

CSIRO MARINE & ATMOSPHERIC RESEARCH
www.csiro.au



Upper Hunter Valley Particle Characterization Study

1st Progress Report – Site Commissioning and Methodology

Mark F. Hibberd, Melita D. Keywood, and David D. Cohen (ANSTO)
30 March 2012

Prepared for
NSW Office of Environment and Heritage (Contact: Chris Eiser)
NSW Department of Health (Contact: Wayne Smith)

CSIRO Marine & Atmospheric Research

Citation

Hibberd MF, Keywood MD, and Cohen DD (2012). Upper Hunter Valley Particle Characterization Study; 1st Progress Report – Site Commissioning and Methodology. CSIRO, Australia.

Copyright and disclaimer

© 2012 CSIRO To the extent permitted by law, all rights are reserved and no part of this publication covered by copyright may be reproduced or copied in any form or by any means except with the written permission of CSIRO.

Important disclaimer

CSIRO advises that the information contained in this publication comprises general statements based on scientific research. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional, scientific and technical advice. To the extent permitted by law, CSIRO (including its employees and consultants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this publication (in part or in whole) and any information or material contained in it.

Contents

Acknowledgments	ii
1 Aim	1
2 Project description	1
3 Methodology	1
3.1 Measurement sites	1
3.2 Sampling equipment	3
3.3 Sampling strategy	5
3.4 Analysis	5
3.5 Deliverables	6
4 Commissioning	7
Appendix A Outline of project for community briefing by OEH and NSW Health	9

Acknowledgments

This is a CSIRO co-investment project funded by

NSW Office of Environment & Heritage

NSW Department of Health

CSIRO Climate & Atmosphere Theme

We acknowledge the assistance provided by OEH staff in organising, setting up and running the sampling equipment – Chris Eiser, Melinda Hale, Scott Thompson, Matt Flack and John Kirkwood.

We acknowledge the contributions of the ANSTO project team: Ed Stelcer, David Garton, Armand Atanacio, and Peter Drewer who assisted with the sampling program and the ANSTO accelerator staff involved in the IBA analyses.

We acknowledge the contributions of the CSIRO project team: Kate Boast, Paul Selleck, and Fabienne Reisen for the analyses.

1 Aim

The objective of the Upper Hunter Valley Particle Characterization Study is to determine the major components and sources of particulate matter (as PM_{2.5} – particles with a diameter of less than 2.5 micrometres) in the two main population centres in the Upper Hunter Valley, namely Singleton and Muswellbrook.

This 1st Progress Report outlines the design of the project, the methodology, and the commissioning phase.

2 Project description

This project will determine the major components and sources of PM_{2.5} in the two main population centres in the Upper Hunter. This will be achieved by collecting PM_{2.5} samples in Muswellbrook and Singleton. Because the sources of PM_{2.5} and their relative importances vary from season to season, samples will be collected over one full calendar year (January 2012 to December 2012). Two different types of samplers will be used to collect 24-hour samples every third day.

A range of analysis techniques will be employed to determine the concentrations in these samples of organic carbon, elemental carbon, soluble ions, and anhydrous sugars, as well as pH, elemental composition, and gravimetric mass.

The full chemical composition of all the samples from each site will be analysed using Positive Matrix Factorisation to determine the sources of PM at the sites and the contribution each source makes to the particulate loading. This analysis will enable the study to provide:

- a description of the contributors to fine particles in the Upper Hunter
- an estimate of which sources are important and their relative contribution to fine particles in the Upper Hunter
- an indication of any weekly and seasonal changes in PM_{2.5} particles in the Upper Hunter.

3 Methodology

3.1 Measurement sites

The sampling equipment is sited on the roof platforms of the OEH Upper Hunter Air Quality Monitoring Network (UHAQMN) sites in Singleton and Muswellbrook. Figure 1 shows the location of the Singleton site with respect to rest of the town, the surrounding agricultural land and the nearest mine sites. Figure 2 shows a photograph of the monitoring station with the view towards the north.

The equivalent information for the Muswellbrook site is given in Figure 3 and Figure 4, with latter showing the view towards the south-east.



Figure 1 Location maps for Singleton monitoring site (X) (Google Earth)



Figure 2 Singleton monitoring station, part of the UHAQMN



Figure 3 Location maps for Muswellbrook monitoring site (X)



Figure 4 Muswellbrook monitoring station, part of the UHAQMN

3.2 Sampling equipment

Two types of sampling equipment are being used in this study to be able to analyse for a wide range of constituents:

- Ecotech HiVol 3000 high volume samplers with a PM_{2.5} size selective inlet. These PM_{2.5} samples will be collected on quartz tissue filters and analysed by CSIRO.
- ANSTO ASP (Aerosol Sampling Program) PM_{2.5} particulate Cyclone samplers with 25mm stretched Teflon filters and pumps.

Both types of samplers have been installed at each site.

Note that different filters are required for the various analyses. The method for determining OC (organic carbon) and EC (elemental carbon) involves combusting the sample, hence a filter substrate that includes organic material (such as Teflon) is not appropriate because it will have very high blank concentrations.

Similarly the fibrous nature of the quartz filters means that their gravimetric mass is not stable, so that quartz filters cannot be used for the determination of gravimetric mass. The ultra thin stretched Teflon filters together with the low volume sampling are optimised for IBA techniques at ANSTO. Finally, quartz filters cannot be used for ion beam analysis (such as PIXE) because they are typically too thick and have high blank elemental concentrations.

Figure 5 shows the high volume sampler installed at Singleton, and Figure 6 shows the ANSTO ASP sampler installed at Muswellbrook.



Figure 5 The high volume sampler at Singleton with flow rate calibration being carried out



Figure 6 ANSTO ASP sampler with cover open for filter changing

3.3 Sampling strategy

Samples are being collected at the two sites on a 1-in-3 day cycle during calendar year 2012. Sampling runs from midnight to midnight with both instruments sampling at the same time.

Timing on the samplers is Eastern Standard Time for the full duration of the study, i.e. the clocks will not be adjusted to daylight savings time.

Field blanks will be included once every 30 days for the high volume sampler.

Calibration and maintenance of the high volume samplers will be undertaken every 3 months. Log sheets and diagnostic outputs from all samplers will flag any instruments problems (such as pump or timing errors), so that they can be addressed quickly during the study.

3.4 Analysis

These samples collected by the high volume sampler on quartz tissue filters will be analysed by CSIRO at CMAR Aspendale to determine the ambient concentrations:

- Gravimetric mass of PM2.5
- Organic carbon
- Elemental carbon
- The following soluble ions
- Chloride (Cl⁻)
- Nitrate (NO₃⁻)
- Sulphate (SO₄²⁻)
- Oxalate
- Formate
- Acetate
- Phosphate
- Methanesulfonate (MSA)
- Sodium (Na⁺)
- Ammonium (NH₄⁺)
- Magnesium (Mg²⁺)
- Calcium (Ca²⁺)
- Potassium (K⁺)
- The following anhydrous sugars:
- Levoglucosan (woodsmoke tracer)
- Mannosan (woodsmoke tracer)
- Aribitol (fungus tracer)
- Mannitol (fungus tracer)
- pH

The ANSTO ASP samples collected on 25mm stretched Teflon filters will be analysed to determine:

- Gravimetric mass
- Black carbon (using a laser integrated plate method)
- Elemental concentrations of the following 20 elements using three simultaneous ion beam analysis (IBA) techniques, namely PIXE, PIGE and PESA:
- Hydrogen (H)
- Sodium (Na)
- Aluminium (Al)
- Silicon (Si)

- Phosphorous (P)
- Sulfur (S)
- Chlorine (Cl)
- Potassium (K)
- Calcium (Ca)
- Titanium (Ti)
- Vanadium (V)
- Chromium (Cr)
- Manganese (Mn)
- Iron (Fe)
- Cobolt (Co)
- Nickel (Ni)
- Copper (Cu)
- Zinc (Zn)
- Bromine (Br)
- Lead (Pb)

The full chemical composition of the approximately 180 samples (including blanks) from each site will be analysed using Positive Matrix Factorisation to determine the sources of PM2.5 at the sites and the contribution each source makes to the particulate loading. The ultimate success of this technique depends critically on the number of sampling days the number of different chemical species analysed on each filter.

QC/QA procedures will include deployment and analysis of sample blanks, maintenance and calibration of the samplers, mass closure calculations, estimation of the uncertainty and detection limits for all results, and internal review. The CMAR Aspendale laboratory is NATA accredited for soluble ions, pH and mass measurements.

The high volume PM2.5 filters will be archived for possible future tests including toxicological studies. The ANSTO samples will be archived for possible future isotopic carbon analysis on selected days to distinguish between old carbon (fossil fuels) and new carbon (wood, biomass) sources.

3.5 Deliverables

Table 1 list the timetable for the delivery of the reports for this study.

Table 1 Report schedule

REPORT	DATE	
1st Progress report	Mar 2012	Site commissioning and methods
2nd Progress report	May 2012	Report on summer PM measurements and analysis
3rd Progress report	Dec 2012	Report on winter PM measurements and analysis
Draft final report	May 2013	Complete data analysis including interpretation of results from source apportionment
Final report	Jun 2013	Following review by OEH and DoH

4 Commissioning

The ANSTO ASP PM2.5 samplers were installed at the two sites by ANSTO staff on 12-13 December 2011 and preliminary sampling commenced on 14 December.

The Ecotech HliVol 3000 samplers were installed by OEH staff on 8 December 2011. They were calibrated by CSIRO on 19 December and test runs were undertaken over Christmas..

Sampling for the study commenced on 4 January 2012 with the sampling period being from 00:00 on 4 January until 00:00 on 5 January. The final samples will be collected on 29 December 2012.

OEH is providing technical assistance (field officer) to receive unexposed filters, change filters and send exposed filters to CSIRO and ANSTO. Training and work instructions were provided for the field officer (Melinda Hale) for both instruments in mid December.

Teleconferences between the study participants (OEH, DoH, ANSTO, CSIRO) were held on 22 December and 7 March to check on progress. The study is progressing well.

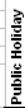





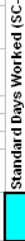
The exposed filters from the high volume sampler are shipped to CSIRO each month. CSIRO has received the January and February samples and has commenced analysis.

The ASP filters are posted to ANSTO after every second sampling period. All exposed filters (until 22 March) have been received by ANSTO. Analysis of the filters is being undertaken in batches as part of ANSTO's standard procedures for ASP filters from their existing network of sites.

Figure 7 lists the filter change schedule for the study.

UPPER HUNTER FINE PARTICLE CHARACTERISATION STUDY - FILTER CHANGE TIMETABLE 2012

DECEMBER '11		JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
THU	1	SUN	1	WED	1	THU	1	SUN	1	TUE	1	FRI	1	SUN	1	WED	1	SAT	1	MON	1	THU	1	SAT	1
FRI	2	MON	2	THU	2	FRI	2	MON	2	WED	2	SAT	2	MON	2	THU	2	SUN	2	TUE	2	FRI	2	SUN	2
SAT	3	TUE	3	FRI	3	SAT	3	TUE	3	THU	3	SUN	3	TUE	3	FRI	3	MON	3	WED	3	SAT	3	MON	3
SUN	4	WED	4	SAT	4	SUN	4	WED	4	FRI	4	MON	4	WED	4	SAT	4	TUE	4	THU	4	SUN	4	TUE	4
MON	5	THU	5	SUN	5	MON	5	THU	5	SAT	5	TUE	5	THU	5	SUN	5	WED	5	FRI	5	MON	5	WED	5
TUE	6	FRI	6	MON	6	TUE	6	FRI	6	SUN	6	WED	6	FRI	6	MON	6	THU	6	SAT	6	TUE	6	THU	6
WED	7	SAT	7	WED	7	THU	7	SAT	7	MON	7	THU	7	SAT	7	SUN	7	TUE	7	SUN	7	WED	7	FRI	7
THU	8	SUN	8	THU	8	FRI	8	SUN	8	TUE	8	FRI	8	SUN	8	WED	8	THU	8	MON	8	THU	8	SAT	8
FRI	9	MON	9	THU	9	SAT	9	MON	9	WED	9	SAT	9	MON	9	THU	9	SUN	9	TUE	9	FRI	9	SUN	9
SAT	10	TUE	10	FRI	10	SAT	10	TUE	10	THU	10	SUN	10	TUE	10	FRI	10	MON	10	WED	10	SAT	10	MON	10
SUN	11	WED	11	SAT	11	SUN	11	WED	11	FRI	11	MON	11	WED	11	SAT	11	TUE	11	THU	11	SUN	11	TUE	11
MON	12	THU	12	SUN	12	MON	12	THU	12	SAT	12	TUE	12	THU	12	SUN	12	WED	12	FRI	12	MON	12	WED	12
TUE	13	FRI	13	MON	13	TUE	13	FRI	13	SUN	13	WED	13	FRI	13	MON	13	THU	13	SAT	13	TUE	13	THU	13
WED	14	SAT	14	TUE	14	WED	14	MON	14	THU	14	MON	14	SAT	14	TUE	14	FRI	14	SUN	14	WED	14	FRI	14
THU	15	SUN	15	WED	15	THU	15	SUN	15	TUE	15	FRI	15	SAT	15	WED	15	SAT	15	MON	15	THU	15	SAT	15
FRI	16	MON	16	THU	16	FRI	16	MON	16	WED	16	SAT	16	MON	16	THU	16	SUN	16	TUE	16	FRI	16	SUN	16
SAT	17	TUE	17	SAT	17	SAT	17	TUE	17	THU	17	SUN	17	TUE	17	FRI	17	MON	17	WED	17	SAT	17	MON	17
SUN	18	WED	18	FRI	18	SUN	18	WED	18	FRI	18	MON	18	WED	18	SAT	18	TUE	18	THU	18	SUN	18	TUE	18
MON	19	THU	19	SUN	19	MON	19	THU	19	SAT	19	TUE	19	THU	19	SUN	19	WED	19	FRI	19	MON	19	WED	19
TUE	20	FRI	20	MON	20	TUE	20	FRI	20	SUN	20	WED	20	FRI	20	MON	20	THU	20	SAT	20	TUE	20	THU	20
WED	21	SAT	21	TUE	21	WED	21	SAT	21	MON	21	THU	21	THU	21	SAT	21	FRI	21	SUN	21	WED	21	FRI	21
THU	22	SUN	22	WED	22	THU	22	SUN	22	TUE	22	FRI	22	SUN	22	WED	22	SAT	22	MON	22	THU	22	SAT	22
FRI	23	MON	23	THU	23	FRI	23	MON	23	WED	23	SAT	23	MON	23	THU	23	SUN	23	TUE	23	FRI	23	SUN	23
SAT	24	TUE	24	FRI	24	SAT	24	TUE	24	THU	24	SUN	24	TUE	24	FRI	24	MON	24	WED	24	SAT	24	MON	24
SUN	25	WED	25	SAT	25	SUN	25	WED	25	FRI	25	MON	25	WED	25	SAT	25	TUE	25	THU	25	SUN	25	TUE	25
MON	26	THU	26	SUN	26	MON	26	THU	26	SAT	26	TUE	26	THU	26	SUN	26	WED	26	FRI	26	MON	26	WED	26
TUE	27	FRI	27	MON	27	TUE	27	FRI	27	SUN	27	WED	27	FRI	27	MON	27	THU	27	SAT	27	TUE	27	THU	27
WED	28	SAT	28	TUE	28	WED	28	SAT	28	MON	28	THU	28	SAT	28	TUE	28	FRI	28	SUN	28	WED	28	FRI	28
THU	29	SUN	29	WED	29	THU	29	SUN	29	TUE	29	FRI	29	SUN	29	WED	29	SAT	29	MON	29	THU	29	SAT	29
FRI	30	MON	30	THU	30	FRI	30	MON	30	WED	30	SAT	30	MON	30	THU	30	SUN	30	TUE	30	FRI	30	SUN	30
SAT	31	TUE	31	SAT	31	SAT	31	THU	31	THU	31	TUE	31	TUE	31	FRI	31	FRI	31	WED	31	WED	31	MON	31

	Public Holiday
	Sampling Days
	Filter Changing Days CSIRO only
	Filter Changing Days A & C
	Filter Changing Days A & C plus blank
	Filter Changing AUSTO only
	Standard Days Worked (SC-RT9 Form)

A-AIISO, C-CSIRO

Figure 7 Filter change schedule the study

Appendix A Outline of project for community briefing by OEH and NSW Health



PROPOSED UPPER HUNTER PARTICLE CHARACTERISATION STUDY OUTLINE

FIL11/10163

This is a summary outline of a proposed fine particle characterisation study for the Upper Hunter (developed and funded jointly by NSW Health and Office of Environment and Heritage (OEH)) to be undertaken by CSIRO and ANSTO.

BACKGROUND

The Upper Hunter Air Quality Monitoring Network (UHAQMN) has 7 of the planned 14 stations currently providing routine particle (PM_{10} & $PM_{2.5}$) and meteorological data to the OEH web-site. The installation and commissioning of all 14 stations by the end of December 2011 is on track. The UHAQMN stations are also able to be used as platforms for any further specialised research studies.

The NSW Health Air Pollution Expert Advisory Committee recommended that a number of special studies be undertaken to better understand the health impacts of mining and related activities on communities in the Hunter.

The initial results from the first 8 months of data have seen evidence of slightly elevated fine particle (as $PM_{2.5}$) concentrations in Muswellbrook during winter. There are multiple sources of $PM_{2.5}$ including woodsmoke from solid fuel heaters and other forms of combustion (e.g. road & rail transport, coal-fired power generation and coal seam spontaneous combustion).. There is a need to better characterise the components of fine particles and their sources.

In response, NSW Health and OEH have developed an initial study to better understand the composition and source of fine particles in the Upper Hunter.

PROPOSED STUDY

The field sampling component of the proposed study will be carried out at the 2 larger secure UHAQMN sites in Singleton and Muswellbrook. CSIRO and ANSTO are expected to formally start sampling from early January 2012 and cover a 12 month period to ensure any seasonal variation is captured. Sampling will cease at the end of December 2012.

Objectives:

The study will seek to:

- determine the contributors to the overall fine particle burden in the 2 major populated centres in the Upper Hunter.

Methodology:

CSIRO will install high volume samplers at the OEH sites in Singleton and Muswellbrook and collect samples of PM_{2.5} particles on quartz filters on a 1 day in 3 cycle for further analysis.

ANSTO will also install their low volume ASP PM_{2.5} cyclone samplers using Teflon filters at Singleton and Muswellbrook and collect PM_{2.5} samples on the same 1 day in 3 cycle for further analysis.

ANSTO and CSIRO will then use Ion Beam Analysis and Ion Chromatography to determine the elemental composition (from Hydrogen to Lead (Pb)), organic carbon, black carbon, soluble ions (including chloride, nitrate, sulfate, ammonium, sodium and potassium) and anhydrous sugars (including levoglucosan) to identify as much of the PM_{2.5} mass as possible. Levoglucosan, a woodsmoke tracer, will allow a specific assessment of the contribution of woodsmoke.

These 2 techniques combined are estimated to be able to identify more than 95% of the total mass of the PM_{2.5} samples.

Expected Outcomes:

Analysis of these data, including the use of ANSTO's Positive Matrix Factorisation (PMF), will provide:

- a description of the contributors to fine particles in the Upper Hunter;
- an estimate of which sources are important and their relative contribution to fine particles in the Upper Hunter;
- an indication of any weekly and seasonal changes in PM_{2.5} particles in the Upper Hunter.

The filter papers will be kept and be available for any further analysis (e.g. Carbon14 analysis or toxicological analyses) should that be deemed appropriate at a later stage.

Project Management

The project is being jointly funded by OEH and NSW Health and will be overseen by a project team involving those organisations and the CSIRO and ANSTO researchers.

Deliverables:

To ensure that an assessment of the data is available at key points during the 12 months of the project (but recognising that the data analysis and interpretation is complex and time-consuming), the following reports are proposed:

DELIVERABLE	DESCRIPTION	PROPOSED TIMETABLE
Initial report	Site commissioning & methods	End March 2012
First progress report	Report on Summer measurements & analysis	End June 2012
Second progress report	Report on Winter measurements & analysis	End December 2012
Draft final report	Complete data analysis and interpretation	End May 2013
Final Report		End June 2013

NEXT STEPS

The contracts for the proposed study have now been finalised and the necessary equipment is being ordered for installation in Singleton & Muswellbrook during December 2011.

Briefings of the 3 local Councils involved in the UHAQMN have been scheduled for 21 November and 28 November 2011.

Validation of the equipment is expected in December 2011 with the official start to the project expected in early January 2012.

NSW Health
Office of Environment and Heritage
18th November 2011

CONTACT US

t 1300 363 400
+61 3 9545 2176
e enquiries@csiro.au
w www.csiro.au

YOUR CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.

FOR FURTHER INFORMATION

CSIRO Marine & Atmospheric Research
Mark Hibberd
t +61 3 9239 4400
e mark.hibberd@csiro.au
w www.csiro.au/cmar

CSIRO Marine & Atmospheric Research
Melita Keywood
t +61 3 9239 4400
e melita.keywood@csiro.au
w www.csiro.au/cmar