action taken.

In addition, the report includes a brief comparison of SMPS and CPC data collected at London Bloomsbury, where the instruments have been co-located

2. Sampling Locations and Details

Instruments are located at 11 established sites, ten of which form part of DEFRA's Automatic Urban and Rural Monitoring Network either directly or through affiliation, and one (Harwell Organic) which is part of the Automatic Hydrocarbon Monitoring Network. The sites are:

- Belfast Centre (Urban Centre, O.S Grid ref J339744)
- Birmingham Centre (Urban Centre, O.S Grid ref SP064868)
- Glasgow Centre (Urban Centre, O.S Grid ref NS589650)
- Harwell Inorganic (Rural, O.S Grid ref SU474863)
- Harwell Organic (Rural, O.S Grid ref SU 474863)
- London Bloomsbury (Urban Centre, O.S Grid ref TQ302820)
- London Kensington (Urban Centre, O.S Grid ref TQ240817)
- London Marylebone Rd (Urban Kerbside, O.S Grid ref TQ281820)
- Manchester Piccadilly (Urban Centre, O.S Grid ref SJ843983)
- Port Talbot (Urban Centre, O.S Grid ref SS780882)
- Rochester (rural, O.S Grid ref TQ831762)

Table 1 details the location of the monitoring equipment.

Table 1 Location of monitoring equipment

Site	$PM_{2.5}$ Partisol	$PM_{2.5}$ TEOM	PM_{10} Partisol	PM_{10} TEOM	PM_{10} Sulphate	PM_{10} Carbon	$PM_{2.5}$ Nitrate	SMPS	CPC	Met Sensor
Belfast Centre	*			*	√	√	√		√	
Birmingham Centre	*			*					√	
Glasgow Centre	*		*	*					√	
Harwell (Inorganic)		√		√				√		√
Harwell (organic)					√	√	√			
London Bloomsbury		√		*				√	√	
London Kensington	*			*	√	√			√	
London Marylebone Rd		√		*	√	√		√		
Manchester Piccadilly	*		*	*					√	
Port Talbot	*			*					√	
Rochester		√		*						√ (1)

* Monitoring equipment operating under AURN contract

(1) Local authority owned equipment

3. Data Capture

3.1 *TEOM*

Data capture statistics for PM_{10} and $PM_{2.5}$ mass concentrations are presented in Table 2 for each of the monitoring sites.

Table 2 Monthly particle mass data capture (%)
April - June 2002

	PM_{10}				$PM_{2.5}$			
	LM(1)	LB(2)	RO(2)	HAR	LM	LB	RO	HAR
April	98	92	93	99	86	98	93	98
May	99	93	99	96	100	96	99	95
June	99	93	99	100	90	95	100	100
Quarterly	99	93	97	98	92	96	97	98
Running (Oct 01 – Mar 02)	89	96	98	99	97	97	97	99

(1) PM_{10} data from Marylebone Rd is available as part of the London Network, which is operated by SEIPH. Casella Stanger do not report these data directly.

(2) London Bloomsbury PM_{10}, Rochester PM_{10} and Harwell PM_{10} are operated under DEFRA's AURN contract.

Data capture from the TEOM instruments was high, with the only significant losses occurring due to a pump seizure at Marylebone Rd ($PM_{2.5}$).

3.2 *SMPS*

Table 3 SMPS particle count data capture (%) at London Bloomsbury, Marylebone Rd and Harwell, January - March 2002

	Bloomsbury	Marylebone Rd	Harwell
April	65	51	100(1)
May	49	100	-
Jun	24	100	-
Quarterly	46	84	100[1]
Running (Oct 01 – Jun 02)	35	67	83

(1) Capture rates at Harwell based on available data

Due a serious hardware failure on the PC at Harwell, there is currently no data available after the download on the 10th April. The Hard disk on the computer has been replaced and a data recovery company contacted to retrieve the SMPS data from the faulty disk. This data recovery could not be conducted within the time scale of this report.

Data for Bloomsbury has been removed between the 10th of May to the 17th of May due to the CPC inlet flow being unstable due to moisture contaminating the internal pump. The unit was removed for repair by BIRAL and returned on the 17th. The same fault occurred again, resulting in the loss of data between the 7th and 25th of June. Further data has been removed after the repaired CPC was reinstated due to anomalously high readings. This is currently under investigation.

Some data from Marylebone Rd was lost between the 8th and 12th when the fault with the TEOM pump described in Section 3.1 caused the electricity supply to trip out. A further period of data was lost at the end of April when the controlling computer crashed.

3.3 *CPC*

Table 4 CPC particle count data capture (%) at the seven monitoring sites, January - March 2002

	CPC						
	LB	**Belf**	**Man Pic**	**Birm**	**Port Talbot**	**Glasgow**	**N Kens**
April	71	97	100	75[(1)]	100	-	100
May	97	100	100	15	100	100[(1)]	100
Jun	100	100	98	93	98	100	92
Quarterly	89	99	99	58[(1)]	99	100[(1)]	97
Running (Oct 01 – Jun 02)	86	96	98	84[(1)]	88	61[(1)]	95

(1) Data capture excludes servicing down time at Birmingham and Glasgow

The April data capture at London Bloomsbury was reduced by the fact that the instrument was not moved from it's previous location until the 9th. It has operated very well since this time.

Birmingham lost a large amount of data due to routine servicing. Following the service the controlling PC failed and data was lost until a suitable replacement could be found.

Glasgow was also serviced during the quarter and a large period of data is subsequently missing. Data capture figures have been adjusted to take this into account.

3.4 *Sulphate Partisol*

Table 5 Particulate sulphate data capture (%)

January - March 2002

	Data capture	Total days sampling
North Kensington	84	77
Marlyebone Road	100	92
Belfast	96	88
Harwell	100	92

Data Capture was generally good for the Sulphate particulate monitoring during the report period.

3.5 Carbon Particulate Monitor

After the initial installation of the Ambient Carbon Particulate Monitors there were considerable problems preventing reliable and continuous operation due to a fault identified within the sampling mechanism. This was referred back to the manufacturers (Rupprecht and Patashnick) by the UK supplier (EMC Environmental Engineering Ltd), and the sampling and collection system had to be redesigned. New parts were fabricated by R&P and all units removed from site and returned to EMC's workshop to be modified. The units were re-installed during November and December 2001.

There were a succession of further problems with the sample pinch valves and sensor switches on the Harwell and North Kensington instruments, delaying the start of monitoring, and there was ingress of water in the Marylebone Road unit which required a complete strip down and service. It was not clear how this water got into the instrument, although it has not recurred since.

The Carbon Particulate monitoring start dates for each site were:

Belfast Centre: 21 November 2001
Harwell: 14 February 2002
London Marylebone Road: 13 March 2002
London North Kensington: 13 March 2002

and data capture statistics have been prepared from these dates.

Table 6 Carbon particulate data capture (%)
January – March 2002

Site	January	February	March	Average (1)
Belfast Centre	100	62	99	87
Harwell	-	88 (1)	88	88
London Marylebone Road	-	-	75 (1)	75
London North Kensington	-	-	100 (1)	100

(1) calculated from monitoring start date

Table 7 Carbon particulate data capture (%)
April – June 2002

Site	April	May	June	Average
Belfast Centre	98	100	100	99
Harwell	64	100	94	86
London Marylebone Road	0	78	100	59
London North Kensington	100	100	100	100

During April the sample pinch valve sensor switches on the Harwell unit became misaligned, resulting in the loss of ten days data. Problems with the pinch valve mechanisms on the Marylebone Road unit resulted in the loss of data from 27 March to 7 May, the delay being caused by the need to ship spares directly from R&P. It is understood that EMC now keep a stock of spare parts for these instruments at their service centre, so such delays should be avoided in the future.

Since repairs and adjustments have been made to the pinch valve mechanisms data capture has been high, ranging from 94 – 100% across the sites.

Table 8 Carbon particulate rolling average data capture from start of monitoring to 30 June 2002

Site	Data capture (%)
Belfast Centre	93
Harwell	87
London Marylebone Road	67
London North Kensington	100

3.6 Nitrate Particulate Monitor

The continuous operation of the Nitrate monitor has been seriously compromised due to two major factors:

- an inherent weakness in the design of the flash strip and
- incompatibility between the communications software and the instrument.

3.6.1 Flash Strip

This is an exchangeable NiChrome strip that serves as the $PM_{2.5}$ impaction surface during sample collection, and undergoes resistive heating during the sample analysis whereby the particulate nitrate is flash volatilised before quantification using a chemiluminescence detector.

Although the flash time is short (50-90 ms), after a few days of operation the strip was fracturing either through arcing at the terminal posts or through the mechanical stresses present as the strip heated and cooled. This was exhaustively investigated

by EMC who concluded that the method of fixing the strip to the terminal posts was exacerbating the problem and, in consultation with R&P, special fixing washers were supplied. This modification was tested on the Harwell instrument during March 2002 but failure of the ambient temperature probe, essential for the correct regulation of sample flows, shut down the instrument. A replacement probe was obtained from R&P and testing resumed in April.

The results of these tests are very encouraging and the Harwell instrument has been operating continuously for almost two months on the same flash strip, which exceeds the typical operational lifetime suggested by the manufacturer.

3.6.2 Communications Software

The communications software (RPComm) supplied originally with the instruments would not interface with the Nitrate monitor and contained bugs which caused other R&P equipment, e.g. Partisols, to malfunction. After several software revisions we are still unable to retrieve Nitrate data and have referred this to EMC/R&P to resolve as a matter of urgency, giving them a deadline of 31 July by which to establish full communications with all instruments. Since the Harwell unit appears to be collecting valid data, and which is being stored in its internal data logger, it is most likely that this will be recoverable.

The operation of the Carbon and Nitrate Monitors has been problematic, but these are state-of-the-art technologies hitherto untried in remote continuous monitoring locations in the UK. As such some development work is inevitable in order to establish a reliable monitoring network, and it is anticipated that all instruments will be producing valid data during the forthcoming quarter.

4 Summary Data and Statistics

4.1 Particle Mass concentration

Table 9 Average particle mass concentration (μg m^{-3}), April - June 2002

	PM_{10}	$PM_{2.5}$	PM_{coarse}
Harwell	12.8	8.7	4.1
London Bloomsbury	26.6	13.1	13.5
Marylebone Road	33.7	22.3	11.4
Rochester	18.8	11.5	7.3

- PM_{coarse} is defined as $PM_{10} – PM_{2.5}$

Note that the coarse fraction has decreased slightly at London Bloomsbury whilst remaining fairly constant at Marylebone Rd. This reduction is likely to be due to the cessation of construction work undertaken close to the site in Russell Square Gardens last Quarter.

The greatest change can be seen in the two rural sites Harwell and Rochester, where coarse fractions have increased substantially.

No sulphate data have been presented in this report as this work is being conducted by the University of Birmingham and will be presented as soon as they are made available.

4.2 CPC vs SMPS measurements (London Bloomsbury)

The co-located CPC and SMPS instruments were moved from Marylebone Rd to London Bloomsbury at the start of the quarter to gather comparative data. Due to

the relatively low data capture during the monitoring period the CPC instrument has remained at London Bloomsbury and will be moved to Harwell in October. Available data show that the total particle counts differ by a factor of approximately 1- 2. The reasons for this lie in the size ranges of the instruments, the CPC and SMPS sampling between 7.5 – 1000nm and 11.5 – 450nm respectively.

The SMPS may also undergo particle losses in the classifier, which although corrected for in the software by in-built algorithms, may not account for all the losses observed.

Average particle counts for the quarter are shown in the following table.

Table 10 Avg Total Particle Numbers per Cubic Centimetre (Marylebone Rd)

	CPC	SMPS	Factor
April	20,774	11,815	1.8
May	18,030	7,802	2.3
June	11,502	11,384	1.1
Quarter	16,347	10,127	1.6

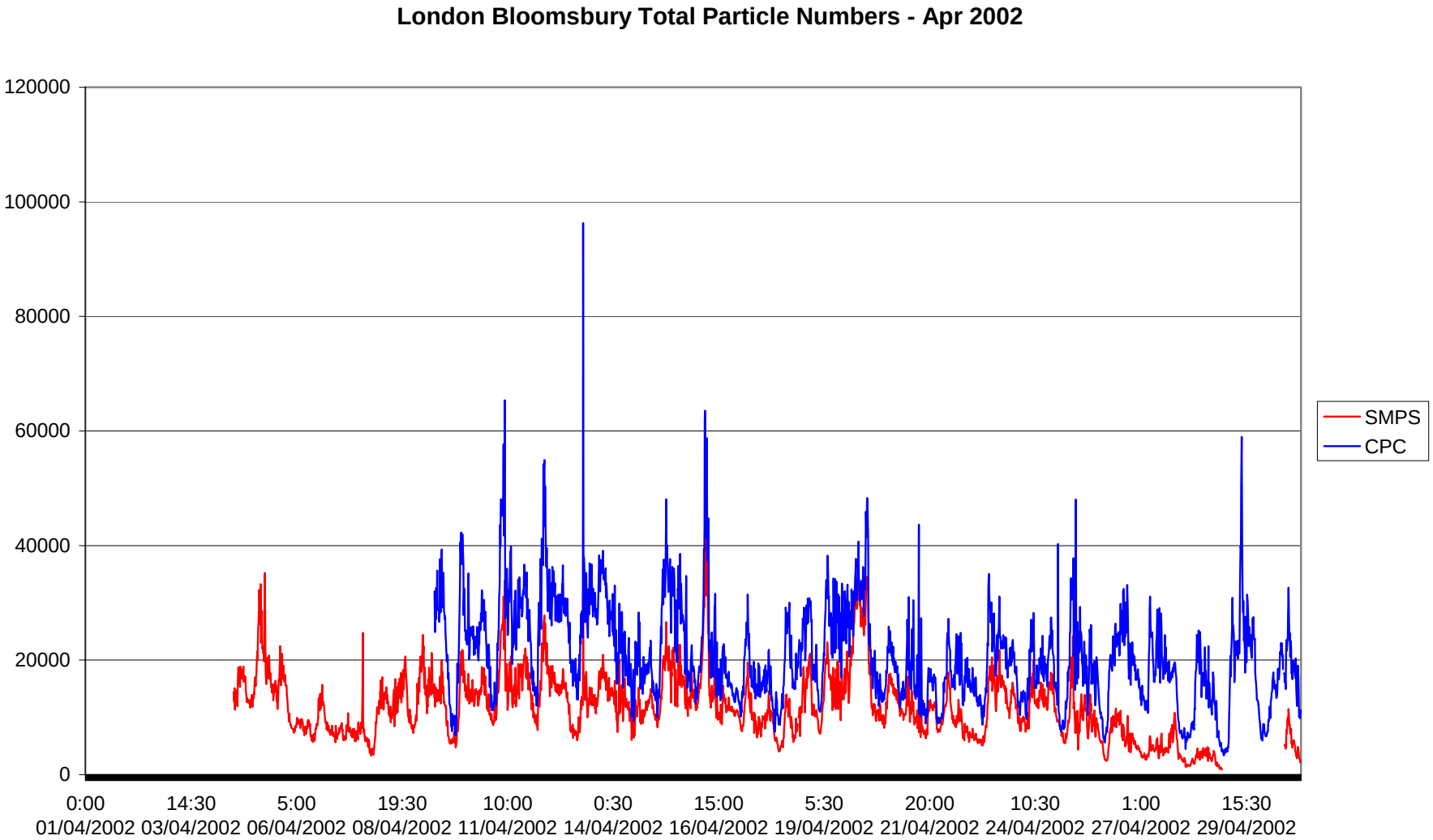
Data capture was very low for the SMPS instrument, particularly during May and June which makes it difficult to draw conclusions from the direct comparison above.

Graphs of CPC and SMPS data during April - June 2002 are located In APPENDIX 1, and clearly show that both instruments produce a very similar data trend. However, the figures in the table above show that the extent of the SMPS under-reading does not appear constant and varies from month to month.

There is insufficient data to comment on the effects of site location. This will be investigated in next quarter's report, when the data from the second co-location period at Bloomsbury is available.

APPENDIX 1

Plots of CPC and SMPS Total Particle Numbers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80000
60000
40000
20000
0
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14:30 03/04/2002
5:00 06/04/2002
19:30 08/04/2002
10:00 11/04/2002
0:30 14/04/2002
15:00 16/04/2002
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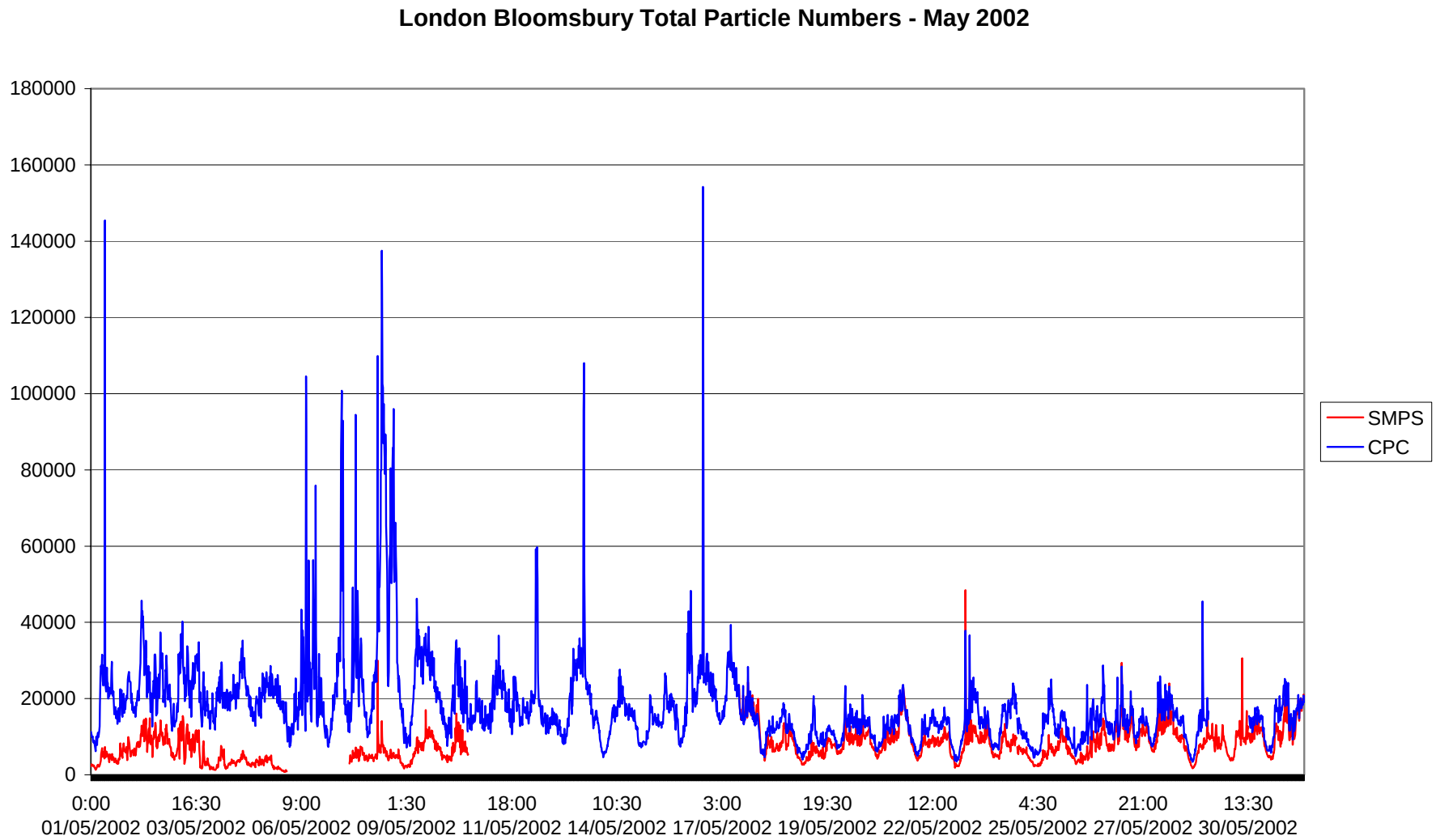
1:00 27/04/2002
15:30 29/04/2002
SMPS
CPC


London Bloomsbury Total Particle Numbers - May 2002
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140000
120000
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80000
60000
40000
20000
0
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03/05/2002
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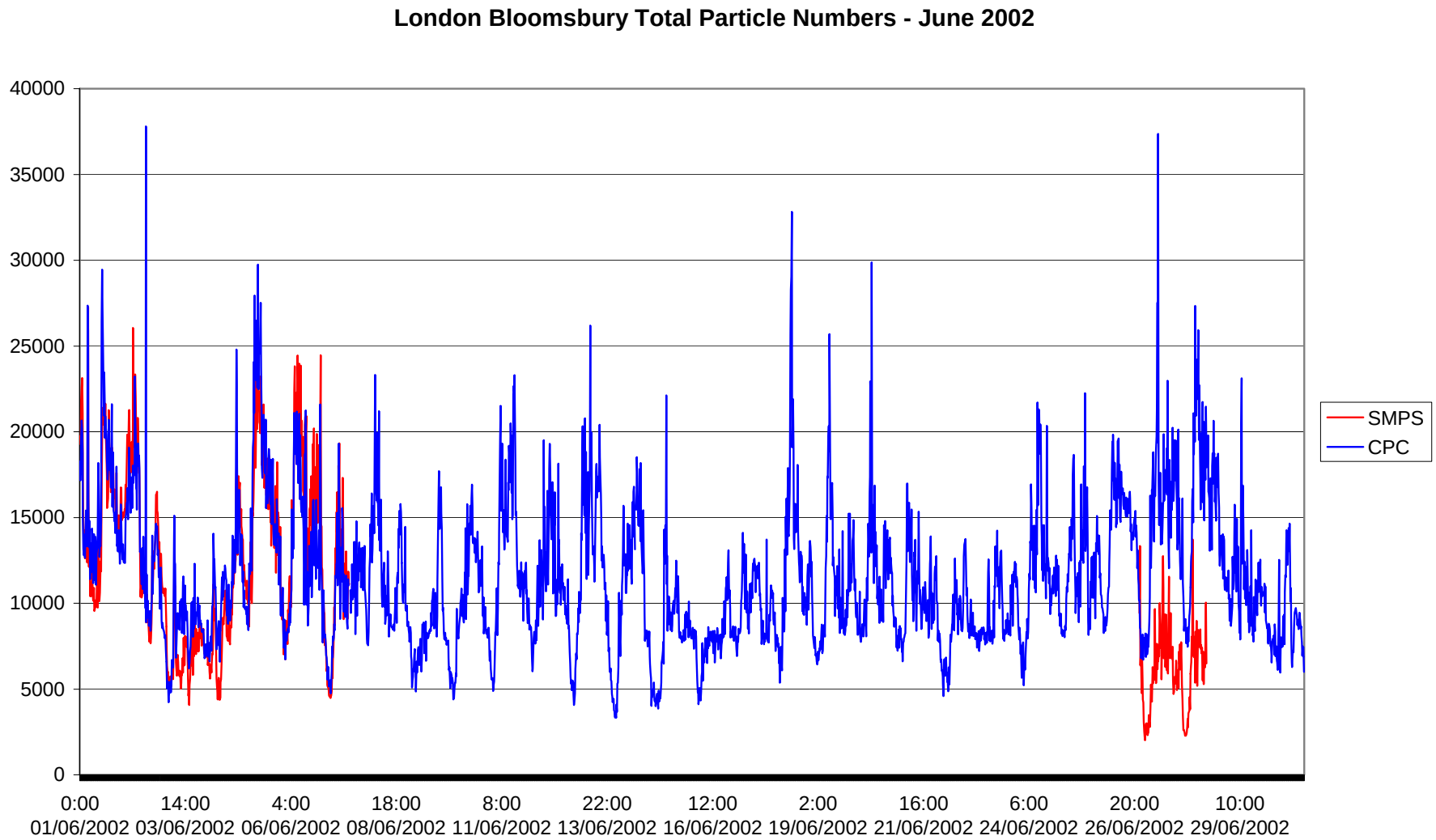
27/05/2002
13:30
30/05/2002
SMPS
CPC


London Bloomsbury Total Particle Numbers - June 2002
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35000
30000
25000
20000
15000
10000
5000
0
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18:00 08/06/2002
8:00 11/06/2002
22:00 13/06/2002
12:00 16/06/2002
2:00 19/06/2002
16:00 21/06/2002
6:00 24/06/2002
20:00 26/06/2002
10:00 29/06/2002
SMPS
CPC