Queensland Government
Department of
Environment and Heritage Protection

Ref CTS 17242/17

4 July 2017

Mrs Jo-Ann Miller MP
Chair
Coal Worker's Pneumoconiosis Select Committee
Parliament House
George Street
BRISBANE QLD 4000

email: cwpsc@parliament.qld.gov.au

Dear Mrs Miller MP

In response to your request for information received via email on 21 June 2017, please find enclosed further information in relation to questions raised during the Committee's hearing on Wednesday 14 June 2017. I apologise for the delay in responding.

Included in this information is a wider explanation of the Department of Environment and Heritage Protection's (EHP) and the Department of Science, Information Technology and Innovation's (DSITI) roles in air quality monitoring and regulation as well as an explanation of EHP's procedures in relation to investigation of complaints and notifications and issue of enforcement action. Also enclosed is data in relation to complaints received and enforcement actions issued by EHP specific to coal mines, coal terminals and coal load out facilities.

Should your staff have any further enquiries, please ask them to contact Dr Faiz Khan, Chief Scientist, of the department on telephone .

Yours sincerely

Jim Reeves
Director-General

Att.

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Attachments:

1. Detailed response to CWP by EHP and DSITI
2. Excel Spreadsheet '20170622 EHP CWPSC Response'
3. Department's Regulatory Strategy
4. Form Nuisance Pollution Complaint EM2669
5. General Community Notification Response Flowchart
6. EA Holder Notification Flowchart
7. Boonal Load Out Facility (Yarrabee Coal Company Pty Ltd) Compliance Activity Report
8. Boonal Load Out Facility (Yarrabee Coal Company Pty Ltd) Written Warning (WARN7177)
9. Department of Environment and Heritage Protection Enforcement Guidelines
10. Collinsville and Scottville Data and Air Quality Management Plans:
    - Collinsville Coal Mine (Glencore) Air Quality Management Plan (October 2014);
    - Collinsville Coal Mine (Glencore) Air Quality Monitoring Program (October 2014);
    - Collinsville Coal Mine (Glencore) Dust Monitoring Network (September 2014); and
    - Collinsville Coal Mine (Glencore) Optimisation Project (Air Quality Impact Assessment) (July 2014).
11. Particle monitoring conducted at DSITI air quality monitoring stations
12. Airport Link/Northern Busway Dust Monitoring Investigation letter
13. Airport Link/Northern Busway Dust Monitoring Investigation report
14. QH report on Coal seam gas in the Tara region
15. QH report on Coal seam gas Wieambilla Estates Odour Investigation Results
16. Monitoring program for heavy metals at a property in the Chinchilla region
17. SEQ_Mar17 Bulletin
18. CQ_Mar17 Bulletin
19. NQ_Mar17 Bulletin
20. Ambient Air Quality NEPM monitoring 2016
21. Ambient Air Quality NEPM
22. PM10 & PM2.5 monitoring locations and measuring techniques
23. AirportLink_Apr-Jul11rep_final
24. Caboolture_dust_report
25. Ormeau-Yatala air quality investigation report
26. SuntownLandfill_report- Feb-Apr 2010
27. Moranbah PM10 summary 2011 to 2016

Response to Coal Workers Pneumoconiosis (CWP) Select Committee. Prepared by the Department of Environment and Heritage Protection and Department of Science Information Technology and Innovation

Role of the EHP

EHP is responsible for administering the *Environmental Protection Act 1994* (EP Act) amongst other environmental legislation. The object of the EP Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development). One of the primary functions of EHP under the EP Act, is to regulate environmental harm and environmental nuisance associated with environmentally relevant activities, through the issue of environmental authorities (EA's).

EHP does not administer matters relating to the *Coal Mining Safety and Health Act 1999*, which, in conjunction with the Coal Mining Safety and Health Regulation 2001, is the primary legislation regulating coal dust management and associated impacts on the health of workers.

Under section 14(1) of the EP Act, **environmental harm** is defined as any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

Under section 15 of the EP Act, **environmental nuisance** is defined as unreasonable interference or likely interference with an environmental value caused by –

a) aerosols, fumes, light, noise, odour, particles or smoke; or
b) an unhealthy, offensive or unsightly condition because of contamination; or
c) another way prescribed by regulation.

Under section 9 of the EP Act, an **environmental value** is:

a) a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or
b) another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.

Environmental authority (EA) holders are required to monitor local air quality, under conditions in their EA. Ambient air quality can be impacted by emissions from a range of other nearby activities including industry, transport, rural and domestic activities as well as natural processes such as bush fires and dust storms. Cumulative impacts, such as multiple industries operating in the local area, can influence air quality and present significant challenges in determining the source of pollutants including dust. Air quality monitoring required under the conditions of an EA is designed to inform offsite impacts to air quality and is not intended to address workplace health and safety considerations including Coal Worker's Pneumoconiosis.

Generally, coal mines, coal terminals and load out facilities are conditioned to monitor for PM_{10} particulates, Total Suspended Particulates (TSP) and $PM_{2.5}$ particulates. The Environment Protection (Air) Policy 2008 (EPP (Air)) – Schedule 1 specifies air quality objectives for health and wellbeing related to dust (PM_{10} fine particles of less than 10 microns in diameter) and for long-term nuisance (TSP). There is no requirement under the EPP (Air) to specifically monitor coal dust.

EAs impose dust limits at locations of relevance around a particular operation, the intent being to ensure that dust impacts outside an operation are appropriately managed. EHP's objective when administering the EP Act is to protect the health and wellbeing of nearby neighbours, communities and other sensitive receptors. As such, the dust limits imposed by coal mining EA's do not apply to the environment in which mine workers operate. Instead, the limits used by EHP apply to dust more broadly in the environment and not specifically to coal dust, although in some instances coal dust can make up a portion of the total dust

Historically, EAs have been conditioned to impose dust limits at mining lease boundaries, but require investigation, notification and mitigation only in response to complaints from the community. EHP's current approach to conditioning dust impacts differs in that it now imposes limits at mining lease boundaries which must be complied with at all times, regardless of complaints. Complying with these contemporary conditions requires operators to undertake continuous dust monitoring and mitigation to ensure imposed dust limits are not exceeded. These EA's also require operators to notify EHP of any exceedances of these dust limits regardless of receipt of complaints from the community. Notifications of exceedances and complaints from the community are investigated by EHP and enforcement action taken in accordance with EHP's published Enforcement Guidelines.

Compliance Program
EHP undertakes compliance activities both proactively as a targeted program and reactively in response to complaints, incidents or notifications received by EHP.

Proactive compliance activities are undertaken using a risk based approach contained within EHP's Compliance Prioritisation Model (CPM). The CPM effectively assigns a risk rating to each environmentally relevant activity regulated by EHP, allowing compliance activities to be directed to those operations which present the highest risk. This process allows EHP to allocate resources to risk in delivering an effective and efficient compliance function. The CPM assigns risk to each environmental activity with consideration for a number of risk factors including (but not limited to) activity risk, location risk, client risk and compliance history. Operations which present the highest risk in terms of the activity itself or the compliance history associated with the operation receive the most frequent compliance inspections by EHP. Utilisation of the CPM has resulted in approximately 110 proactive inspections of coal mines and coal exploration activities during the twelve month period from January 2016 to January 2017.

In relation to dust, reactive compliance activities are undertaken by EHP in response to a notification of exceedance of dust limits by an EA holder or in response to receipt of a dust complaint from the community. In both instances EHP will liaise with the EA holder, request information in relation to the matter and investigate with a view to enforcement.

While a large part of this approach is to encourage voluntary compliance with environmental obligations in line with EHP's Regulatory Strategy (see Attachment 3), EHP implements a strong compliance and enforcement framework. This framework includes planned and unplanned inspections intended to act as a deterrent to non-compliance.

Community Concern
Community members can submit notifications or complaints about pollution or environmental nuisance through EHP's pollution hotline (phone 1300 130 372 or pollutionhotline@ehp.qld.gov.au). A copy of EHP's complaint form, which is available to the public, is included (at attachment 4).

EHP conducts assessments of all submitted community notifications or complaints according to environmental risk and allocates these complaints, where necessary, to compliance officers for action. This action may include a desktop audit, request for further information, site inspection, sampling, formal investigation, enforcement which may involve prosecution. Additionally, EHP may refer a complaint or associated information to an internal technical specialist or to a technical specialist in another department (e.g. Department of Science, Information Technology and Innovation).

The General Community Notification Response Flowchart (attachment 5) provides further guidance on EHP's complaints process.

An example of a submitted complaint is outlined below. EHP has removed the names of complainants in line with the requirements of the *Information Privacy Act 2009.*

CR Ref	Complainant Name	Received Date	Alleged Source	Details
CR73002	Community Member	10/05/2016	Isaac Plains Coal Mine	**Complaint:** Department received complaint form in relation to excess dust reportedly being generated by Isaac Plains Coal Mine which entered residence. **Departmental Action:** Department contacted EA holder on 12/05/2016 who confirmed dust could be from a number of sources. Department reviewed air quality monitoring for Moranbah and noted no exceedances or issues. Noted multiples mines in area could contribute to any dust. Letter sent to complainant detailing findings on 29/07/2016.

Notifications

EA holders are required under EA conditions to submit notifications to EHP, where exceedances to specified dust limits occur. EHP will conduct a review of the provided information to ascertain whether further investigation or enforcement action is required. Similar to the complaints process, action may include a desktop audit, request for further information, site inspection, sampling, formal investigation, or enforcement action which may involve prosecution. Advice from an internal or external technical specialist may also be sought.

The EA Holder Notification Flowchart (attachment 6) to provide further guidance on EHP's notification process.

An example of a submitted notification is outlined below. The Boonal Load Out Facility Compliance Activity Report (Attachment 7) and Written Warning (Attachment 8) are include as an example of such reports

CR Ref	Notification Details	Received Date	Client	Departmental Action
CR76163	EA holder submitted quarterly dust monitoring report (May 2016 to July 2016) for Boonal Load Out Facility (EA EPPR00832813) as per Condition B15.	28/11/2016	Yarrabee Coal Company Pty Ltd	EHP performed a review of the provided information on 12/12/2016. A contravention of Conditions B12, B14 and G5 were identified during review. Contraventions related to multiple exceedances of TSP 1 Hour averages at site DM2, submission of notification being overdue and monitoring station out of compliance with Australian Standards (AS3580.10.1:2003). A Written Warning was issued on 06/01/2017 informing EA holder to remediate noted non-compliances.

Enforcement Action
EHP utilises its Enforcement Guidelines (Attachment 9) to determine appropriate enforcement actions under the EP Act and other administered legislation. This guideline ensures enforcement action is proportionate to the conduct, impartial and based on available evidence, consistent with past responses for similar conduct and occurs in a timely fashion.

A range of enforcement action is available to EHP, which includes warning notices, penalty infringement notices (PIN), administrative notices, orders made under legislation, proceedings for court orders provided for under legislation, prosecution and suspension or cancellation of EA.

Overall Numbers – Complaints, Notifications and Enforcement Action

CWP- 1. Please provide data on complaints-driven air monitoring activities (already being collated). See video at 11.00

CWP- 5. Provide details of compliance action undertaken (already being collated), including details of any enforcement action and including the six instances of exceedances (2011-16) in coal areas. (Video at 31.00 to 34.00.)

CWP- 11. Details of the extent of any investigations undertaken in response to community concerns in relation to ambient dust. Include details of the extent to which investigations are audited or reviewed. See video at 1.02.00 and 1.03.00.

The requested information, which addresses questions on notice 1, 5 and 11, is summarised below.

Complaints:

- 49 complaints received from 2006 to 2017 in relation to coal mines (26 complaints from 2011 to 2016);
- 41 complaints from 2006 to 2017 in relation to coal ports; and
- 9 complaints from 2006 to 2017 in relation to coal load out facilities.

Notifications:

- 19 notifications from 2006 to 2017 in relation to coal mines;
- 15 notifications from 2006 to 2017 in relation to coal ports; and
- 2 notifications from 2006 to 2017 in relation to coal load out facilities.

Enforcements:

- 2 PINs;
- 2 Management Programs;
- 2 Statutory Orders; and
- 4 Warning Notices.

Further information about the above specific enforcement actions is provided in the table below.

Ref	Enforcement Type	EA Holder	Issue Date	Details
WARN 7177	Written Warning	Yarrabee Coal Company Pty Ltd	13/04/2017	Boonal Load Out Facility was issued a Warning on 13/04/2017 in relation to multiple air quality exceedances in a submitted notification as well as non-compliances relating to time of submission.
WARN 6976	Written Warning	Stanmore IP Coal Pty Ltd	20/01/2017	Isaac Plains Coal Mine was issued a Warning on 20/01/2017 in relation to non-operational air quality monitoring stations.
STAT973	Emergency Direction	Anglo Coal (Dawson) Limited	13/10/2015	Emergency Direction issued to Dawson Central and North Coal Mine following a blast misfire due to unforeseen geotechnical problems.
WARN 6083	Written Warning	Yarrabee Coal Company Pty Ltd	12/04/2015	Boonal Load Out Facility was issued a Warning on 12/04/2015 in relation to failing to ensure appropriate dust mitigation measures were in place following a site inspection.
PIN5809	Penalty Infringement Notice	Gladstone Ports Corporation Limited	17/12/2013	Barney Point Coal Terminal issued a PIN ($2,200) on 17/12/2013 in relation to the generation of coal dust following the submission of a complaint from a local business.

Ref	Enforcement Type	EA Holder	Issue Date	Details
PIN5778	Penalty Infringement Notice	Gladstone Ports Corporation Limited	13/11/2013	Barney Point Coal Terminal issued a PIN ($2,200) on 13/11/2013 in relation to the generation of coal dust following the submission of a complaint from a local business.
WARN 3851	Written Warning	Gladstone Ports Corporation	27/08/2012	Barney Point Coal Terminal was issued a Warning on 27/08/2012 in relation to exceedances of PM10 air quality objectives.
MAN13980	Management Program	Gladstone Ports Corporation Limited	7/12/2011 to 30/12/2012	Barney Point Coal Terminal underwent a Transitional Environmental Program (TEP) (7/12/2011 to 30/12/2012) in relation to improving mitigation practices relating to dust and stormwater management.
MAN11159	Management Program	Gladstone Ports Corporation Limited	17/12/2010 to 31/12/2011	Barney Point Coal Terminal underwent a Transitional Environmental Program (TEP) (17/12/2010 to 31/12/2011) in relation to improving mitigation practices relating to dust and stormwater management.

EHP has also provided a spreadsheet (Attachment 2) which details each specific complaint or notification received by EHP.

Please note the number of dust complaints from 2011 to 2016 in relation to coal mines totals 26 complaints. The increase in the number of dust complaints during this time period, from that originally stated in the hearing on 14 June 2017, is due to an administrative error and further identification and verification of available data.

Data Availability
EHP collated complaint and enforcement data using search phrases including 'dust', 'coal dust', 'ash' and 'soot'. Due to changes in EHP's structure (formerly the Environmental Protection Agency and the Department of Environment and Resource Management) and different data collection processes, the earliest available data in relation to complaints and enforcement dates back to 2006.

Over the last 10 years, 2007 – 2017, DSITI has been involved in 27 air monitoring investigations which have been instigated by EHP from community concerns/complaints.

Investigation	Period	Pollutants measured
Narangba particle monitoring investigation	Oct 2006 – Aug 2007	Particles (TSP, PM_{10})
Swanbank Dust Monitoring investigation	Dec 2007 – Jun 2009	Particles (TSP, PM_{10})
Townsville Dust Monitoring Investigation	Mar 2008 – Dec 2009	Particles (TSP) Deposited dust Heavy metals

Investigation	Period	Pollutants measured
Clean and Healthy Air for Gladstone – Ambient Air Monitoring Program	Jun 2008 – Jul 2010	Particles (TSP, PM_{10}, $PM_{2.5}$, PM_1, visibility reducing particles & ultrafine) Nitrogen oxides Sulfur dioxide Ozone Carbon monoxide Fluoride Cyanide Black carbon Heavy metals Volatile organic compounds Aldehyde compounds PAHs Dioxin & Furans Ionizing radiation
Silveressence Murarrie Landfill Dust Investigation	Sep – Oct 2008	Particles (TSP, PM_{10} & $PM_{2.5}$) Deposited dust Heavy metals Crystalline silica Asbestos
Mount Cotton Quarry Dust Monitoring Investigation	Dec 2008 – Dec 2009	Particles (PM_{10} & $PM_{2.5}$) Crystalline silica Deposited dust
Runcorn Foundry Air Monitoring Investigation	Sep 2009 – March 2010	Particles (TSP, PM_{10}) Heavy metals Volatile organic compounds Aldehyde compounds Fluoride compounds Hydrogen sulfide
Suntown Landfill Particle Monitoring Investigation	Feb – Apr 2010 Oct – Dec 2010	Particles (TSP, PM_{10} & $PM_{2.5}$) Deposited dust Heavy metals Asbestos Volatile organic compounds Aldehyde compounds
Clutha Creek Sands Quarry Particle Monitoring Investigation	Sep – Nov 2010	Particles (PM_{10} & $PM_{2.5}$) Crystalline silica Deposited dust
Arundel Monitoring Investigation	Nov 2010 - Feb 2012	Particles (PM_{10} & $PM_{2.5}$) Ozone Nitrogen oxides
Airport Link/Northern Busway Dust Monitoring Investigation	April – July 2011	Particles (PM_{10} & $PM_{2.5}$) Crystalline silica
Burdekin air quality monitoring investigation	March 2011 – Feb 2016	Particles (PM_{10} & visibility reducing particles)
Burdell (Townsville) Odour Investigation	April 2012	Volatile organic compounds
Wieambilla Estates Odour Investigation	Jul – Dec 2012	Volatile organic compounds

Investigation	Period	Pollutants measured
Tennyson Dust Monitoring Investigation	Sep – Oct 2012	Particles (PM_{10}) Deposited dust Particle composition (includes coal dust) of deposited dust
Western–Metropolitan Rail System Coal Dust Monitoring Program	Mar – Jul 2013 Feb 2014 - current	Particles (TSP, PM_{10} & $PM_{2.5}$) Deposited dust Particle composition (includes coal dust) of deposited dust
Currumbin Foundry Air Monitoring Investigation	May 2013	Particles (PM_{10}) Heavy metal Volatile organic compounds Aldehyde compounds
Mount Cotton air quality monitoring investigation	Jul – Dec 2013	Particles (PM_{10} & $PM_{2.5}$)
Aurizon Rockhampton rail freight terminal dust investigation	Aug – Nov 2013	Deposited dust Particle composition of deposited dust
Caboolture Industrial Estate Particle Monitoring Investigation	Jan – Feb 2014	Particles (PM_{10}) Crystalline silica Deposited dust
Cloncurry dust monitoring investigation	Jul – Dec 2014	Particles (PM_{10}) Heavy metals Deposited dust
Jondaryan Dust Monitoring Program	Mar 2014 – Aug 2016	Particles (TSP, PM_{10} & $PM_{2.5}$) Deposited dust Particle composition (includes coal dust) of TSP and deposited dust
Air Quality Investigation Hopeland and Chinchilla	March 2015 Dec 2015	Volatile organic compounds Aldehyde compounds Hydrogen sulphide Phenols Carbon monoxide
Ormeau/Yatala air quality investigation	Sep 2015 – Nov 2016	Particles (TSP, PM_{10} & $PM_{2.5}$) Crystalline silica Asbestos Deposited dust
Fishermans Landing (Gladstone)monitoring investigation of LNG impacts	Feb 2016 - current	Particles (PM_{10}, $PM_{2.5}$ & visibility reducing particles) Nitrogen oxides Sulfur dioxide Black carbon Methane PAHs
Pinkenba Dust Investigation (Note: Confidential)	Nov 2016 - Current	Particles ($PM_{2.5}$) Crystalline silica Deposited dust

Collinsville and Scottville

CWP- 10. Details of monitoring results at Collinsville and Scottsville. See video at 1.01.00.

In response to question on notice 10, EHP has received complaints from residents in Collinsville and Scottville in relation to dust from two alleged sources, Collinsville Coal Mine (Glencore) and Sonoma Coal Mine (QCoal).

Where complaints are submitted to EHP, following a review of the complaint in line with departmental process, further action may be taken including site inspections, referrals to other departments (Queensland Health), review of monitoring data and implementation of further monitoring.

The complaints submitted in relation to Collinsville Coal Mine and Sonoma Coal Mine are further detailed below. Additional information can be found in the spreadsheet provided (in Attachment 2).

CR Ref	Complainant	Received Date	Alleged Source	Details
CR63988	Community Member	5/09/2014	Collinsville Coal Mine	**Complaint:** Department received complaint form in relation to resident in Scottville who reported that smoke and black sticky soot/ash/dust was being generated by Collinsville Coal Mine. **Departmental Action:** Department met with representatives of Collinsville Coal Mine to implement $PM_{2.5}$ monitoring stations and EA conditions requiring $PM_{2.5}$ monitoring.
CR63433	Community Member	10/07/2014	Collinsville Coal Mine	**Complaint:** Department received complaint form in relation to Scottville who reported that smoke and black sticky soot/ash/dust was being generated by Collinsville Coal Mine. **Departmental Action:** See above complaint (CR63988).
CR63110	Community Member	6/3/2014	Collinsville Coal Mine	**Complaint:** Department received complaint form in relation to resident in Scottville who reported that smoke and black sticky soot/ash/dust was being generated by Collinsville Coal Mine. **Departmental Action:** See above complaint (CR63988).

CR Ref	Complainant	Received Date	Alleged Source	Details
CR54654	Community Member	24/05/2012	Sonoma Coal Mine	**Complaint:** Department received complaint form in relation to excessive dust reportedly being generated by Sonoma Coal Mine. **Departmental Action:** Desktop review of complaint occurred on 08/09/2016 and no further action required.
CR54345	Community Members	18/04/2012	Sonoma Coal Mine	**Complaint:** Complaint emailed to department in relation to Sonoma Coal Mine and reported dust coming off spoil dumps on site. **Departmental Action:** Department contacted complainant to confirm details. Sonoma Coal Mine contacted to discuss and implement dust mitigation practices.
CR52212	Community Member	1/09/2011	Sonoma Coal Mine	**Complaint:** Complaint form received from complainant in relation to alleged dust offence by Sonoma Coal Mine. **Departmental Action:** Department contacted complainant on 02/09/2011 and did not receive response.
CR49662	Community Member	9/08/2010	Sonoma Coal Mine	**Complaint:** Department received phone call complaint in relation to dust issues reportedly occurring at Collinsville town from Sonoma Coal Mine. **Departmental Action:** Department conducted inspection of Sonoma Coal mine on 31/08/2010. Review of inspection results against EA conditions found non-compliances.

CR Ref	Complainant	Received Date	Alleged Source	Details
CR43432	Community Member	25/09/2008	Sonoma Coal Mine	**Complaint:** Department received complaint in relation to dust reportedly coming from Sonoma Coal Mine over Scottville. **Departmental Action:** Department contacted complainant to provide details of Sonoma Coal Mine in order to discuss concerns and implement dust mitigation practices.

Available air quality management plans and monitoring data, in relation to the above complaints, has also been included (in Attachments 10-1 to 10-4).

CWP- 2. Please provide details of results of air quality monitoring over time including any exceedances against the standards. See video from 12.13and again at 13.40

DSITI publishes reports and data from the monitoring programs through:

- Live air quality data on the DEHP website updated hourly http://www.ehp.qld.gov.au/air/data/search.php
- Summary data and exceedances in DSITI's Air Quality Bulletins
  - South East Queensland (Attachment 17)
  - Central Queensland (Attachment 18)
  - Northern Queensland (Attachment 19)
- Annual report for the National Environment Protection (Ambient Air Quality) Measure (Attachment 20)
- Investigation reports
- Queensland Government Open Data portal (all monitoring data 2010 – 2016) https://data.qld.gov.au/dataset?q=air+quality

A summary of the particle monitoring data collected at DSITI air quality monitoring stations is available in Attachment 11.

CWP- 3. Please clarify the role of Queensland Health (including which unit within QH) in requesting air monitoring action by DSITI. See video at 17.15

DSITI seeks Queensland Health's Health Protection Branch advice on the likelihood of human health risk from the pollutant levels measured in DSITI's air monitoring investigations (example: Airport Link/Northern Busway Dust Monitoring Investigation, Attachment 12 & 13).

Queensland Health's Health Protection Branch also uses DSITI's monitoring data to undertake health risk assessments (Example: QH report on 'Coal seam gas in the Tara region: Summary risk assessment of health complaints and environmental monitoring data, Attachment 14 & 15).

Queensland Health's Health Protection Branch has on occasions requested DSITI to arrange for air monitoring programs to allow them to ascertain whether pollutants of interest are present at levels which would pose a risk to human health. (Example: Monitoring program for heavy metals at a property in the Chinchilla region, Attachment 16).

CWP- 4. Please provide further information on how the national standards process works and how the standards are set. See video at 26.30

There is an established national approach to setting air quality standards in Australia. That process is established by the *National Environment Protection Council Act 1994* through National Environment Protection Measures (NEPMs). The Ambient Air Quality NEPM was the first step in establishing national standards for six air pollutants (ozone, carbon monoxide, nitrogen oxides, sulfur dioxide, particles and lead) in 1998. The national standards in the NEPM replaced individual state standards, guidelines, goals or objectives. This provided a common set of air quality standards for establishing a consistent approach to managing air quality around Australia.

The development of the NEPM air quality standards required consideration of not just the issues concerning health, exposure and risk, but also economic, social and environmental impacts. Impact statements and cost benefit analyses were also conducted. In many cases the final standards are a balance of all of the issues and are set with an inherent level of human health risk associated with them. The Queensland Environment Protection (Air) Policy 2008 adopted the national standards as air quality objectives. The NEPM for Ambient Air Quality is under review. The particle standards (PM10 & PM2.5) were amended in December 2015. The other NEPM standards are currently under review.

Many countries develop air quality standards and guidelines. The standards are used in different legislative frameworks, and the approaches to developing the standards or guidelines can differ. In the United States, the United States Environmental Protection Agency (US EPA) establishes National Ambient Air Quality Standards (NAAQS) for the criteria pollutants. The NAAQS are legally binding on states, which must develop State Implementation Plans to meet the NAAQS. The NAAQS are based solely on the consideration of health effects; economic considerations are not explicitly taken into account.

The World Health Organization (WHO) bases its air quality guidelines solely on health considerations. The WHO guidelines are used as the basis of air quality standards in many countries; for example, they are used by the European Union as the basis of limit values. However, WHO recommends that social and economic issues for each country or region be considered in setting standards. For the 24hour average standard for particles (PM_{10}) the European Union has chosen the WHO value but allows 35 days of exceedances.
As can be seen from the table below, Australia has the most stringent particle standards.

Summary of international air quality standards for PM_{10} and $PM_{2.5}$

	PM_{10} (μg/m^3)			$PM_{2.5}$ (μg/m^3)		
	Annual Ave	**24-hour Ave**	**Allowable Exceedances(a)**	**Annual Ave**	**24-hour Ave**	**Allowable Exceedances**
WHO	20	50^b	0	10	25^b	0
Australia	25	50	0^c	8	25	0^c
European Union/UK	40	50	35	25	-	-
United States	-	150^d	1	12^d	35de	-
Canada	-	-	-	10^d	28de	-
China	70	150	0	35	75	0

(a) Allowable exceedances in a year
(b) 99th percentile
(c) Extreme events due to bushfires/dust storms exempt
(d) Averaged over 3 years
(e) 98th percentile

CWP- 6. Please provide details of any investigation of various particulates, including crystalline silica, in coal dust monitoring results. Is it possible to extract data on crystalline silica in coal dust samples. (Video at 44.00 and 45.30.)

DSITI has monitored for asbestos, crystalline silica and heavy metals in some of the investigations. Crystalline silica levels have been measured in the PM_{10} & $PM_{2.5}$ size fractions collected in the community adjacent to hard rock quarries, land fill sites, transfer stations and road construction. Asbestos has been monitored in the community adjacent to hard rock quarries and land fill sites. Coal dust in deposited dust has been monitored along the Western and Metropolitan rail corridors. Coal dust in deposited dust and particles (TSP) has been monitored adjacent to coal load-out facility. Crystalline silica has not been monitored for in these studies. Where samples of PM_{10} & $PM_{2.5}$ size fractions were collected in these studies there was not sufficient sample collected to undertake crystalline silica analysis.

The work place exposure limits for crystalline silica in dust in coal mines and metalliferous mines and quarries is a TWA limit of 100μg/m^3 for respirable (particles less than approximately four micrometres in diameter) crystalline silica.

There are no Queensland or national criteria for ambient guidelines/standards (i.e. in the community) for respirable crystalline silica concentrations. In the absence of a Queensland EPP Air objective or national ambient air quality guideline for crystalline silica in ambient air (community exposure), DSITI uses the measured $PM_{2.5}$ crystalline silica levels to compare against the annual guideline of 3 μg/m^3 set in the Victorian Government's Protocol for Environmental Management for Mining and Extractive Industries (PEMMEI). The Victorian criterion is based on the Californian Office of Environmental Health Assessment (OEHHA) chronic inhalation Reference Exposure Level (REL) of 3 μg/m^3 for respirable crystalline silica for community exposures, but measures the crystalline silica concentration in the $PM_{2.5}$ fraction rather than the respirable fraction (particles less than approximately four micrometres in diameter). The chronic inhalation REL has been defined by the OEHHA as "an airborne level that would pose no significant health risk to individuals indefinitely exposed to that level". Queensland Government monitoring of ambient crystalline silica levels adjacent to road construction works has determined that $PM_{2.5}$ crystalline silica measurements provide a very close approximation of respirable crystalline silica levels.

Summary of Investigations involved with the monitoring of crystalline silica

Investigation	Period	Crystalline Silica Annual Ave ($\mu g/m^3$)	Report	Pollutants measured
Silveressence Murarrie Landfill Dust Investigation	Sep – Oct 2008	0.12[a]	Available on request	Particles (TSP, PM_{10} & $PM_{2.5}$) Deposited dust Heavy metals Crystalline silica Asbestos
Mount Cotton Quarry Dust Monitoring Investigation	Dec 2008 – Dec 2009	Site 1 – 0.14 Site 2 – 0.26	Available on request	Particles (PM_{10} & $PM_{2.5}$) Crystalline silica Deposited dust
Clutha Creek Sands Quarry Particle Monitoring Investigation	Sep – Nov 2010	<0.06[b]	Available on request	Particles (PM_{10} & $PM_{2.5}$) Crystalline silica Deposited dust
Airport Link/Northern Busway Dust Monitoring Investigation	April – July 2011	Site 1 – 0.57[c] Site 2 – 1.43[c]	Attachment 23	Particles (PM_{10} & $PM_{2.5}$) Crystalline silica
Caboolture Industrial Estate Particle Monitoring Investigation	Jan – Feb 2014	0.07[a]	Attachment 24	Particles (PM_{10}) Crystalline silica Deposited dust
Ormeau/Yatala air quality investigation	Sep 2015 – Nov 2016	Site 1 – 0.04 Site 2 – 0.03	Attachment 25	Particles (TSP, PM_{10} & $PM_{2.5}$) Crystalline silica Asbestos Deposited dust

(a) Estimated from a 4 week sampling program
(b) Estimated from a 8 week sampling program
(c) Estimated from a 16 week sampling program

All crystalline silica monitoring to date has indicated that the levels of crystalline silica in the ambient air are below the annual guideline of 3 $\mu g/m^3$ set in the Victorian Government's Protocol for Environmental Management for Mining and Extractive Industries.

The National Occupational Health and Safety Commission's National Exposure Standard for asbestos (all forms) in occupational environments is 0.1 fibres/ml. The Workplace Health and Safety Queensland 'clearance' level following asbestos removal works (i.e. the area is considered safe for normal use) is when the measured level of airborne asbestos fibres is below 0.01 fibres/ml.

Summary of Investigations involved with the monitoring of asbestos

Investigation	Period	Asbestos fibre concentration (fibres/ml)	Report	Pollutants measured
Silveressence Murarrie Landfill Dust Investigation	Sep – Oct 2008	<0.01		Particles (TSP, PM_{10} & $PM_{2.5}$) Deposited dust Heavy metals Crystalline silica Asbestos
Suntown Landfill Particle Monitoring Investigation	Feb – Apr 2010 Oct – Dec 2010	<0.01	Attachment 26	Particles (TSP, PM10 & PM2.5) Deposited dust Heavy metals Asbestos Volatile organic compounds Aldehyde compounds
Ormeau/Yatala air quality investigation	Sep 2015 – Nov 2016	<0.001	Attachment 25	Particles (TSP, PM_{10} & $PM_{2.5}$) Crystalline silica Asbestos Deposited dust

All asbestos monitoring to date has indicated that the levels of asbestos in the ambient air are below the Workplace Health and Safety Queensland 'clearance' level of 0.01 fibres/ml. following asbestos removal works.

CWP- 7. Please provide details of the extent of any provision by industry of its monitoring data to DSITI/DEHP – what is provided, from which sites, by which entities and to which entities? Is provision of data made on a voluntary basis or pursuant to a regulatory requirement? See video at 51.00 to 54.00.

All the monitoring data that is recorded from an industry's EA condition requiring a monitoring program has to be made available upon request by DEHP.
Summary of monitoring data supplied to DSITI/DEHP

Industry	EA	Pollutants Monitored	Report to DSITI
Caltex Refineries (Qld) Pty Ltd	EPPR00536213	EA condition to monitor at 3 sites: 1 x Nitrogen oxides 3 x Sulfur dioxide 3 x PM_{10} 3 x $PM_{2.5}$	Voluntarily provides all data to DSITI on an hourly basis – data displayed on DEHP website
Sun Metals	EPPR01325913	EA condition to monitor at 1 site: Sulfur dioxide TSP & PM_{10} Heavy metals	Voluntarily provides sulfur dioxide data to DSITI on an hourly basis – data displayed on DEHP website

Industry	EA	Pollutants Monitored	Report to DSITI
Port of Townsville	EPPR00771113	Voluntarily monitors at 1 site: PM10	Voluntarily provides PM_{10} to DSITI on an hourly basis – data displayed on DEHP website.
Mount Isa Mines	EPML00977513	EA condition to monitor at 18 sites: 12 x sulfur dioxide 6 x sulfur dioxide (annual) 7 x deposited dust 7 x heavy metals 7 x TSP (24hr ave) 3 x PM10 3 x PM2.5	EA condition to provide continuous measured data (PM10 and PM2.5 and sulfur dioxide) hourly to DEHP through DSITI; all other data provided to DEHP and DSITI monthly.
GISERA		Voluntarily monitors at 5 sites in the Surat Basin Coal Seam Gas region: 5 x carbon monoxide 5 x ozone 5 x nitrogen oxides 3 x TSP 3 x PM_{10} 3 x $PM_{2.5}$	Voluntarily provides all data to DSITI on an hourly basis – data displayed on DEHP website. https://gisera.org.au/news/live-stream-air-quality/

CWP- 8. Details of monitoring devices - What types of monitoring devices are located where? See video at 54.00 to 55.00 How are air monitoring sites determined?

Air quality monitoring provides the baseline information necessary to evaluate air quality against national standards; identify long-term trends in air quality; assess the effectiveness of management strategies; and keep the community informed about the quality of outdoor air. Investigation monitoring assists EHP to assess the veracity of specific community concerns and to determine if changes to existing industry emissions management are required. Health risk assessments conducted by Queensland Health often rely on DSITI air monitoring data.

A summary of the monitoring techniques used to measure air pollutants can be found in the Annual report for the National Environment Protection (Ambient Air Quality) Measure (Air NEPM) (Attachment 20 page 3). The measurement techniques employed by DSITI comply with the measurement protocols described in the (Air NEPM) and the relevant Australian Standard Methods for sampling and analysis of ambient air (Attachment 21). The location of the monitoring sites and measurement techniques used by DSITI for PM_{10} and $PM_{2.5}$ are shown in Attachment 22.

The requirements for siting a monitoring station will depend on the monitoring program. DSITI monitoring stations fall into three categories:

(a) Air NEPM Performance Monitoring stations

The Air NEPM standards are designed to be measured at specifically nominated 'performance monitoring stations' located to give an 'average' representation of general air quality and of population exposure to the six main pollutants. The NEPM monitoring protocol does not apply to monitoring and controlling peak concentrations from major sources such as heavily trafficked roads and major industries.

To demonstrate if the goal and standards of the Air NEPM are met or not met the Air NEPM defines a protocol for the siting of the monitoring stations. The relative section from the Air NEPM is described below.

13 Location of performance monitoring stations

(1) To the extent practicable, performance monitoring stations should be sited in accordance with the requirements for Australian Standard AS/NZS 3580.1.1:2007 (Methods for sampling and analysis of ambient air – Guide to siting air monitoring equipment). Any variations from AS/NZS 3580.1.1:2007 must be notified to Council for use in assessing reports.

(2) Performance monitoring station(s) must be located in a manner such that they contribute to obtaining a representative measure of the air quality likely to be experienced by the general population in the region or sub-region.

(3) A performance monitoring station should be operated in the same location for at least 5 years unless the integrity of the measurements is affected by unforeseen circumstances.

14 Number of performance monitoring stations

(1) Subject to subclauses (2) and (3) below, the number of performance monitoring stations for a region with a population of 25,000 people or more must be the next whole number above the number calculated in accordance with the formula:

$$1.5P + 0.5$$

*where **P** is the population of the region (in millions).*

(2) Additional performance monitoring stations may be needed where pollutant levels are influenced by local characteristics such as topography, weather or emission sources.

(3) Fewer performance monitoring stations may be needed where it can be demonstrated that pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure.

(b) Investigation monitoring (campaign/short term)

Located to ensure general compliance with Australian Standard AS/NZS 3580.1.1:2007 (Methods for sampling and analysis of ambient air – Guide to siting air monitoring equipment). Actual location will depend on the objective of the investigation (eg peak location, community, background).

(c) Non-NEPM monitoring stations could be located to give a good representation of the air quality experienced by a concerned community, peak locations near industry, roads and also background locations. Compliance with Australian Standard AS/NZS 3580.1.1:2007 (Methods for sampling and analysis of ambient air – Guide to siting air monitoring equipment) is also considered.

CWP- 9. Please provide information on the reasons for there not being monitoring devices in coal communities, other than Moranbah? See video at 57.00 to 1.00.00

The allocation of monitoring stations to establish Queensland's air quality monitoring network has been prioritised on the following basis:

- Fulfilling the monitoring and reporting requirements for Queensland under the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM);
- The need to assess population exposure in potential high risk areas;
- Assessment of the effectiveness of management strategies;
- Addressing community concern (includes investigative/campaign monitoring);
- The existence of industry-based monitoring networks;
- Government resources.

The Moranbah monitoring station was established in March 2011 at the request of the Moranbah Cumulative Impact Group (MCIG) to address concerns relating to impacts from expansion and development in Moranbah and its surrounds. The group comprised of members from Industry, Local and State Government, Traditional Owners and the Community.

At the time, of the 41 coal mines operating in Central Queensland (including Bowen and Gallilee basins) only 8 complaints were received by EHP between 2006 – 2010: (2006(1), 2007(2), 2008(2), 2009(1) and 2010(2)). The Moranbah station is located in the middle of a dozen of coal mines, so the monitoring data would be representative of a worst case situation of the likely impacts on a community surrounded by coal mines. Because of this and the low number of complaints EHP has received about emissions from coal mines, there was a low priority to establish additional stations in the region.

Analysis of the Moranbah station's air quality monitoring data since its inception (2011 – current) reveals that the AAQ NEPM standards have seldom been exceeded (see Attachment 27). In cases of exceedances the mine dust contribution is minimal. In most cases the exceedances are due to bushfire smoke and windblown dust not related to mining activities or, in 2012, dust from earthworks associated with a housing estate development next to the monitoring station. The annual PM_{10} concentrations exceeded the new AAQ NEPM standard of 25 $\mu g/m^3$ only in 2012 (28.8 $\mu g/m^3$) because of added dust emissions from the housing estate development works. The average of the annual PM_{10} concentrations recorded at this site is 21.3 $\mu g/m^3$ (excluding 2012 data). The 24-hour PM_{10} concentrations in most years are well below AAQ NEPM standards of 50 $\mu g/m^3$. Explanations of exceedances are tabled in Attachment 27.

In 2016-2017 DEHP has allocated funds for a further 2 stations to be established in the Central Queensland coalfield region by the end of 2017. A monitoring station costs approximately $120k each to establish with a further $15k a year per station to operate.

Regulatory Strategy

Great state. Great opportunity.

Queensland Government

Prepared by: Environmental Performance and Coordination, Department of Environment and Heritage Protection

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First published in 2013. This is version two of the Regulatory Strategy and includes amendments to how the department assesses applications and monitors performance.

May 2014

#30521

Foreword

The Department of Environment and Heritage Protection is responsible for managing the health of Queensland's environment, protecting its unique ecosystems, and conserving the state's built heritage. The department is also committed to enabling sustainable long-term economic development in Queensland.

The department's vision is to be Australia's most respected and responsive environment and heritage protection regulator. Fundamental to this vision is strong risk-based regulation. The department's regulatory approach is outlined in this Regulatory Strategy, which addresses community expectations of strong environmental management, as well as industry expectations of faster approvals and reduced regulatory burden.

There has already been a significant shift in the way the department's environment and heritage regulatory activities are being undertaken. This strategy builds on that shift by acknowledging that industry is best placed to identify the most appropriate way to manage their activities to ensure environmental outcomes are achieved and standards are maintained. This presents industry with a new opportunity to adopt innovative approaches and to manage their activities to most effectively meet the standards or outcomes set by government.

This approach will be complemented by the department's adoption of a sophisticated and targeted approach to identifying environmental risks, increasing compliance and taking strong enforcement action where necessary.

The department's role is to clearly articulate the environmental outcomes industry must achieve. Where the risk to the environment is greatest, standards will be higher and if necessary, compliance and enforcement actions stronger. Regulatory effort is directed towards reducing environmental risks through a robust problem-solving approach to deliver real, measurable results. A wide range of regulatory tools will be used to solve complex issues, for example the use of economic instruments to achieve environmental outcomes.

The department is focused on communicating with its customers and capitalising on risk-mitigation opportunities through the establishment of cooperative partnerships. We will also collaborate with other agencies, particularly with data systems, to enable more efficient delivery of many services.

Implementation of the Regulatory Strategy will ensure industry is able to prosper while ensuring Queensland's unique environment and heritage places are well-managed and protected now and into the future.

Jonathan (Jon) PC Black

Director-General
Department of Environment and Heritage Protection

Introduction update

This Regulatory Strategy outlines the long-term vision for the Department of Environment and Heritage Protection's regulatory, compliance and enforcement activities.

This vision includes a regulatory framework which is responsive to the needs of the government, industry and the community.

At its core this strategy reinforces the department's objective of strong environmental management supporting sustainable economic development.

Over time this strategy will set the direction for a significant cultural and operational change in the way the department undertakes its role.

These activities will lead to:

- a significant streamlining in application processes
- an increased focus on effective and targeted compliance activities
- a more consistent application of strong but proportionate enforcement activities
- a formidable specialist knowledge base—linked to industry and academic partners—for all major activities that pollute.

This strategy also acknowledges the growing importance of building an improved voluntary compliance culture within industry.

To assist industry improve its compliance practices the department will set clear expectations about acceptable standards of environmental performance, as well as publish easy to understand guidance material and information to assist customers to meet their environmental obligations. The department will not impose restrictive conditions about how environmental risks are to be managed, providing business with enough scope to develop innovative environmental solutions.

This information will assist industry to better understand its responsibilities in achieving good environmental practices, and give operators every opportunity to know what their environmental obligations are.

For those industry members who choose not to comply with their obligations, the department will be consistent in taking prompt, strong enforcement action. This enforcement will provide assurance to the vast majority of industry members that do act responsibly and meet their environmental obligations that the department is consistently dealing with those who do not.

Critical to the strategy's success is effective engagement with the department's customers, their industry associations and the supporting consulting industry—to ensure the new regulatory approach is understood. This engagement will also include expanding the use of accredited third party auditors to ensure that solutions developed by customers are appropriate and effective.

What does the department regulate?

The department is responsible for Queensland's environment and heritage protection laws and regulations and regulates activities under the:

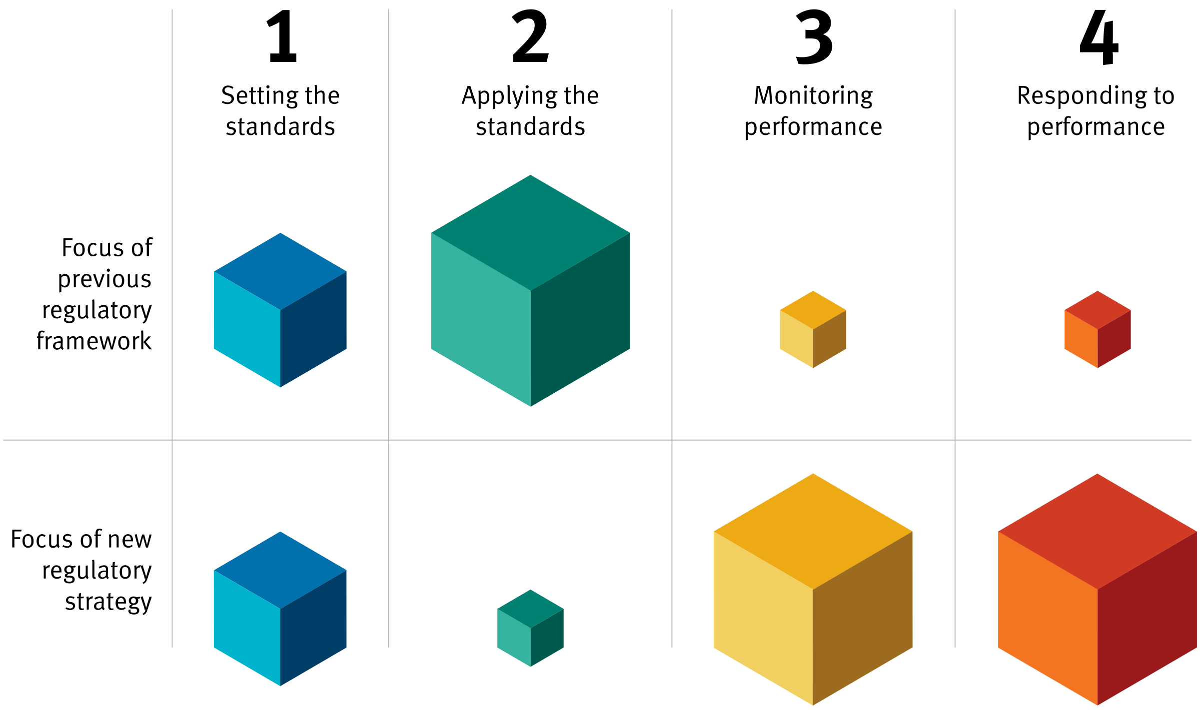
- *Coastal Protection and Management Act 1995*
- *Environmental Protection Act 1994*
- *Nature Conservation Act 1992*
- *Queensland Heritage Act 1992*
- *Sustainable Planning Act 2009*
- *Waste Reduction and Recycling Act 2011*
- *Water Act 2000 (Chapter 3)*

How does regulation work?

The department's many different types of regulatory activities can sometimes seem complicated. These activities can be broken down in four simple stages.

They are:

1. Setting the standards that clients must meet.
2. Applying those standards to specific cases by assessing applications for approvals.
3. Monitoring the performance of activities that have been approved.
4. Responding to that performance, including by taking strong, proportionate and consistent enforcement action.



What activities will the department implement under its Regulatory Strategy?

To help achieve the Regulatory Strategy's vision the department will:

- Introduce new policies and amendments to legislation to cut red tape and streamline processes that are focused on strong environmental outcomes.

- Consult with industry associations, peak bodies and community groups on regulatory matters that affect their members.

- Develop easy to understand education and information material for clients and departmental staff, including guidance on making and assessing applications, complying with the department's expectations and taking enforcement action.

- Introduction of market-based incentives which will provide clients with greater flexibility to meet their environmental obligations, for example, water quality offsets.

- Adopt new technologies, such as innovative remote sensing platforms, to help identify high risk activities requiring closer on-ground scrutiny.

- Publish regular compliance plans which outline priority compliance areas.

- Introduce measures to quantify the continued improvement in application processing times and industry compliance.

- Distribute compliance alerts, prosecution bulletins and other information to clients, industry associations, peak bodies and the community.

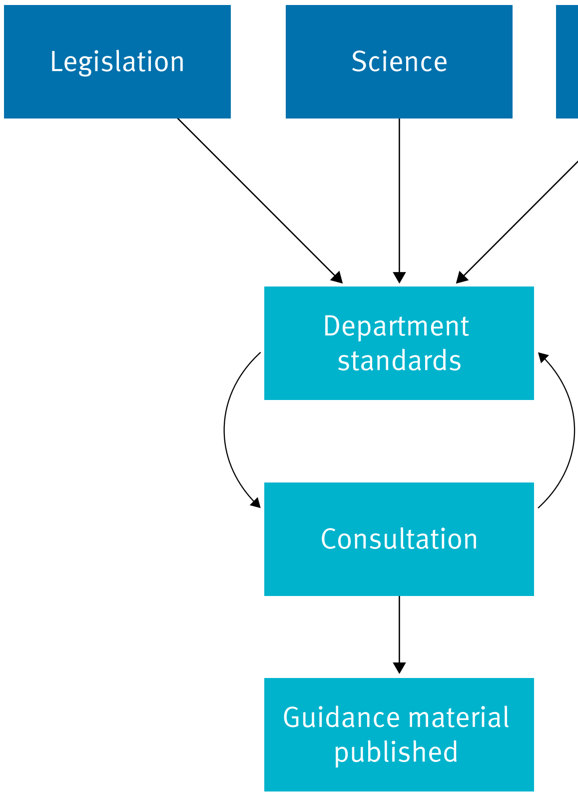
Benefits to industry	Benefits to the environment
▸ More certainty and consistency in approval conditions ▸ Quicker approvals ▸ More scope to develop innovative, low-cost environmental solutions ▸ Reduced compliance costs	▸ More best practice environmental management measures are adopted by industry ▸ Assessment based on environmental risk ▸ Allows increased proactive compliance ▸ Greater education about environmental management

Stage 1 – how does the department set the standards that clients must meet?

Queensland's environment and heritage protection laws outline the standards that different clients must meet. In addition to these standards set down in law, there are also other standards set by the department under various policies. These departmental standards are based on the latest available science and consideration of the community's expectations that the environment is protected from undue harm by industry's activities.

Guidance material will be published to assist clients in making applications and meeting the department's standards.

When the department prepares new legislation or amendments to legislation, or when it updates its policies, it will consult appropriately with industry associations, peak industry groups and the community to discuss the practical implications of any proposed changes. The department will encourage industries to take responsibility for their members' environmental performance and develop their own standards of practice. The department will explore opportunities for co-regulation, for example, industry-led development of Codes of Practice.



Department's responsibility	Client's responsibility
Clearly setting environmental outcomes for industry to meet	Implementing actions to meet the environmental outcomes sought

Stage 2 – how does the department assess applications?

To assess a new application the department will:

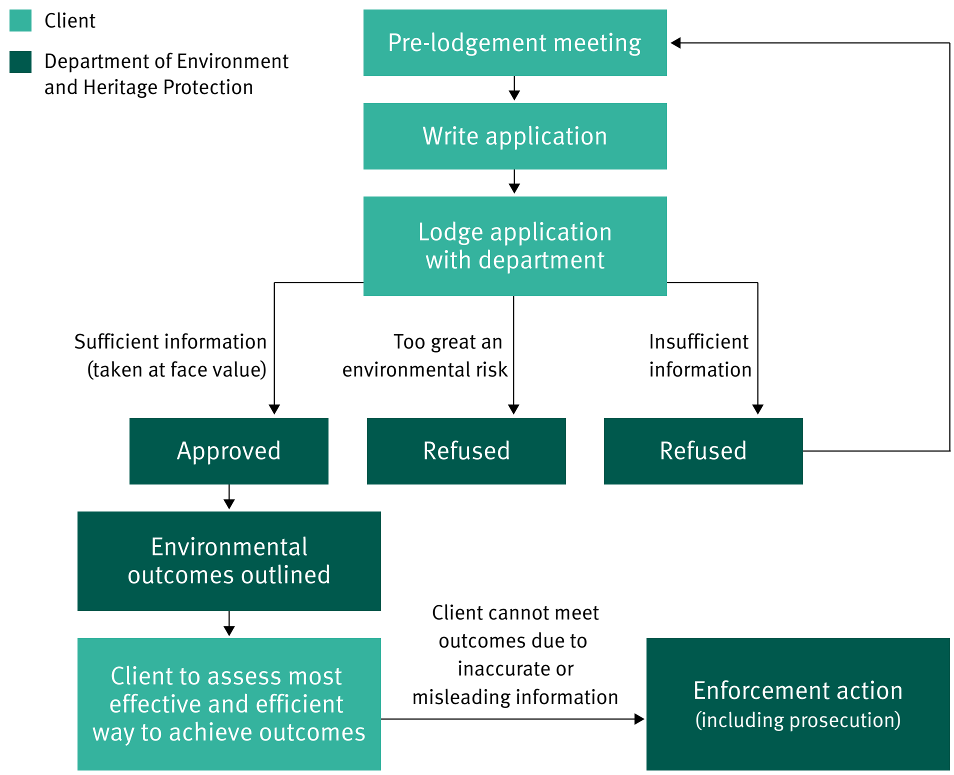
- ask for information to assess the risks posed by the activity
- set the environmental outcomes the client must meet by imposing wherever possible, non-prescriptive conditions on approvals.

The department encourages clients to hold pre-lodgement meetings so that they can fully understand the information that they must provide. If the information received is insufficient to assess the risk then the application will normally be refused.

Information received by the department as part of an application will be accepted at face value. Except for obvious errors or omissions, the department will not check the accuracy or sufficiency of information provided by an applicant. If a client is found to have provided inaccurate or misleading information then appropriate enforcement action, including prosecution, may be taken.

In making its decision on the application the department will either:

- Approve the application and outline the environmental outcomes that the clients must achieve. This will include setting release limits for activities with discharges to air, water or land. Except where there is a high risk of harm occurring, the department will not outline "how" the client must achieve these environmental outcomes. It is the responsibility of the client to assess the most efficient and effective way to achieve these outcomes for their own particular circumstance.
- Refuse the application. An application can be refused because the information supplied was insufficient to allow appropriate conditions to be imposed or because the proposed activity represents too great an environmental risk.



Department's responsibility	Client's responsibility
▶ Make clear what information is required from applicants ▶ Ask only for information that is necessary to decide an application ▶ Assess applications in the shortest time possible	▶ Provide accurate, complete information to support an application

Stage 3 – how does the department monitor the performance of individual activities?

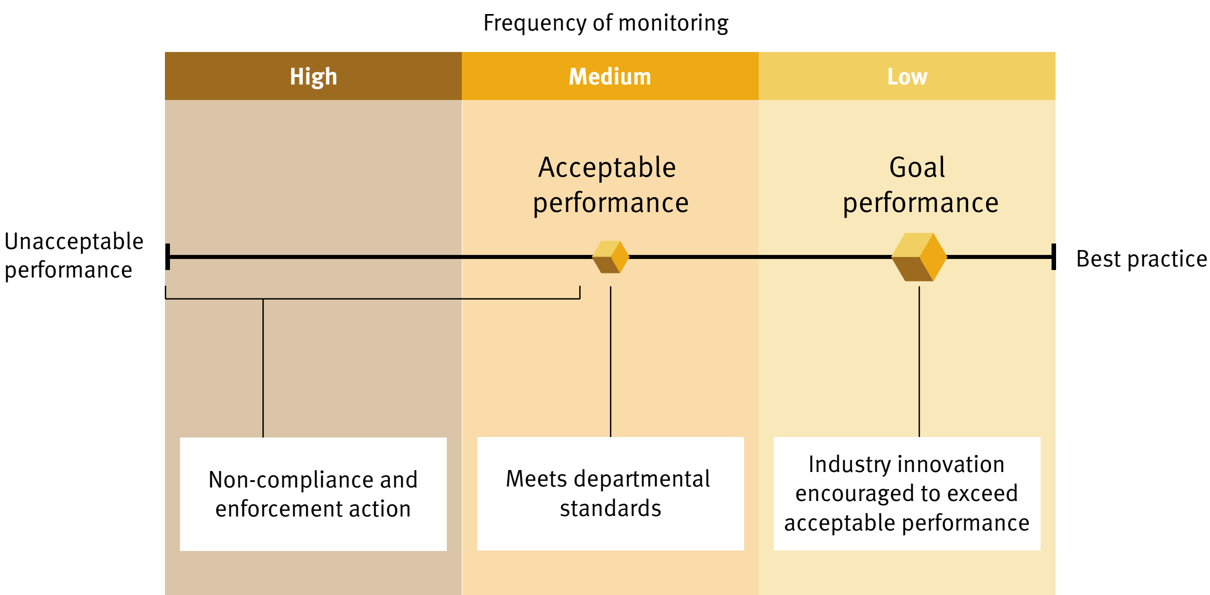
To ascertain whether clients are complying with their conditions and other legal obligations, the department will monitor their performance. The department will increase the amount of time it spends monitoring client performance, as it reduces the amount of time it spends assessing applications.

Monitoring activities carried out by the department will include desktop audits and inspections of sites that have an approval from the department. The department will also use new technologies to assist in identifying those who are not achieving the environmental outcomes.

The department will be targeted and transparent in deciding which industries or activities will be the focus of its compliance activities. It will be **targeted** by identifying the areas where breaches of its legislation pose the greatest risk to the environment or heritage places and taking action to reduce that risk. It will be **transparent** by publishing information about which areas it is focusing on and what it is doing about them in compliance plans.

The department will monitor client performance based on risk. Where individual clients represent a higher risk to the environment because of their poor performance, the department will check their compliance more frequently. Where a client consistently demonstrates good performance and manages its risk appropriately, the department will acknowledge that good performance and lower risk by conducting less frequent inspections.

Education and information sharing will also be a focus to highlight best practice opportunities to improve performance.



Department's responsibility	Client's responsibility
▸ Identify areas of greatest risk and target its resources accordingly ▸ Reduce the regulatory burden on good performers, increase the consequences for poor performers ▸ Communicate compliance focus and actions ▸ Educate and share information on best practice environmental management	▸ Monitor its own performance ▸ Respond to risks before they become problems ▸ Notify the department of serious incidents

Stage 4 – how does the department respond to performance?

It is the goal of the department to foster a positive culture of compliance within industry.

To ensure clients do the right thing the department will make available easy to understand education resources and information guidelines to help them better understand their responsibilities.

Whilst the vast majority of clients are responsible and endeavour to achieve or go beyond their environmental requirements, there will be occasions where some clients fail to meet their obligations.

If the department finds that a client has broken the law, it will take action to bring the client back into compliance with its obligations. This may mean providing an opportunity for the client to voluntarily fix the problem, or taking enforcement action in accordance with the department's enforcement guidelines.

This enforcement action can include warnings, penalty infringement notices and prosecutions. Where necessary to stop unlawful harm to the environment or a heritage place, the department will require someone to do, or not do, certain things to prevent harm from occurring. This may include stopping an activity or suspending an approval until the department is satisfied that the activity will be properly managed.

The department will provide information to industry and the community on its compliance and enforcement actions by publishing compliance alerts and prosecution bulletins.

Department's responsibility	Client's responsibility
▸ Take enforcement action quickly, fairly and in accordance with the enforcement guidelines ▸ Make clients aware of the consequences of breaking the law	▸ Cooperate with the department ▸ Take action to fix the consequences of an incident that causes harm to the environment or a heritage place

How will the department measure whether the Regulatory Strategy is successful?

The department will introduce a suite of measures to quantify the effectiveness of its Regulatory Strategy including:

- obtaining feedback via targeted questionaires from clients in relation to the quality of information being provided by the department, and provide departments performance
- monitoring application processing times to ensure a reduction in overall processing time
- monitoring compliance activities against performance indicators in the department's compliance plan
- monitoring compliance of the activities the department regulates
- tracking improvements to environmental standards
- tracking progress of sustainable economic growth.

Where else can I find information on the department's regulatory activities?

The department's website—**www.ehp.qld.gov.au**—will be continually updated as new activities under the Regulatory Strategy are implemented, including the delivery of new education and information tools.

ehp.qld.gov.au

#30521

Complaint form

Compliance

Environmental nuisance complaint and/or pollution incident allegation

This form is to be completed by the complainant that is the person who is making the complaint about a nuisance, or reporting a pollution incident. Any ensuing investigation will require your further assistance.

Complainant information

1 Complainant name and address

Telephone	Home Work	Fax Email

2 Do you give permission for your details to be released to the alleged source if required?

☐ Yes ☐ No ☐ Only after consultation with a departmental officer.

Alleged source information

3 Name and address of the alleged source of nuisance/pollution

Department of Environment and Heritage Protection (EHP) may not be able to proceed further with your nuisance complaint/incident report if you do not provide details of the alleged source

Individual's name and/or company/business name	
Street address of the individual and/or company/business	
Telephone	Fax

4 Type of premises where the nuisance or pollution originates from

☐ Residential ☐ Commercial/industrial ☐ Public land (e.g. roads, waterways and parkland)

5 Have you contacted the person/company/business about the problem?

☐ Yes ☐ No

6 Allegation type

Nuisance:

- ☐ Noise
- ☐ Light
- ☐ Dust/particulate
- ☐ Chemical/paint over spray
- ☐ Odour/fume/smoke
- ☐ Other

Pollution:

- ☐ Waste dumping
- ☐ Water pollution
- ☐ Other

7 Details of allegations and/or description of the problem

(Including location if different to alleged source address in Question 3)

8 Details of the days and times that the nuisance/pollution incident has occurred?

For example**, "Monday to Friday 6am to 5pm"** or **"every Sunday at 8am"**

9 How long does the nuisance/pollution incident usually last for?

For example, **"5 mins"**, **"30** mins**"** or **"24 hours a day"**

10 To the best of your knowledge how long has the pollution/nuisance incident been occurring?

Please provide dates where possible.

***Only complete Questions 11 and 12 if the problem was identified as a nuisance allegation at Question 6.**

***If the problem relates to a pollution allegation go to Question 13.**

11 When is the nuisance most annoying, and where does the nuisance affect you the most?

Details (For example, the nuisance is affecting you inside your home when you are trying to sleep)

12 Will you be willing to keep a diary regarding the nuisance, if required?

☐ Yes ☐ No

13 Have you brought the nuisance/pollution incident to the attention of any of the following authorities?

☐ EHP ☐ Local Council ☐ Police ☐ Another government agency

Please provide details of who you spoke to.

14 Additional notes

If there is any further information you would like to provide, please enter the information below or attach a separately signed statement.

Declaration

Please read through the certification carefully before signing.

- I do solemnly and sincerely declare that the information provided is true and correct to the best of my knowledge.
- I understand that all information supplied on or with this application form may be disclosed publicly in accordance with the *Right to Information Act 2009*, the *Information Privacy Act 2009* or the *Evidence Act 1977.*

The Department of Environment and Heritage Protection is committed to protecting the privacy, accuracy and security of your personal information in accordance with the *Information Privacy Act 2009*. Your information will be accessed only by Department of Environment and Heritage Protection personnel to assess complaints. To be able to address these complaints, information may be provided to other state and local government departments. Your personal information will not be disclosed to any other third parties without your consent or unless authorised or required by law.

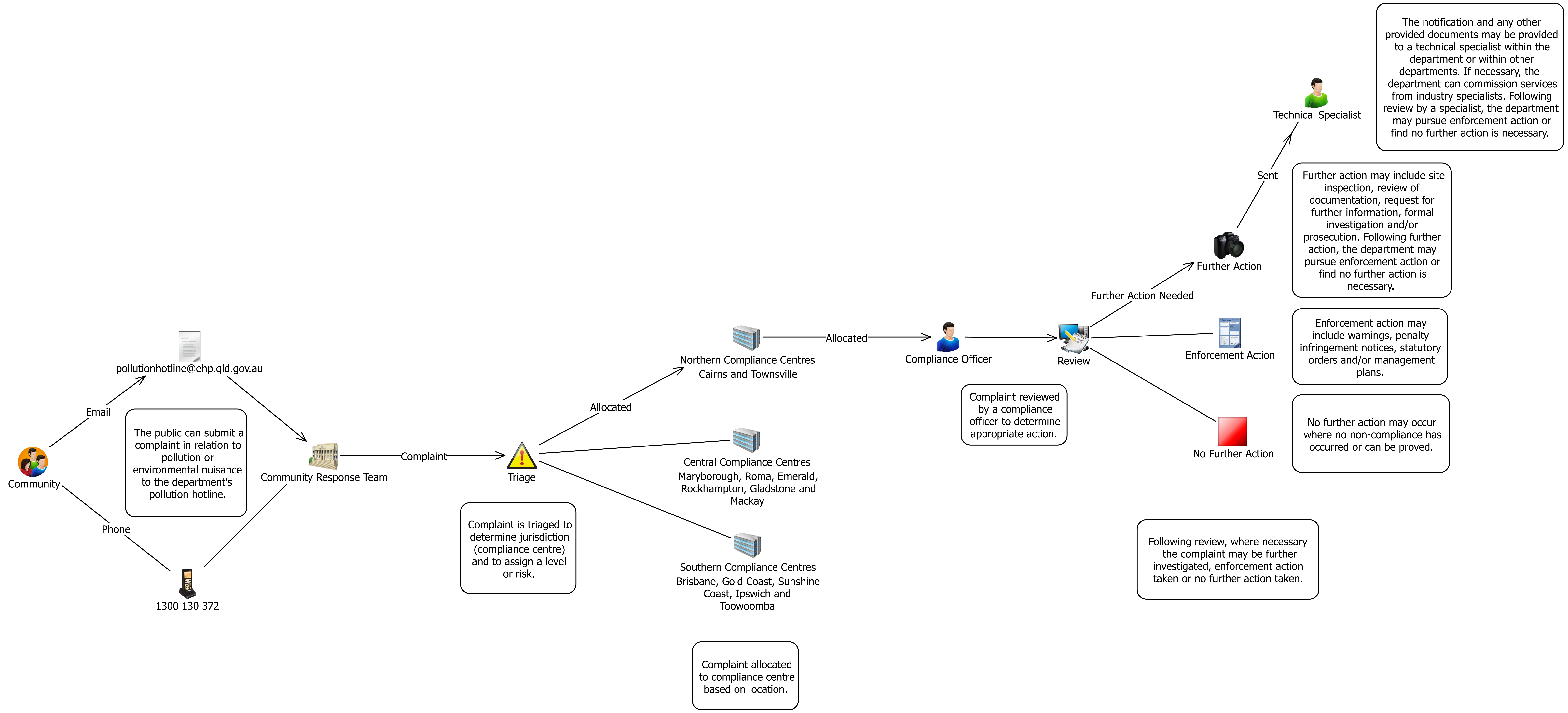
Complainant's signature	Date

Please return your completed complaint form to:

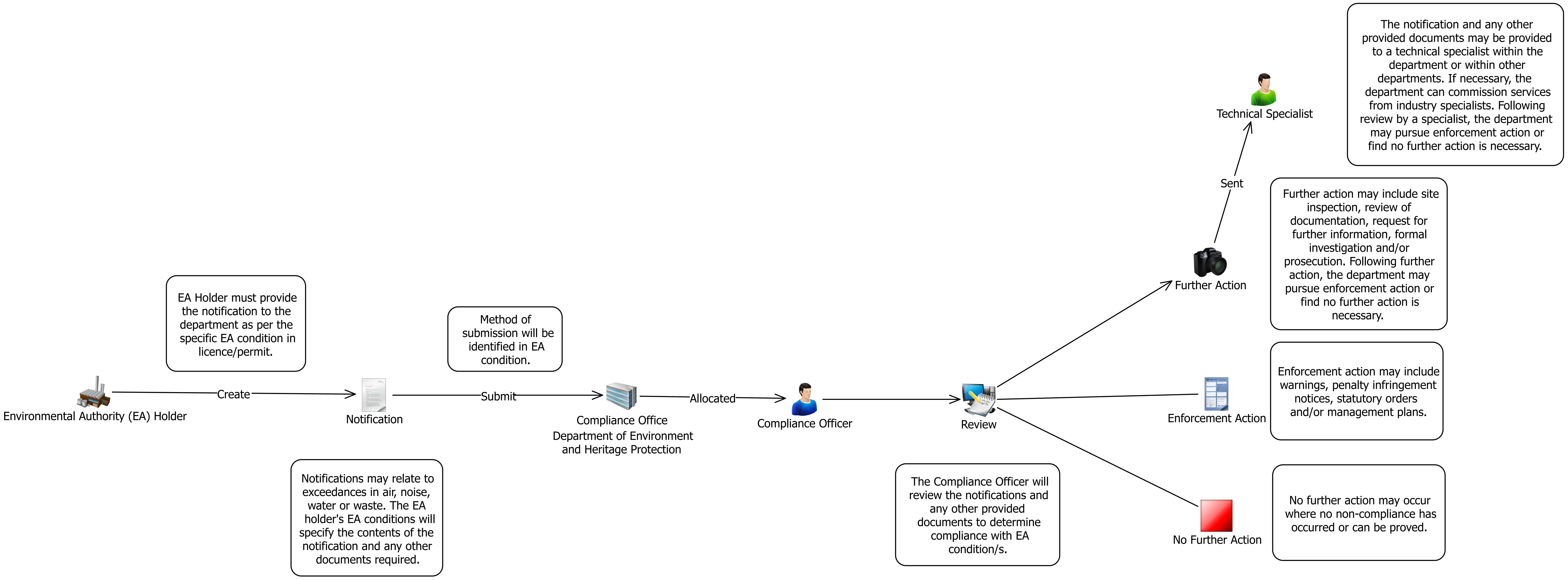
Department of Environment and Heritage Protection	Enquiries:	1300 130 372 (Option 2)
Permit and Licence Management	Facsimile:	(07) 3896 3342
GPO Box 2454	Email:	pollutionhotline@ehp.qld.gov.au
BRISBANE QLD 4001		

Official use only:
Ecotrack reference: CR

General Community Notification Response Flowchart
Department of Environment and Heritage Protection



Environmental Authority (EA) Holder Notification Flowchart
Department of Environment and Heritage Protection



Compliance Activity Report

Pre-Evaluation, Compliance Evaluation, Post Evaluation and Enforcement Response

This document is for internal use to assist officers of the Department of Environment and Heritage Protection (the department) to record compliance evaluation and enforcement information when undertaking a compliance activity (inspection or desktop). Part D of this form is suitable if a Penalty Infringement Notice (PIN) or Warning is being proposed.

Part A: Pre-Evaluation

1. Client and Site details

Reference details (Ecotrack Procedure Guide)	CR76163
File Number	101/0000742
Licence/Permit Number	EPPR00832813
Legal Entity Name	Yarrabee Coal Company Pty Ltd Capregin Pty Ltd
Other names	Boonal Joint Venture Boonal Loadout Facility
Location	Boonal Haul Road, Bluff QLD 4702
Registered address	Level 26, 363 George Street, Sydney South, NSW, 2000 PO Box 431, Blackwater QLD 4717
Contact details	Daniel Jones, Environment and Community Manager Phone: (07) 4983 8905 Mobile: 0448 367 359 Email: DanielM.Jones@yancoal.com.au Crystal Merlow, Environmental Coordinator Phone: (07) 4983 8947 Mobile: 0408 232 710 Email: Crystal.Merlow@yancoal.com.au
Date(s) of compliance activity	21 November 2016

2. Compliance Activity Background

Environmental risk	Low

Last inspection date	20 October 2016
General description of location and surrounding environment	The Boonal Joint Venture (BJV) is a bulk material handling facility owned by Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd located approximately 10km east of Blackwater. The BJV is a coal handling facility which is ultimately responsible for the loading of coal trains. Boonal Joint Venture is authorised by environmental authority (EA) EPPR00832813 for the bulk material handling operations. The land surrounding Boonal Joint Venture is used primarily for cattle grazing with a number of coal mines also located within the area.
Description of permit or location activity	***Environmental Protection Regulation 2008*, Schedule 2** **ERA 50(1)(a) Bulk material handling** – loading or unloading 100t or more of minerals in a day or stockpiling 50,000t or more of minerals. **ERA 8 (3)(a) Chemical storage** – storing the following total quantity of chemicals of class C1 or C2 combustible liquids under AS1940 or dangerous goods class 3 under subsection (1)(c) – 10m³ to 500m³.
History of the client/operator and location	There are a number of compliance actions listed against the EA holder on Ecotrack for Boonal Joint Venture. Two warning letters and 1 transitional environmental program (TEP) have been issued to the EA holder within the past 5 years for contraventions of a condition of the environmental authority. These enforcement actions include: • 1 x TEP (MAN18060) – issued on 28 March 2014 to ensure that adequate controls are put into place to prevent mine affected water releases. • 1 x Warning letter (WARN6083) – issued on 4 December 2015 due to poor on site practices allowing generated dust to be released from site. • 1 x Warning letter (WARN6787) – issued on 24 October 2016 for releasing stormwater from the site with no release conditions. • 1 x Warning letter (WARN6892) – issued on 9 November 2016 for not undertaking a third party audit in 2015 as required by condition A6 of the EA.
☐ If undertaking a site inspection, I have completed the Workplace and personal health and safety considerations checklist in Appendix 1 and the in-vehicle safety checklist	
☐ If undertaking a site inspection, I have completed the Inspection Plan checklist in Appendix 2	

Part B: Compliance Evaluation

3. Evaluation of Conditions/Legislation

Compliance activity type	Desktop audit of a UCE
Date of compliance activity	May to July 2016
Time of compliance activity	Continuous through the above stated period
EA Site representative/s:	Daniel Jones, Crystal Merlow.
Department's representatives	Not applicable.
Objectives and scope	To determine whether the dust monitoring levels are compliant when assessed against the conditions of the EA.

Condition number: B12 **Compliant: Yes ☐ No ☒ TBA ☐ Not inspected ☐**

Dust Management Objectives

B12 The release of dust must comply with the following levels:

Dust Deposition

a) Less than **four (4) grams** per square metre per month (total insoluble solids) at site boundaries nearest the closest residential premises at the points;

b) Less than **two (2) grams** coal per square metre per month at site boundaries nearest the closest residential premises at the points;

c) Less than **three (3) grams** per square metre per month (total insoluble solids) at any nuisance sensitive place; and

d) Less than **one (1) gram** coal per square metre per month at any nuisance sensitive place.

Total Suspended Particulates (TSP)

a) Less than 150 micrograms per cubic metre expressed as a twenty-four (24) hour average at the site boundary; and

b) Less than 200 micrograms per cubic metre expressed as a one (1) hour average at the site boundary

PM10 Particulates

a) Less than 150 micrograms per cubic metre expressed as a twenty-four (24) hour average at the site boundary; and

b) Less than 50 micrograms per cubic metre expressed as an annual average at the site boundary.

Dust monitoring for the period May to July 2016 was undertaken in accordance with condition B15 of environmental authority (EA) EPPR00832813 dated 8 August 2011 with the *Dust Monitoring Program Report May to July 2016* submitted to the department on 21 November 2016 for the Boonal Joint Venture.

Condition B15 of EA EPPR00832813 states:

B15 The holder of this development approval shall submit a report to the administering authority every **three (3) months** on the results of dust monitoring in a format requested by the administering authority, and remedial actions taken to prevent or minimise any dust emissions.

Yarrabee Coal Company Pty Ltd engaged Gauge Industrial and Environmental Pty Ltd (Gauge) to undertake the dust sampling and to produce a report analysing the results of this monitoring. Gauge undertook dust deposition, total suspended particulates (TSP) and PM_{10} particulates sampling. A number of exceedances with the Dust Management Objectives prescribed in condition B12 were identified as described below.

Dust Deposition

Condition B12 prescribes a limit of:

(a) 4 grams of total insoluble solids per square metre per month at the site boundaries nearest the closest residential premises; and

(b) 2 grams of coal per square metre per month at the site boundaries nearest the closest residential premises

Monitoring station DM1' and DM4' have registered continual exceedances over the May to July 2016 period for both the total insoluble solids and the coal limit. The levels are detailed below.

Total insoluble solids and coal fraction limits at DM1 and DM4

Month	Site	Total insoluble solids (g/m²/month)	Coal Fraction (g/m²/month)
May 2016	DM1'	11.6	10.8
	DM4'	11.2	10.9
June 2016	DM1'	11.1	10.3
	DM4'	36.2	35.1
July 2016	DM1'	5.8	5.4
	DM4'	11.6	11.3

Although all of these results have been identified as exceedances to the limits prescribed within the EA, there are reasons why enforcement action should not be taken. The Boonal Joint Venture is currently undertaking pre-lodgement discussions with the Business Centre (Coal) to amend the Air Schedule conditions as they have been identified as inappropriate and the department has conditioned GPS points within the EA. Information provided as part of these pre-lodgement discussions state that DM1' is located directly adjacent to a coal stockpile and is not located along the site boundary. The condition requires a maximum of the limits detailed above along the site boundary. As DM1' is not located on the site boundary, enforcement action is unable to be taken making this section of the condition unenforceable.

DM4' is considered to be in an inappropriate location as it is situated within the bamboo screening which assists in reducing the dust emissions from the site. Ultimately, the bamboo screening is capturing excess dust emissions which are then falling into the monitoring station and concentrating the result. Information provided as part of the pre-lodgement documentation states that this location does not comply with the Australia Standard AS/NZS 3580.1.1:2007 as it is influenced by extraneous local emissions. It is recommended that this be raised as an issue of concern as the department has conditioned the monitoring station to be located at this site and there are intentions of amending the Air Schedule conditions.

Total Suspended Particulates (TSP)

Condition B12 prescribes a limit of:

(a) 150µg/m³ expressed as a 24hour average at the site boundary; and

(b) 200µg/m³ expressed as a 1 hour average at the site boundary.

24 Hour average:

Monitoring stations DM4 and DM4' have registered exceedances during May 2016 period for the 24hour average TSP levels. The limit expressed as a 24hour average at the site boundary is 150µg/m³. These exceedances are detailed in graphs below.

- DM4' registered an exceedance on 1 May 2016 of approximately 165µg/m³.
- DM4 registered an exceedance on 30 May 2016 of approximately 175µg/m³.

BJV did not provided exact monitoring results identifying exceedances. They only provided the below graphs that show exceedance approximations.

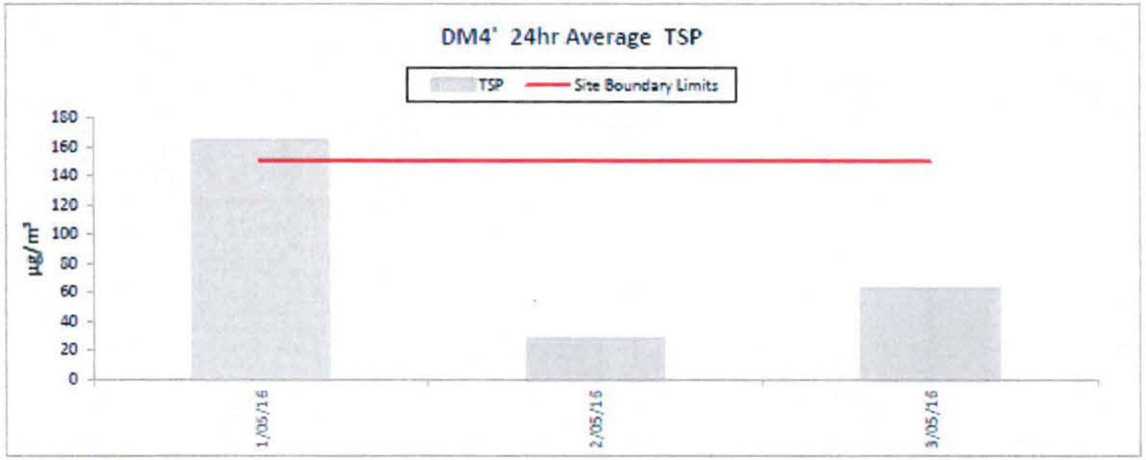


Figure 7 – Site DM4' 24-hour Average TSP

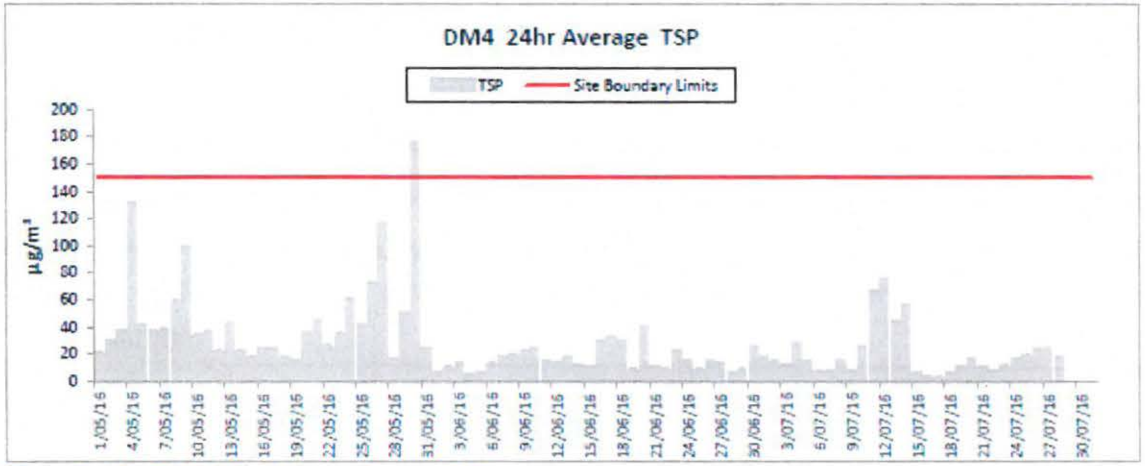


Figure 9 – Site DM4 (Orica) 24-hour Average TSP

1 Hour average:

Monitoring stations DM1', DM2, DM3, DM4 and DM4' have registered exceedances throughout the May to July period for the 1 hour average TSP levels. The limit expressed as a 24hour average at the site boundary is 200µg/m³. These exceedances are detailed in graphs below.

- DM1' registered multiple exceedances from 2 May 2016 to 19 June 2016 with the largest exceedance measuring approximately 450µg/m³.
- DM2 registered 8 exceedances from 20 May 2016 to 11 July 2016 with the largest exceedance measuring approximately 300µg/m³.
- DM3 registered 2 exceedances between 11 June 2016 and 25 June with the largest exceedance measuring approximately 250µg/m³.
- DM4 registered multiple exceedances between 1 May 2016 and 11 July 2016 with the largest exceedance measuring approximately 900µg/m³.
- DM4' registered 6 exceedances between 1 May 2016 and 2 May 2016 with the largest exceedance measuring approximately 700µg/m³.

Please note that these levels are approximations only as only the below graphs were supplied indicating exceedances.

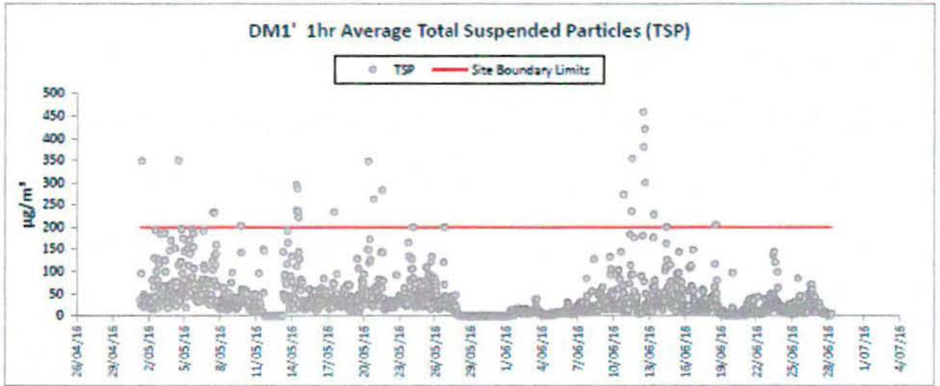


Figure 10 – Site DM1' One-hour Average TSP

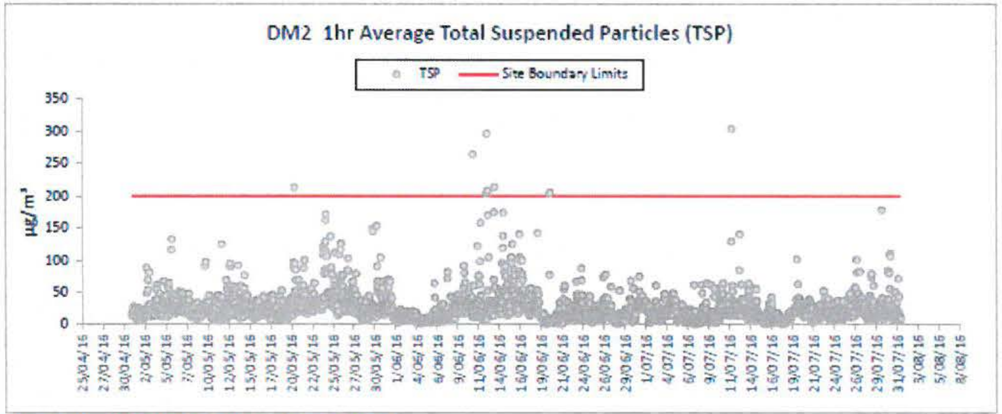


Figure 11 – Site DM2 One-hour Average TSP

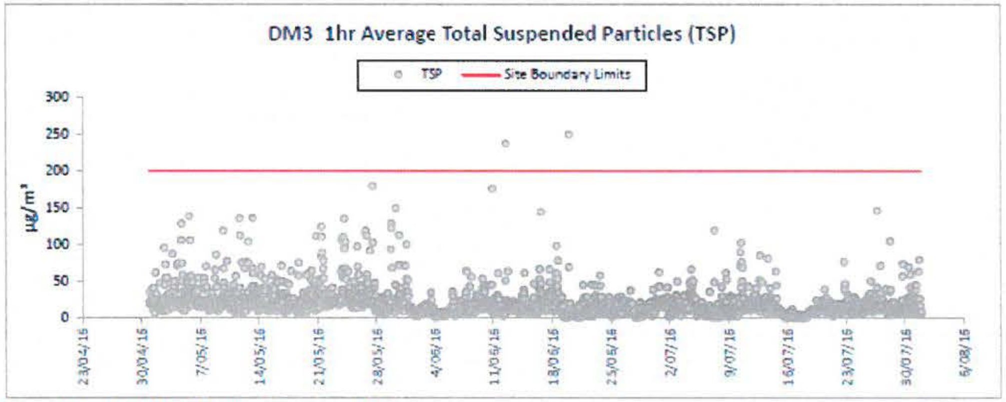


Figure 12 – Site DM3 One-hour Average TSP

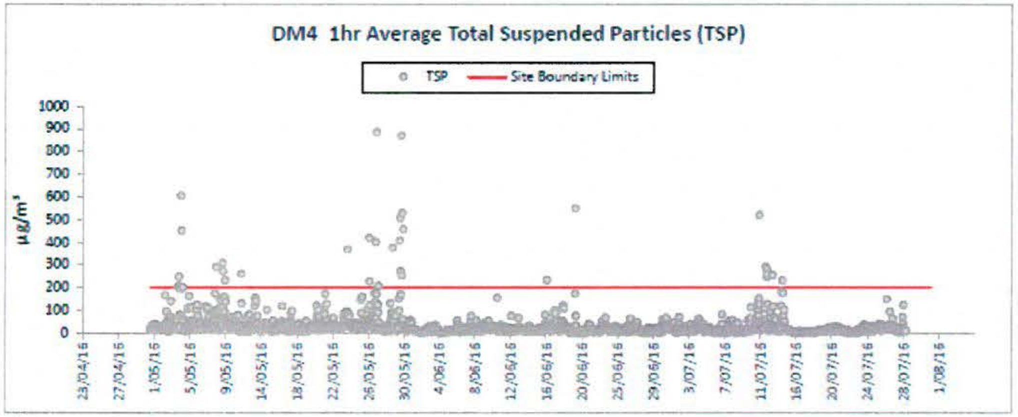


Figure 15 - Site DM4 (Orica) One-hour Average TSP

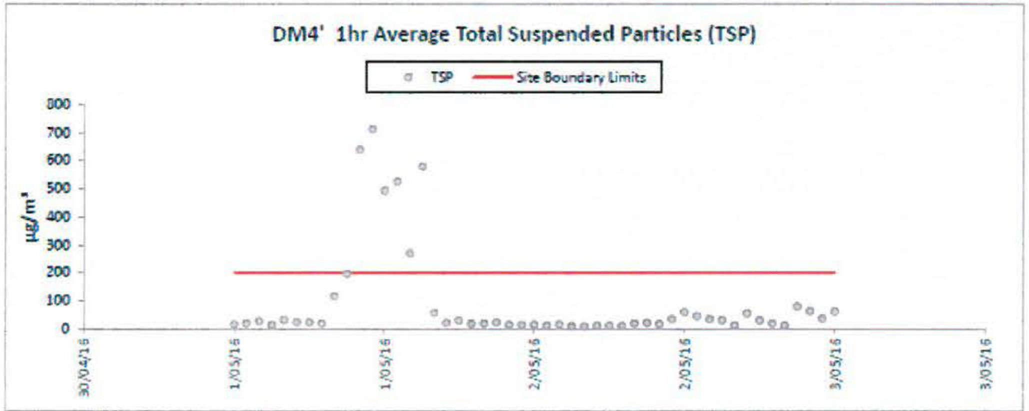


Figure 13 – Site DM4' One-hour Average TSP

Due to the location issues surrounding DM1', DM4 and DM4', it is recommended that enforcement action is not taken for these sites. In relation to DM3, information provided as part of the pre-lodgement documentation states that this location does not comply with the Australia Standard AS/NZS 3580.1.1:2007 as it is influenced by extraneous local emissions. It is recommended that this be raised as an issue of concern as the department has conditioned the monitoring station to be located at this site and there are intentions of amending the Air Schedule conditions.

However, the pre-lodgement documentation states that DM2 is considered to be in an adequate location and as such, it is recommended that enforcement actions are taken in relation to the identified non-compliances. DM2 is also located on the western site boundary and as such, this section of the condition is enforceable.

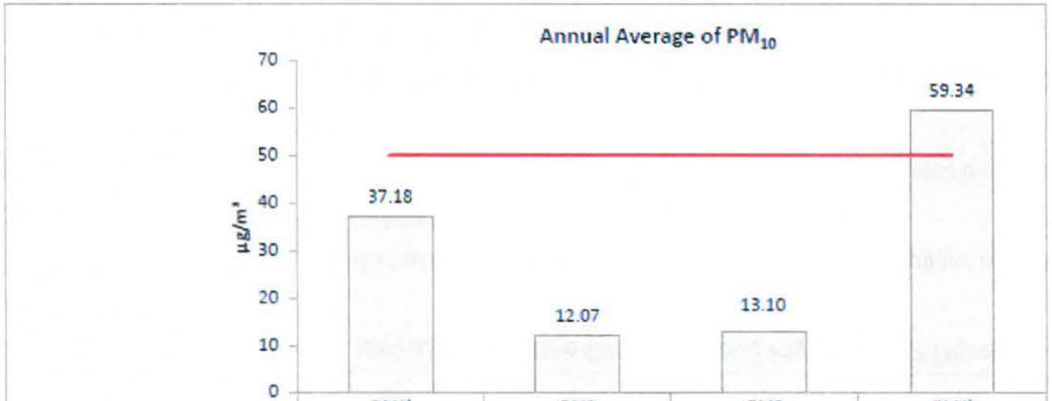
PM_{10} Monitoring

Condition B12 prescribes a limit of:

(a) 150µg/m³ expressed as a 24hour average at the site boundary; and

(b) 50µg/m³ expressed as an annual average at the site boundary.

Only 1 exceedance was identified as part of the PM_{10} monitoring and this was in relation to the annual average for the DM4' monitoring station. This station measured an annual average of 59.34µg/m³ which exceeded the prescribed annual limit of 50µg/m³. However, the DM4' location has been deemed to be inappropriate as it is located within the bamboo screening and is not compliant with Australia Standard AS/NZS 3580.1.1:2007.



	DM1'	DM2	DM3	DM4'
Annual Average	37.18	12.07	13.10	59.34
Months of Data	11	12	12	9
Management Objective	50	50	50	50

A pre-enforcement letter was issued to Yarrabee Coal Company Pty Ltd on 12 December 2016 with a response received on 23 December 2016. The response stated:

Sites DM1' and DM4' are located at inappropriate locations that are non-compliant with the applicable standard and therefore this data is not appropriate for comparison with the current license boundary limits.

DM3: DM3 is located in a non-compliant location and this data should not be relied on for compliance purposes. This is being addressed through the licence amendment as noted above.

Due to sites DM1', DM3 and DM4' being located at inappropriate locations, it is recommended that no enforcement action is taken against the dust deposition, PM_{10} and TSP exceedances.

However, in relation to TSP 1 hour average, the response states:

DM2: It is acknowledged that there was a potential exceedance of the 1hr average TSP limit on a number of occasions in May, June and July.

On review of the Gauge Report, the department identified 8 exceedances from 20 May 2016 – 11 July 2016 with the largest exceedance measuring approximately 300µg/m^3. As the EA prescribes a TSP 1 hour average limit of 200µg/m^3, the EA holder is in non-compliance with condition B12 of EA EPPR00832813.

Proposed compliance action

It is recommended that the following actions are taken in relation to condition B12 of EA EPPR00832813:

- Warning letter for 1 hour average TSP exceedance; and
- Include in the warning letter, the importance of amending the Air Schedule of EA EPML00832813.

Please note that this condition has been referred to the Business Centre (Coal) due to enforceability issues.

Condition number: B13 **Compliant: Yes ☐ No ☒ TBA ☐ Not inspected ☐**

Ambient Dust Monitoring

B13 The holder of this development approval must conduct a dust monitoring program for the parameters and at the frequency specified in Table 1, at the locations listed in Table 2.

Table 1 – Air monitoring requirements

Determination Required	Monitoring Location	Frequency
mass deposition rate of insoluble solids	DM1, DM2, DM3, DM4	Monthly
mass deposition rate of ash	DM1, DM2, DM3, DM4	Monthly
mass deposition rate of total solids	DM1, DM2, DM3, DM4	Monthly
combustible matter	DM1, DM2, DM3, DM4	Monthly
Compositional analysis (%) +	DM1, DM2, DM3, DM4	Monthly
particle identification +	DM1, DM2, DM3, DM4	Monthly
Total suspended particulate matter (TSP)	DM1, DM2, DM3, DM4	Continually (instrument availability not less than 80% in any 30 day period)
PM10	DM1, DM2, DM3, DM4	Continually (instrument availability not less than 80% in any 30 day period)

+ means required when dust levels are exceeded.

Table 2 – Continuous monitoring locations

Site number	Site Description
DM1	Real Time Monitoring on the West perimeter (Figure 1)
DM2	Real Time Monitoring on the Far West perimeter (Figure 1)
DM3	Real Time Monitoring on the South West perimeter (Figure 1)
DM4	Real Time Monitoring on the South perimeter (Figure 1)

Observations (include name and relevant comments made by any on-site staff)

Condition B13 requires dust deposition to be monitored on a monthly basis and also requires TSP and PM_{10} to be monitored continually with instrument availablility not less than 80% in any 30 day period.
 	
The *Dust Monitoring Program Report May to July 2016* states that monitoring at DM1' was not undertaken from 11 May 2016 – 13 May 2016 and again from 28 May 2016 – 1 June 2016 due to a lack of solar power resulting in power failure. As well as this, dust monitoring at DM1' was not undertaken from 28 June 2016 – 31 July 2016 as the instrument was sent for annual servicing.
 	
The report also states that monitoring at DM4' was not undertaken from 4 May 2016 – 31 July 2016. This was due to water damaged electrical systems which required equipment to be sourced from the supplier to fix.
 	
The report also stated that dust deposition monitoring was not undertaken at DM3 for the month of May due to delays in refurbishing damages to the monitoring site.
 	
The following non-compliances have been identified due to this:
 	
• Dust deposition – DM3 was not monitored monthly (May) as required by condition B12 of EA EPPR00832813;
• TSP -
    o DM1' 24 hour average TSP was not monitored from 11 May 2016 – 13 May 2016, 28 May 2016 – 1 June 2016 and 29 June 2016 – 31 July 2016. It is a requirement of the EA that TSP at DM1' is monitored continually for not less than 80% in any 30 day period. The following percentages were monitored: 78% in May, 90% in June and 0% in July.
    o DM1' 1 hour average TSP was not monitored from 11 May 2016 – 13 May 2016, 28 May 2016 – 1 June 2016 and 29 June 2016 – 31 July 2016. It is a requirement of the EA that 1 hour average TSP at DM1' is monitored continually for not less than 80% in any 30 day period. The following percentages were monitored: 78% in May, 90% in June and 0% in July.
    o DM4' 24 hour average TSP was not monitored from 4 May 2016 – 31 July 2016. It is a requirement of the EA that 24 hour average TSP at DM4' is monitored continually for not less than 80% in any 30 day period. The following percentages were monitored: 13% in May, 0% in June and 0% in July.
    o DM4' 1 hour average TSP was not monitored from 4 May 2016 – 31 July 2016. It is a requirement of the EA that 1 hour average TSP at DM4' is monitored continually for not less than 80% in any 30 day period. The following percentages were monitored: 13% in May, 0% in June and 0% in July.

- PM_{10} –
  - DM1' annual average of PM_{10} is required to be monitored continually for not less than 80% in any 30 day period. DM1' annual average was only monitored for 11 months in a 12 month period.
  - DM1' 24 hour average of PM_{10} is required to be monitored continually for not less than 80% in any 30 day period. It was was not monitored from 11 May 2016 – 13 May 2016, 28 May 2016 – 1 June 2016 and 29 June 2016 – 31 July 2016. The following percentages were monitored: 78% in May, 90% in June and 0% in July.
  - DM4' annual average of PM_{10} is required to be monitored continually for not less than 80% in any 30 day period. DM4' annual average was only monitored for 9 months in a 12 month period.
  - DM4' 24 hour average of PM_{10} was not monitored from 4 May 2016 – 31 July 2016 and is required to be monitored continually for not less than 80% in any 30 day period. The following percentages were monitored: 13% in May, 0% in June and 0% in July.

In section *5 Data Quality Assurance* of the report, the following information is provided.

Table 3 – Events Relating to the Quality of Data

Station	Issue	Dates	Cause
DM1'	NA values	11/05/2016 – 13/05/2016 and 28/05/2016 – 1/06/2016	Power failure due to lack of solar power.
DM1'	No data recorded	28/06/2016 – 31/07/2016	Instrument sent for annual servicing.
DM4'	No data recorded	4/5/2016 - 31/7/2016	Water damaged electrical systems, which required equipment to be sourced from supplier to fix.

The report also states that DM3 was unavailable to undertake dust deposition monitoring in May 2016. The report states:

DM3 was not monitored during May due to delays in refurbishing damages to the monitoring site.

In section *5 Data Quality Assurance* of the report, it states that there are a number of times that DM1' and DM4' are not monitored however, dust deposition results have been provided for these sites. Clarification will be requested as part of the pre-enforcement letter.

A pre-enforcement letter was issued to Yarrabee Coal Company Pty Ltd on 12 December 2016 with a response received on 23 December 2016. The response stated:

Dust Deposition

DM3 monitoring data for the period was lost as the monitoring station fell over during a weather event in May.

TSP

<u>DM1'</u>

May: Power failure due to lack of solar power

July: Water damaged the system (note the high rainfall in July on Figure 1 of the report). This unit was required to be sent to the supplier for repair.

PM_{10}

<u>DM1'</u>

May: Power failure due to lack of solar power

July: This unit was required to be sent to the supplier for annual calibration.

<u>DM4'</u>

May to July: Water damaged the system and the unit was required to be sent to the supplier for repair.

Quality Assurance

Based on feedback from our air quality consultant, to calculate the hourly average the full data set is required however to calculate a 24hr average only approximately 20% of the dataset is required.

Due to sites DM1', DM3 and DM4' being located at inappropriate locations, it is recommended that no enforcement action is taken against the dust deposition, PM_{10} and TSP exceedances.

The report also states that DM1 and DM4 are not recognised compliance stations within the EA however, assist to provide information when sites DM1' and DM4' are unavailable.

Proposed compliance action

It is recommended that no enforcement action is taken in relation to this condition.

Condition number: B14 **Compliant: Yes ☐ No ☒ TBA ☐ Not inspected ☐**

Element/question

B14 Monitoring provisions for the release points listed in Schedule B, Table 1 must comply with:

a) For **dust deposition**, Australian Standard AS 3580, 10.1, 2003 *Determination of Particulates - Deposited Matter - Gravimetric Method*;

b) For **Total Suspended Particulate**, Australian Standard AS 3580.9.3:2003 *'Method for sampling and analysis of ambient air – Determination of suspended particulate matter – Total suspended particulate matter (TSP) High volume sampler gravimetric method*; or any alternative method of monitoring TSP which may be permitted by the administering authority;

c) For health effects caused by dust, the concentration per cubic metre of particulate matter with an aerodynamic diameter of less than 10 micrometre (µm) (**PM10**,) suspended in the atmosphere over a twenty-four (24) hour averaging time when measured using AS 3580.9.8:2001 *Method 9.8: Determination of suspended particulate matter-PM10 continuous direct mass method using a tapered element oscillating microbalance analyser*, or any alternative method of monitoring PM10 which may be permitted by the administering authority.

Observations (include name and relevant comments made by any on-site staff)

Condition B14 of EA EPPR00832813 requires the monitoring stations for dust deposition to operate in compliance with the Australian Standard (AS) *3580.10.1 2003 Determination of Particulates – Deposited Matter – Gravimetric Method*. This Australian Standard also requires the monitoring station to be located in a position that is compliant with *AS/NZS 3580.1.1 Methods for Sampling and Analysis of Ambient Air – Guide to Siting Air Monitoring Equipment*. The *Dust Monitoring Program Report May to July 2016* states that monitoring stations DM3 and DM4' do not comply with the siting criteria stated in AS 3580.1.1 as per the 2013 GAUGE report, *Ambient Air and Meteorological Siting Audit Report July 2013 – Final* for dust deposition, TSP and PM_{10}. The report states:

- *Site DM3 is located within 50m of a roadway.*

- *Site DM4' is located in the middle of the bamboo screening.*

Dust Deposition:

The Report also states that for the months of May and June, the sample times with the typical period of exposure for routine monitoring do not comply with AS 3580.10.1. The Report states:

The exposure periods of the deposition dust samples were 56-days for May, 34-days for June and 28-days for July. The sample times for July align with the recommended (AS/NZS 3580.10.1 2003) typical period of exposure of 30±2 days for routine monitoring, but exceed by two days for June and twenty-four days for May.

PM_{10}:

The report states that the monitoring site of DM4' does not comply with the siting standard. The report states:

Site DM4', whilst above the annual average management objective and 24-hour average limit, is not compliant with the siting standard due to the bamboo screening, and it would be inappropriate to compare any data with the licence limits.

A pre-enforcement letter was issued to Yarrabee Coal Company Pty Ltd on 12 December 2016 with a response received on 23 December 2016. The response included the Gauge report, *Ambient Dust Siting Review Boonal Coal Load-out Facility* dated October 2016. The review determined the following outcomes:

<u>DM1 Monitoring Location</u>

- AS compliant.
- Does not meet monitoring objective as it is located approximately 50m inside the operational boundary.

<u>DM2 Monitoring Location</u>

- AS compliant.
- Meets the monitoring objectives.

<u>DM3 Monitoring Location</u>

- Non-compliant with AS.

- Meets the monitoring objectives.

DM4 Monitoring Location

- Non-compliant with AS.
- Does not meet the monitoring objectives as it is located under the clumping bamboo screen that can create absorption alterations and physical interference with the dust.

On review of the Gauge Report, the department has identified that monitoring locations DM3 and DM4 are not compliant with the Australia Standard 3580.10.1:2003 *Determination of Particles – Deposited Matter – Gravimetric Method*. As the EA requires that the monitoring locations are located in accordance with the AS, the EA holder is in non-compliance with condition B14 of EA EPPR00832813.

Proposed compliance action

It is recommended that the following actions are taken in relation to condition B12 of EA EPPR00832813:

- Warning letter for DM3 and DM4 being not compliant with AS; and
- Include in the warning letter, the importance of amending the Air Schedule of EA EPML00832813.

Please note that this condition has been referred to the Business Centre (Coal) due to enforceability issues

Condition number: G5 **Compliant: Yes ☐ No ☒ TBA ☐ Not inspected ☐**

Element/question

Exception Reporting

G5 The holder of this development approval must notify the administering authority within **seven (7) days** of completion of analysis of any result of a monitoring program required by a condition of this development approval that indicates an exceedance of any limit specified in this approval.

Observations (include name and relevant comments made by any on-site staff)

The Boonal Joint Venture submitted the quarterly dust monitoring results for May – July 2016 to the department on 21 November 2016 as per condition B15

of EA EPPR00832813. As per condition G5 of EA EPPR00832813, the EA holders are required to submit the results of any monitoring program that indicates an exceedance within 7 days of receiving the results. The *Dust Monitoring Program Report May to July 2016* states that the 'Final – Approved' version of the report was dated 7 November 2016. As the report was dated 7 November 2016, the results of the monitoring program were due to be submitted by 14 November 2016. As the report was not submitted until 21 November 2016, the results were submitted 7 days late. A pre-enforcement letter was issued to Yarrabee Coal Company Pty Ltd on 12 December 2016 with a response received on 23 December 2016. The report states: *Future reports will be submitted to DEHP promptly to ensure compliance with Condition G5.* As the EA requires that the monitoring reports are to be submitted within 7 days of completion of the report, the EA holder is in non-compliance with condition G5 of EA EPPR00832813.
Proposed compliance action
It is proposed that a warning letter is issued to the EA holder for contravention of condition G5 of EA EPPR00832813.

4. Other relevant inspection observation or matters for noting

Provide additional information relating to the inspection for departmental records. This section can be completed on site.

Nil.

Part C: Post Evaluation

5. Outcome and follow-up of non-compliances and matters of concern

Outcomes: A matter of concern may be identified that could become a potential non-compliance or increase risk to environmental values if not addressed by the operator. A condition may be inadequate in addressing the risk posed by an activity or may be out of date. A non-compliance with a condition may be identified.

Follow – up actions: Where a matter of concern has been identified that does not amount to a non-compliance, the issue should be included in a follow up letter to the client. Referral means referral to a Business Centre for amendments to conditions or for the need to commence an application for an environmental authority etc. An enforcement tool includes any type of enforcement from a warning to a prosecution e.g. PIN, EPO etc.

Issue	Condition/section of legislation	Outcome	Follow-up
1	B12	☐ Matter of concern ☒ Non-compliance ☐ Condition inadequate or out of date	☒ Enforcement tool to be considered (complete Part D) ☐ Include issue in letter to client/operator* ☐ Referral* *INSERT reasons for selecting this follow-up action
2	B14	☐ Matter of concern ☒ Non-compliance ☐ Condition inadequate or out of date	☒ Enforcement tool to be considered (complete Part D) ☐ Include issue in letter to client/operator* ☐ Referral* *INSERT reasons for selecting this follow-up action
3	G5	☐ Matter of concern ☒ Non-compliance ☐ Condition inadequate or out of date	☒ Enforcement tool to be considered (complete Part D) ☐ Include issue in letter to client/operator* ☐ Referral* *INSERT reasons for selecting this follow-up action

Part D: Enforcement Response

You can delete Part D if an enforcement response is not proposed in relation to this compliance activity

Complete this section if a PIN or warning is being proposed in response to identified non-compliance(s). If another enforcement tool is being proposed, use the relevant Assessment Report. EP Act Assessment Reports are provided through links to the documents below.

Environmental Protection Act 1994 - Clean-up Notice (ESR/2016/2211); Cost Recovery Notice (ESR/2016/2146); Direction Notice (ESR/2016/2147); Conduct or Commission Environmental Evaluation (ESR/2016/2135); Considering and acting on Environmental Report (ESR/2016/2204); Emergency Powers (ESR/2016/2143); Environmental Protection Order (ESR/2016/2200); Notice requiring TEP (ESR/2016/2202); Considering TEP (ESR/2016/2270); Generic Assessment Report (ESR/2016/2203).

☒ I have reviewed the enforcement history for this location and for the current and prior operators at this site and have also reviewed the enforcement history of the current operator at their other locations if applicable.

If there has been other enforcement actions recommended in response to observed non-compliance, these must be detailed in ***Compliance Strategy*** in **Part D Section 6**.

☒ I have considered the Warnings Procedural Guide and the PINs Manual.

6. Background details

Date offence(s) identified by department	21 November 2016
Compliance strategy	In relation to the Boonal Joint Venture, Yarrabee Coal Company Pty Ltd has had limited compliance/enforcement actions. The identified non-compliances as part of the recent dust monitoring were in relation to poor dust mitigation practices on site in accordance with condition B12, B14 and G5 of EA EPPR00832813. The department has previously taken compliance action against the EA holders in relation to poor dust mitigation practices (condition B3). However, it is likely that the issuing of a warning letter would be a sufficient compliance tool as it would encourage a review of the dust practices and submission of the EA amendment of the Air Schedule.
Impact of breach(es)	On reviewing the department's *Enforcement Guidelines*, the impact of breach has been determined to be a low *impact or risk of impact* for the following reasons: • There were limited impacts to the environment caused by the dust exceedances. • There was no public concern in relation to this non-compliance. • The offence was inadvertent in nature and did not result in environmental harm occurring. However, it was a non-compliance that could have been prevented.
Culpability	On reviewing the department's *Enforcement Guidelines*, the culpability of the alleged offender has been determined to be low for the following reasons:

	• The non-compliance was inadvertent in nature. • There was a previous non-compliance of condition B3 relating to the site. • There were limited impacts to the environment caused by the dust exceedances. • The site representatives stated that amendment to the Air Schedule of the EA was to be submitted by 30 December 2016. As of yet, this application has not been received.
Is the time since offence(s) committed more than 8 months?	Not applicable.

7. Elements and supporting evidence

List the common elements of offences in the first table below. Use specific offence tables if the common elements do not apply to all offences proposed.

If an offence relates to a condition of an EA, identify only the specific components of the condition that have been contravened and explain how the evidence you have obtained proves the contravention. Some conditions contain multiple components, and it is important to identify and prove only those that have been contravened.

Common elements of offence(s) (each of these elements needs to be satisfied for an alleged offence to be proven)	**Evidence to prove element** (this includes Officer observations, references to any photographs taken, statements made by operators on the site, and any other information and evidence captured that supports the identification of a non-compliance and proves the element)
TIME, DATE, PLACE *Time and date of offence(s) if occurred/identified at a point in time on a specific day OR date ranges for period of time that offence(s) occurred. AND Location details of where offence(s) occurred i.e. GPS coordinates, street address, lot on plan.*	The dust monitoring was undertaken from 1 May 2016 – 31 July 2016. The offence occurred at the Boonal Joint Venture, Lot 14 on SP156184, Yarrabee Road, Bluff QLD 4702.
PERSON *Section 32D of the Acts Interpretation Act 1954 provides that a reference to a person generally includes a reference to a corporation as well as an individual.*	The relevant persons are Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd who are the holders of the EA that is alleged to have been contravened. Both companies are listed as Australian registered companies. • Yarrabee Coal Company Pty Ltd – ACN 010 849 402 • Capregin Pty Ltd – ACN 050412 863
AUTHORITY/PERMIT *(If applicable, if not, insert N/A)*	Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd's mining activities are authorised by Environmental Authority EPPR00832813 which was issued to them by the department on 8 August 2011. Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd are joint holders of the EA.

Offence No.	Elements	Type of evidence	Source of evidence	How evidence was obtained
s430(3) of the *Environmental Protection Act 1994* (EP Act) states: *The person must not contravene a condition of the authority.* *Maximum penalty – 4500 penalty units.*				
S430(3) of the EP Act	**"Must not contravene"** – The definition of contravene is: *Fail to comply with.* Or: *To violate, infringe, or transgress: to contravene the law.* The EA holders have a number of exceedances relating to dust monitoring and reporting requirements. These include: • 1 hour average TSP exceedance; • DM3 and DM4 being not compliant with AS; and • Not providing monitoring report within 7 days. As such, the EA holders have contravened conditions B12, B14 and G5 of EA EPPR00832813.	S36 of the *Acts Interpretation Act 1954* Macquarie Dictionary definition EA EPPR00832813 dated 8 August 2011	EP Act EA EPPR00832813 dated 8 August 2011	Internet
	"Condition" – The conditions relevant to the alleged breaches are conditions B12, B14 and G5 of EA EPPR00832813 dated 8 August 2011. Condition B12 of EA EPPR00832813 states: *The release of dust must comply with the following levels:* ***Dust Deposition*** *a) Less than* ***four (4) grams*** *per square metre per month*	EA EPPR00832813 dated 8 August 2011	EA EPPR00832813 dated 8 August 2011	Ecotrack

	(total insoluble solids) at site boundaries nearest the closest residential premises at the points; *b) Less than **two (2) grams** coal per square metre per month at site boundaries nearest the closest residential premises at the points;* *c) Less than **three (3) grams** per square metre per month (total insoluble solids) at any nuisance sensitive place; and* *d) Less than **one (1) gram** coal per square metre per month at any nuisance sensitive place.* ***Total Suspended Particulates (TSP)*** *a) Less than 150 micrograms per cubic metre expressed as a twenty-four (24) hour average at the site boundary; and* *b) Less than 200 micrograms per cubic metre expressed as a one (1) hour average at the site boundary.* ***PM_{10} Particulates*** *a) Less than 150 micrograms per cubic metre expressed as a twenty-four (24) hour average at the site boundary; and* b) *Less than 50 micrograms per cubic metre expressed as an annual average at the site boundary.* Condition B14 of EA EPPR00832813 states: *Monitoring provisions for the release points listed in Schedule B, Table 1 must comply with:* *a) For **dust deposition**, Australian Standard AS 3580, 10.1, 2003 Determination of Particulates – Deposited Matter – Gravimetric Method;* b) *For **Total Suspended Particulate**, Australian Standard AS 3580.9.3:2003 'Method for sampling and analysis of*			

	ambient air – Determination of suspended particulate matter – Total suspended particulate matter (TSP) High volume sampler gravimetric method; or any alternative method of monitoring TSP which may be permitted by the administering authority; c) *For health effects caused by dust, the concentration per cubic metre of particulate matter with an aerodynamic diameter of less than 10 micrometre (µm) (**PM10,**) suspended in the atmosphere over a twenty-four (24) hour averaging time when measured using AS 3580.9.8:2001 Method: 9.8: Determination of suspended particulate matter-PM10 continuous direct mass method using a tapered element oscillating microbalance analyser; or any alternative method of monitoring PM10 which may be permitted by the administering authority.* Condition G5 of EA EPPR00832813 states: *The holder of this development approval must notify the administering authority within **seven (7) days** of completion of analysis of any result of a monitoring program required by a condition of this development approval that indicates an exceedance of any limit specified in this approval.*			
	"Authority" – The authority refers to the Environmental Authority EPPR00832813 which was issued to Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd by the department on 8 August 2011.	EA EPPR00832813 dated 8 August 2011	EA EPPR00832813 dated 8 August 2011	Ecotrack
Condition B12 of EA EPPR00832813 states: *The release of dust must comply with the following levels:*				

Dust Deposition a) *Less than* ***four (4) grams*** *per square metre per month (total insoluble solids) at site boundaries nearest the closest residential premises at the points;* b) *Less than* ***two (2) grams*** *coal per square metre per month at site boundaries nearest the closest residential premises at the points;* c) *Less than* ***three (3) grams*** *per square metre per month (total insoluble solids) at any nuisance sensitive place; and* d) *Less than* ***one (1) gram*** *coal per square metre per month at any nuisance sensitive place.* ***Total Suspended Particulates (TSP)*** a) *Less than* ***150 micrograms*** *per cubic metre expressed as a twenty-four (24) hour average at the site boundary; and* b) *Less than* ***200 micrograms*** *per cubic metre expressed as a one (1) hour average at the site boundary.* ***PM_{10} Particulates*** a) *Less than* ***150 micrograms*** *per cubic metre expressed as a twenty-four (24) hour average at the site boundary; and* b) *Less than* ***50 micrograms*** *per cubic metre expressed as an annual average at the site boundary.*				
1	**'Release of dust must comply with the following levels'** – The definition of 'release' as per the definitions section of EA EPPR00832813 states: ***"release"*** *means:* a) *To deposit, discharge, emit or disturb the contaminant; and* b) *To cause or allow the contaminant to be deposited, discharged, emitted or disturbed; and* c) *To allow the contaminant to escape; and* d) *To fail to prevent the contaminant from escaping.* The definition of '**dust**' is: *Earth or other matter in fine, dry particles.*	Macquarie Dictionary EA EPPR00832813 dated 8 August 2011	Macquarie Dictionary EA EPPR00832813 dated 8 August 2011	Ecotrack

	The definition of '**comply with**' means: *To act in accordance with.* The phrase, '**following levels**' are the levels prescribed within condition B12 of EA EPPR00832813. As such, Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd are required to release dust in accordance with the prescribed levels in condition B12 of EA EPPR00832813.			
	Dust Deposition a) *Less than **four (4) grams** per square metre per month (total insoluble solids) at site boundaries nearest the closest residential premises at the points;* b) *Less than **two (2) grams** coal per square metre per month at site boundaries nearest the closest residential premises at the points;* c) *Less than **three (3) grams** per square metre per month (total insoluble solids) at any nuisance sensitive place; and* d) *Less than **one (1) gram** coal per square metre per month at any nuisance sensitive place.* ***Total Suspended Particulates (TSP)*** a) *Less than **150 micrograms** per cubic metre expressed as a twenty-four (24) hour average at the site boundary; and* b) *Less than **200 micrograms** per cubic metre expressed as a one (1) hour average at the site boundary.* ***PM_{10} Particulates*** a) *Less than **150 micrograms** per cubic metre expressed as*	EA EPPR00832813 dated 8 August 2011 Gauge Report	EA EPPR00832813 dated 8 August 2011 Gauge Report	Ecotrack Gauge Report

	a twenty-four (24) hour average at the site boundary; and *b) Less than **50 micrograms** per cubic metre expressed as an annual average at the site boundary.* The department identified a number of exceedances relating to dust monitoring for the May-July 2016 period. However, of these, sites DM1', DM3 and DM4' were considered to be in inappropriate locations and as such, the results were not reliable. In relation to TSP 1 hour average at site DM2, results show 8 exceedances from the 20 May 2016 – 11 July 2016 period with the largest exceedance measuring approximately 300µg/m^3. The EA prescribes a limit for TSP 1 hour average of 200µg/m^3. As the results show an exceedance of this limit, the EA holder is in contravention of condition B12 of EA EPPR00832813.			

Are you proposing a PIN or warning for this offence?: PIN ☐ Warning ☒

- It is recommended that 1 warning letter be issued for:
  - contravention of condition **B12** – multiple exceedances of TSP 1 hour averages at site DM2.

Condition B14 of EA EPPR00832813 states:

Monitoring provisions for the release points listed in Schedule B, Table 1 must comply with:

*a) For **dust deposition**, Australian Standard AS 3580, 10.1, 2003 Determination of Particulates – Deposited Matter – Gravimetric Method;*

*b) For **Total Suspended Particulate**, Australian Standard AS 3580.9.3:2003 'Method for sampling and analysis of ambient air – Determination of suspended particulate matter – Total suspended particulate matter (TSP) High volume sampler gravimetric method; or any alternative method of monitoring TSP which may be permitted by the administering authority;*

*c) For health effects caused by dust, the concentration per cubic metre of particulate matter with an aerodynamic diameter of less than 10 micrometre (µm) (**PM10,**) suspended in the atmosphere over a twenty-four (24) hour averaging time when measured using AS 3580.9.8:2001 Method: 9.8: Determination of suspended particulate matter-PM10 continuous direct mass method using a tapered element oscillating microbalance analyser; or any alternative method*

of monitoring PM10 which may be permitted by the administering authority.				
2	**'Monitoring provisions for the release points listed in Schedule B, Table 1 must comply with'** – The definition of 'release' as per the definitions section of EA EPPR00832813 states: ***"monitor"*** *means:* *To check, observe, or record the operation of, without interfering with the operation.* ***"Release points"*** are defined as those listed in Schedule B, Table 1 of EA EPPR00832813. The definition of '**comply with**' means: *To act in accordance with.* As such, Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd are required to ensure that the monitoring stations prescribed in Schedule B, Table 1 comply with the relevant Australian Standard as per condition B14 of EA EPPR00832813.	Macquarie Dictionary EA EPPR00832813 dated 8 August 2011	Macquarie Dictionary EA EPPR00832813 dated 8 August 2011	Ecotrack
	a) *For **dust deposition**, Australian Standard AS 3580, 10.1, 2003 Determination of Particulates – Deposited Matter – Gravimetric Method;* b) *For **Total Suspended Particulate**, Australian Standard AS 3580.9.3:2003 'Method for sampling and analysis of ambient air – Determination of suspended particulate matter – Total suspended particulate matter (TSP) High volume sampler gravimetric method; or any alternative*	EA EPPR00832813 dated 8 August 2011 Gauge Report	EA EPPR00832813 dated 8 August 2011 Gauge Report	Ecotrack Gauge Report

	method of monitoring TSP which may be permitted by the administering authority; c) *For health effects caused by dust, the concentration per cubic metre of particulate matter with an aerodynamic diameter of less than 10 micrometre (µm) (**PM10,**) suspended in the atmosphere over a twenty-four (24) hour averaging time when measured using AS 3580.9.8:2001 Method: 9.8: Determination of suspended particulate matter-PM10 continuous direct mass method using a tapered element oscillating microbalance analyser; or any alternative method of monitoring PM10 which may be permitted by the administering authority.* The following information was provided as part of the pre-enforcement response in the Report titled, *Ambient Dust Siting Review Boonal Coal Load-out Facility*, dated October 2016. <u>DM1 Monitoring Location</u> • AS compliant. • Does not meet monitoring objective as it is located approximately 50m inside the operational boundary. <u>DM2 Monitoring Location</u> • AS compliant. • Meets the monitoring objectives. <u>DM3 Monitoring Location</u> • Non-compliant with AS. • Meets the monitoring objectives.			

	<u>DM4 Monitoring Location</u> • Non-compliant with AS. • Does not meet the monitoring objectives as it is located under the clumping bamboo screen that can create absorption alterations and physical interference with the dust. On review of the Gauge Report, the department has identified that monitoring locations DM3 and DM4 are not compliant with the Australia Standard 3580.10.1:2003 *Determination of Particles – Deposited Matter – Gravimetric Method*. As the EA requires that the monitoring locations are located in accordance with the AS, the EA holder is in non-compliance with condition B14 of EA EPPR00832813.			
Are you proposing a PIN or warning for this offence?: PIN ☐ Warning ☒ • It is recommended that 1 warning letter be issued for: ○ contravention of condition **B14** – DM1', DM3 and DM4' are not in compliance with Australian Standard 3580.10.1:2003 *Determination of Particles – Deposited Matter – Gravimetric Method.*				
Condition G5 of EA EPPR00832813 states: *The holder of this development approval must notify the administering authority within* ***seven (7) days*** *of completion of analysis of any result of a monitoring program required by a condition of this development approval that indicates an exceedance of any limit specified in this approval.*				
3	**'The holder of this development approval'** – The development approval refers to the Environmental Authority EPPR00832813 which was issued to Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd by the department on 8 August 2011. As such, Yarrabee Coal Company Pty Ltd and Capregin	EA EPPR00832813 dated 8 August 2011	EA EPPR00832813 dated 8 August 2011	Ecotrack

	Pty Ltd are the holders of the environmental authority (superseded the development approval).			
	'must notify the administering authority within seven (7) days of completion of analysis of any result of a monitoring program required by a condition of this development approval that indicates an exceedance of any limit specified in this approval' - The EA holders are required to advise the administering authority, defined as the Department of Environment and Resource Management or its successor in the definitions section of the EA, within 7 days of completing the analysis of a monitoring program. This monitoring program is to be any program or requirements for sampling under a condition of EA EPPR00832813 providing that an exceedance has been identified. The Boonal Joint Venture submitted the quarterly dust monitoring results for May – July 2016 to the department on 21 November 2016 as per condition B15 of EA EPPR00832813. The *Dust Monitoring Program Report May to July 2016* states that the 'Final – Approved' version of the report was dated 7 November 2016. As the report was dated 7 November 2016, the results of the monitoring program were due to be submitted by 14 November 2016. As the report was not submitted until 21 November 2016, the results were submitted 7 days late. As the EA requires that the monitoring reports are to be	EA EPPR00832813 dated 8 August 2011 Gauge Report	EA EPPR00832813 dated 8 August 2011 Gauge Report	Ecotrack Gauge Report

	submitted within 7 days of completion of the report, the EA holder is in contravention of condition G5 of EA EPPR00832813.			

Are you proposing a PIN or warning for this offence?: PIN ☐ Warning ☒

- It is recommended that 1 warning letter be issued for:
  - contravention of condition **G5** – The notification identifying exceedances was not submitted to the department within 7 days of completion of the report.

8. Other Considerations

Contact with alleged offender regarding alleged offence	21 November 2016 – Quarterly dust monitoring report for May – July 2016 submitted to the department. 16 December 2016 – Pre-enforcement letter issued. 20 December 2016 – Yarrabee Coal Company Pty Ltd requested an extension to the pre-enforcement response period. 23 December 2016 – Pre-enforcement response submitted to the department.
Mitigating circumstances[1] (including any financial or economic circumstances)	Yarrabee Coal Company Pty Ltd has been in pre-lodgement discussions with the Business Centre (Coal) since June 2016 regarding the proposed amendment to the Air Schedule of the EA. Yarrabee Coal Company Pty Ltd undertook an ambient dust siting review in October 2016 to determine the appropriateness of each monitoring station.
Aggravating circumstances[1] (including any financial or economic circumstances)	Yarrabee Coal Company Pty Ltd was aware that the dust monitoring stations were not compliant with Australian Standard 3580.10.1:2003 *Determination of Particles – Deposited Matter – Gravimetric Method* and as such, the results are unreliable.

☒ I have considered the department's Enforcement Guidelines which provides guidance in the making of enforcement decisions.

Part E: Sign-off

Do not delete Part E. This section must be completed as part of all compliance activities even if the recommendation is for no further action.

9. Recommendation

The officer is required to make a recommendation in relation to the proposed compliance or enforcement response.

It is recommended that one warning letter be issued to the Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd for the following:

- contravention of condition **B12** – multiple exceedances of TSP 1 hour averages at site DM2.
- contravention of condition **B14** – DM1', DM3 and DM4' are not in compliance with Australian Standard 3580.10.1:2003 *Determination of Particles – Deposited Matter – Gravimetric Method*.
- contravention of condition **G5** – The notification identifying exceedances was not submitted to the department within 7 days of completion of the report.

[1] For further guidance as to what may constitute a mitigating or aggravating factor, refer to the Sentencing Principles in Section 9 of the *Penalties and Sentences Act 1992*.

Recommending Officer	
Signature:	**Office Location:** Central Queensland Compliance - Rockhampton
Print Name: Brianna Ryan	**Position:** Senior Environmental Officer
Date: 05/01/17	**Phone:** (07) 4837 3334

10. Supervisory Review

To be completed by Team Leader or CDM as appropriate.

On reviewing all the available information, I have formed a reasonable belief that an offence against section 430 of the *Environmental Protection Act 1994* has been committed. Having regard to the Enforcement Guidelines and PIN manual I agree with the recommendation that the alleged offender is issued with one warning letter.

☒ I confirm I have completed the Quality Assurance checklist for submission with this document.

Reviewing Officer	
Signature:	**Office Location:** Central Queensland Compliance - Rockhampton
Print Name: Angela Hendy	**Position:** Team Leader
Date: 5/1/17	**Phone:** (07) 4837 3490

11. Decision

The Manager (Compliance) or CDM is required to either support or not support the recommendation and sign and date below.

Decision for recommendation	**SUPPORTED / ~~NOT~~ SUPPORTED**
Reason for decision *I support this decision for the reasons set out above.*	
Signature:	**Print Name:** Justin Cagney
Position: Compliance Delivery Manager - Rockhampton	**Date:** 05/01/2017

Queensland Government

Department of
Environment and Heritage Protection

Ref CR76163: 101/0000742

5 January 2017

Yarrabee Coal Company Pty Ltd
Level 26
363 George Street
SYDNEY SOUTH NSW 2000

Attn: Daniel Jones
Email: u

CC. Capregin Pty Ltd
MGI Brisbane, Level 1
200 Mary Street
BRISBANE CITY QLD 4000

CC. Boonal Joint Venture
PO Box 431
BLACKWATER QLD 4717

Dear Directors

Warning letter – Quarterly Dust Monitoring May - July 2016 – Boonal Joint Venture

The Department of Environment and Heritage Protection (the department) refers to the report, *Dust Monitoring Program Report May to July 2016* (the report) submitted on 21 November 2016 by Yancoal Australia Ltd for the Boonal Joint Venture as required by condition B15 of environmental authority (EA) EPPR00832813.

The department has assessed the submitted information regarding the report and has identified the following contraventions of the EA as detailed in Table 1 below.

Table 1: Details of non-compliance with EA EPPR00832813

Contravened condition	Detail of non-compliance
Condition B12 The release of dust must comply with the following levels: **Dust Deposition** a) Less than **four (4) grams** per square metre per month (total insoluble solids) at site boundaries nearest the closest residential premises at the points; b) Less than **two (2) grams** coal per square metre per month at site boundaries nearest the closest residential premises at the points;	The Total Suspended Particulates (TSP), 1 hour average has an EA limit of 200µg/m³. At monitoring location DM2, there were 8 identified exceedances from 20 May to 11 July 2016 with the largest exceedance being approximately 300µg/m³. As there have been exceedances of the TSP 1 hour average prescribed limit, dust has not been released in accordance with condition B12 of EA EPPR00832813.

Level 2/209 Bolsover Street
PO Box 413
Rockhampton QLD 4700
Telephone + 61 7 4837 3517
Website www.ehp.qld.gov.au
ABN 46 640 294 485

c) Less than **three (3) grams** per square metre per month (total insoluble solids) at any nuisance sensitive place; and d) Less than **one (1) gram** coal per square metre per month at any nuisance sensitive place. **Total Suspended Particulates (TSP)** a) Less than 150 micrograms per cubic metre expressed as a twenty-four (24) hour average at the site boundary; and b) Less than 200 micrograms per cubic metre expressed as a one (1) hour average at the site boundary. **PM_{10} Particulates** a) Less than 150 micrograms per cubic metre expressed as a twenty-four (24) hour average at the site boundary; and b) Less than 50 micrograms per cubic metre expressed as an annual average at the site boundary.	
Condition B14 Monitoring provisions for the release points listed in Schedule B, Table 1 must comply with: a) For **dust deposition**, Australian Standard AS 3580, 10.1, 2003 *Determination of Particulates – Deposited Matter – Gravimetric Method*; b) For **Total Suspended Particulate**, Australian Standard AS 3580.9.3:2003 '*Method for sampling and analysis of ambient air – Determination of suspended particulate matter – Total suspended particulate matter (TSP) High volume sampler gravimetric method*; or any alternative method of monitoring TSP which may be permitted by the administering authority; c) For health effects caused by dust, the concentration per cubic metre of	The report, *Ambient Dust Siting Review* dated October 2016, identified that the monitoring locations DM3 and DM4 are not compliant with the *Australia Standard 3580.10.1:2003 Determination of Particles – Deposited Matter – Gravimetric Method.* As the monitoring locations DM3 and DM4 do not comply with the Australian Standard, the stations have not been situated or operated in accordance with condition B14 of EA EPPR00832813.

particulate matter with an aerodynamic diameter of less than 10 micrometre (μm) (**PM10,**) suspended in the atmosphere over a twenty-four (24) hour averaging time when measured using AS 3580.9.8:2001 *Method: 9.8: Determination of suspended particulate matter-PM10 continuous direct mass method using a tapered element oscillating microbalance analyser*; or any alternative method of monitoring PM10 which may be permitted by the administering authority.	
Condition G5 The holder of this development approval must notify the administering authority within **seven (7) days** of completion of analysis of any result of a monitoring program required by a condition of this development approval that indicates an exceedance of any limit specified in this approval.	The *Dust Monitoring Program Report May to July 2016* states that the 'Final – Approved' version of the report was dated 7 November 2016. As the report was dated 7 November 2016, the results of the monitoring program were due to be submitted by 14 November 2016. As the report was not submitted until 21 November 2016, the results were submitted 7 days late and not in accordance with condition G5 of EA EPPR00832813.

Grounds

In this instance and consistent with the department's Enforcement Guideline, the department has decided to formally issue you a ***formal warning*** for failing to comply with the conditions outlined in Table 1.

The facts and circumstances forming the basis for issuing this warning are:

- The department has identified that Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd are in contravention of section 430(3) of the *Environmental Protection Act 1994* (the Act);
- Condition B12 of EA EPPR00832813 does not permit the release of dust in exceedance of the limits prescribed within the EA.
- On 8 occasions between 20 May and 11 July 2016, the TSP 1 hour average was exceeded with the largest exceedance measuring approximately 300μg/m^3.
- Condition B14 of EA EPPR00832813 requires that dust monitoring stations are situated and operated in compliance with the relevant Australian Standard.
- As part of the pre-enforcement response, the report, Ambient Dust Siting Review dated October 2016 was submitted which stated that monitoring stations DM3 and DM4 were not compliant with *AS/NZS 3580.10.1:2003 Determination of Particulates – Deposited Matter – Gravimetric Method.*

- Condition G5 of EA EPPR00832813 requires the EA holder to notify the department within 7 days of completion of analysis of any result of a monitoring program required by a condition of EA EPPR00832813 that indicates an exceedance of any limit specified in that approval.
- The report was submitted 7 days late.

You are advised that it is an offence under section 430 of the Act to contravene a condition of an environmental authority. The maximum penalty for a corporation is 22,500 penalty units, totalling $2,742,750.

The department would like to remind Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd to submit the proposed EA amendment application as soon as possible to bring the Boonal Joint Venture into compliance with the conditions of the EA. Should an EA amendment application not be received and approved, the Boonal Joint Venture will remain in non-compliance with the Air Schedule of the EA which has the potential to lead to escalated enforcement action such as the issuing of a penalty infringement notice or prosecution.

You are also reminded that pursuant to section 319 of the Act, Yarrabee Coal Company Pty Ltd and Capregin Pty Ltd has a general environmental duty to take all reasonable and practical measures to prevent or minimise environmental harm. In that regard, you are encouraged to actively identify all environmental risks associated with the activity on an ongoing basis, and to implement strategies and processes to effectively manage them.

Should further information become available which escalates the seriousness of the identified non-compliance the department will consider taking further action, including prosecution or issuing a penalty infringement notice in accordance with the enforcement guideline. A copy of the enforcement guideline can be found on the department's website at www.ehp.qld.gov.au.

Should you have any queries in relation to this letter, please contact Brianna Ryan, Senior Environmental Officer of the department on (or via

Yours sincerely,

Justin Cagney
Delegate of the chief executive
Department of Environment and Heritage Protection
Environmental Protection Act 1994

Enforcement Guidelines

Prepared by: Litigation Unit, Department of Environment and Heritage Protection

Disclaimer

These guidelines do not bind the department in the exercise of its discretion with respect to the use of its statutory tools and initiation of legal proceedings. It is intended as a guide only.

If you need to access this document in a language other than English, please call the Translating and Interpreting Service (TIS National) on 131 450 and ask them to telephone Library Services on +61 7 3170 5470.

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February 2016

Contents

1 Introduction

Queensland's economic, social and ecological welfare relies upon the sustainable management of its environment and conservation of its heritage.

The Queensland Government is committed to ecologically sustainable development—protecting the ecological processes on which life depends while allowing for development that improves the total quality of life, both now and in the future.

The Department of Environment and Heritage Protection is the government's lead agency for the administration of legislation that protects and manages Queensland's environment and heritage. The department has produced a solid policy platform on which it has built partnerships with the community and industry to encourage greater understanding of sustainable environmental and heritage practices and support for innovation.

To build a culture of voluntary compliance—where business and industry take responsibility for ensuring that their activities do not cause unlawful harm to the environment or heritage—the department will sometimes need to take enforcement action. Enforcement action provides a strong deterrent to non-compliance.

The effective protection of the environment and heritage, as well as good regulatory practice, calls for the department to have clear guidelines governing the taking of enforcement action. These Enforcement Guidelines complement the department's Regulatory Strategy, Annual Compliance Plan, and other documents which set out the department's approach to its enforcement activities (available on the department's website).

To the extent possible in the circumstances, it is the goal of the department's enforcement responses to:

- reinforce legal obligations under environmental and heritage legislation;
- achieve outcomes consistent with environmental and heritage legislation;
- deter non-compliant behaviour; and
- assertively apply consistent and proportionate enforcement action.

1.1 Scope

The department administers a number of pieces of legislation, including:

- *Coastal Protection and Management Act 1995*
- *Environmental Protection Act 1994*
- *Nature Conservation Act 1992* (with respect to the protection and management of wildlife and World Heritage)
- *Queensland Heritage Act 1992*
- *Sustainable Planning Act 2009* (with respect to those parts relevant to the department)
- *Waste Reduction and Recycling Act 2011*
- *Water Act 2000* (Chapter 3).

Under these pieces of legislation there are also a number of different government authorities that may also have delegated or devolved powers, such as the police or local governments. To ensure consistency and transparency of enforcement actions, these enforcement guidelines apply to all decisions about enforcement action made by the department in administering its legislation. It is also intended to guide decisions made under this legislation by other authorities, however it does not bind these authorities.

1.2 Purpose

These enforcement guidelines assist the department and other relevant authorities in making decisions about taking enforcement action under legislation administered by the department. The guidelines set out principles of a general nature to provide an understanding of how the department will approach enforcement.

The department publishes its enforcement guidelines as part of its commitment to transparency in its compliance activities, and to educate the public about the department's expectations and compliance approach. People and businesses who have specific obligations under legislation administered by the department are encouraged to familiarise themselves with these guidelines.

It is important to note that these are guidelines and not directions. They are designed to assist the making of enforcement decisions to achieve consistency, efficiency, effectiveness and transparency in the administration of legislation by the department.

1.3 Procedure

The department will assess all notifications it receives of possible breaches of its legislation, and based on these assessments and any associated investigations, will make decisions as to the appropriate response. In some cases, the decision may be to take no action, for example, if an investigation reveals that no breach of the legislation has taken place. In some cases, the department may provide advice, guidance, or assistance to help a person comply with the legislation. In other cases, it may be necessary for the department to take enforcement action in response to a breach of the legislation.

In these guidelines, enforcement action includes any action taken to punish a breach of legislation administered by the department, to deter or prevent a person or persons from committing future breaches of the legislation, or to require someone to remedy or stop committing a breach of the legislation. Enforcement actions do not include measures intended only to inform or educate a person, and do not include investigations into alleged breaches of legislation although such investigations may be required to inform various enforcement actions.

The range of enforcement actions available to the department includes:

- warning notices and letters;
- penalty infringement notices;
- administrative notices and orders made under legislation;
- proceedings for court orders provided for under legislation;
- prosecution; and
- suspension or cancellation of permit, licence or authority.

Sometimes a number of enforcement actions may be taken in combination.

From time to time, the department becomes aware of matters that are offences against legislation it administers, and which are also offences against legislation administered by another government agency. In these circumstances, the following principles will apply:

- The department may consult the other agency to determine which agency should lead any investigation, and which agency would be the appropriate agency to take any enforcement action. There may be circumstances in which it is appropriate for a joint investigation to take place, and for each agency to take its own enforcement action.
- The department may be the appropriate agency to lead an investigation or take enforcement action where one or more of the following applies:
  - The subject matter is more closely aligned with the department's portfolio of responsibilities than that of the other agency.
  - Enforcement action by the department would more effectively prevent or remedy impacts on the environment or heritage than enforcement action by the other agency.
  - The penalties that apply for the offence under the department's legislation reflect the seriousness of the offence more accurately than the penalties under the other agency's legislation.
- The department will refer a matter to a local government for investigation or enforcement action where the matter is within the devolved responsibility of the local government.
- Where fraud or dishonesty or other criminal offences are involved, the department may refer the matter to the Queensland Police Service, the Australian Federal Police or other authorities as appropriate.

1.4 Principles

The following principles guide the department in making decision about taking enforcement action:

- Enforcement action will be proportionate to the seriousness of the breach.
- Decisions about enforcement action will be impartial, based on available evidence, and on the strategic objectives of the department.
- Where enforcement action involves litigation, the department is bound by the Queensland Government's Model Litigant Principles, which can be found on the Department of Justice and Attorney General website at <www.justice.qld.gov.au>. The principles ensure that, when conducting litigation, the department meets the community's and the courts' expectations that the State conduct itself in a manner which exemplifies the principles of justice, and that State's power be used in the public interest.

The department is guided by the overriding principle that enforcement action must not be taken for improper purposes. A decision whether or not to take enforcement action will not be influenced by factors such as:

- the alleged offender’s gender, ethnicity, nationality, political associations, religion or beliefs;
- a departmental employee’s personal feelings towards the alleged offender or the victim;
- possible political advantage or disadvantage to a government or any political group or party; or
- the possible effect of the decision on the personal or professional circumstances of those responsible for the decision.

2 Who enforcement action will be taken against

One of the main aims of Parliament in making a breach of the law a criminal offence is to deter the offenders and others from similar behaviour. By extending criminal liability to many people (for example, landowners and directors and managers of corporations), the law generates increased awareness and responsibility for environmental performance and heritage management within corporate structures and throughout the community.

Situations can arise where a number of people may be responsible for the commission of an offence and may therefore be liable for enforcement action. The department recognises that it may not always be appropriate to take enforcement action against every person who may be liable for an offence. The following sections set out what the department will consider when determining who enforcement action may be taken against.

2.1 Identification of offender(s)

In determining who was responsible for an offence, the department will take the following considerations into account:

- Who was primarily responsible for the offence, that is:
  - who committed the act;
  - who formed the intention (if relevant);
  - who created the material circumstances leading to the alleged offence; and
  - who benefited from the offence;
- What was the role of each alleged offender (where there is more than one alleged offender).

2.2 Notification

The department will also take into account any notification it receives of a breach by an alleged offender. It will specifically consider whether:

- the alleged offender notified the department of the breach promptly;
- the information assisted in the control or mitigation of any impacts on the environment or heritage;
- the information substantially aided the department's investigation of the incident;
- the information was available from other sources;
- there was a failure to comply with an obligation to notify the department of the breach, and/or
- the notification occurred prior to the department or any other regulatory body obtaining knowledge of the breach.

2.3 Corporate liability

Corporations as well as individuals can be liable for offences against legislation. Where an offence is committed by employees, agents or officers of a corporation in the course of their employment, proceedings will usually be commenced against the corporation. Where, however, the offence has occurred because the employee, agent or officer has committed an offence of their own volition, outside the scope of their employment or authority, proceedings may be instituted against the employee, agent or officer and not against the corporation. Another factor which will be considered is the existence and effective implementation of any training and compliance programs of the corporation.

2.4 Liability of employees and contractors

Employees' obligations under the department’s legislation cannot be overridden by an instruction from their employer—it is not a defence for an employee to assert that he or she was acting under direction from a supervisor, although this may be a consideration and a mitigating factor in sentencing or choice of appropriate enforcement action. This principle equally applies to contractors. Therefore the guiding principle in deciding whether to pursue an employee or a contractor is their degree of culpability or responsibility.

In addition to the issues set out in section 3.1.3, factors to be considered in assessing the degree of culpability include:

- whether the employee or contractor knew or should have known that the activity was likely to be illegal or inappropriate;
- the seniority of the employee and the scope of their duties;
- whether, having regard to the employee's seniority and employment duties or the contractor's contract, the employee or contractor had taken reasonable steps to draw to the attention of the employer or any other relevant person the impropriety of the practice; and
- whether the employee or contractor has taken reasonable steps to mitigate or prevent any impacts (if it was in the employee's or contractor's power to do so).

2.5 Liability of directors and executive officers

Most of the legislation administered by the department contains provisions extending liability for offences committed by a corporation to its executive officers.

When determining whether to take enforcement action against an executive officer in accordance with such a provision, the key consideration will be whether the person had actual control or influence over the conduct of the corporation in a relevant respect. As a general policy, the department will take enforcement action under the executive officer liability provisions only where evidence links the person with the corporation's illegal activity. That evidence will need to show, for example, that the executive officer:

- intended to engage in the action or omission;
- was negligent or reckless with respect to the action or omission;
- intended to deceive the department; or
- failed to monitor or periodically assess and manage risks associated with the corporation's relevant activities or review supporting systems and programs.

The general legislative exceptions to executive officer liability are that:

- the executive officer was not in a position to influence the corporation's conduct; or
- the officer took all reasonable steps to ensure that the corporation complied with the law.

The department may take the view that reasonable steps were taken to ensure that the corporation complied with the law where it can be demonstrated the executive officer ensured that:

- the corporation had an effective environmental or heritage risk management system in place which was aimed at ensuring compliance with relevant legislative requirements;
- all staff were aware of the system;
- the system had been effectively implemented throughout the corporation; and
- the system was regularly reviewed and was amended when necessary.

2.6 Unlicensed operators

When considering enforcement action against people conducting regulated activities without necessary approvals ('unlicensed operators'), the following principles apply:

- The department's first priority is to ensure that any risk of harm or impacts from an unlicensed operation is appropriately managed.
- The department will work cooperatively with other regulators who may also have responsibility for regulating the unlicensed activity (for example, an unlicensed industrial site may have failed to obtain a development approval from local government as well as an environmental authority from the department).
- In deciding the appropriate response, the department will take account of the level of competitive advantage enjoyed by the unlicensed operator as one factor for consideration, however in most cases, some type of enforcement action will be taken in response to an unlicensed operator.

- In rare cases, the department will defer enforcement action until an unlicensed operator has had the opportunity to obtain a licence and operate lawfully. In such cases the operator will be expected to meet contemporary standards for the management of its environmental risk.
- Where the offence is serious or persistent, the department will consider prosecution.

2.7 Liability of external administrators

In terms of ensuring compliance with legislation administered by the department, external administrators (including liquidators, receivers and managers and administrators) who are responsible for the management of a corporation, will be subject to the same considerations as other executive officers. External administrators who assume control of a corporation and become aware of activities or conduct that breaches legislation administered by the department should ensure that the activity or conduct ceases and that the department is informed of the activity or conduct. External administrators should also ensure that the company complies with any notices or orders given to the company by the department as far as is possible given the provisions of the *Corporations Act 2001*.

2.8 Liability of government agencies

The legislation administered by the department binds all persons, including government agencies. The decision to take enforcement action against a government agency will depend on whether to do so is in the public interest. The department acknowledges that there are two competing factors:

- That legislation administered by the department applies equally to both the private and public sectors, and the public has an expectation that both sectors will be treated equally.
- That it is the taxpayer who bears both the costs of a prosecution and ultimately any penalty imposed upon a public authority.

A decision about taking enforcement action against a government agency will consider these factors, together with the other matters set out in these guidelines.

3 Choice of enforcement action

3.1 Determining seriousness of a breach of legislation

The department determines the seriousness of a breach of legislation by reference to three general considerations:

- The objectives of the relevant legislation including the type of impact the offence provision is designed to deter or prevent.
- The actual or potential impact of the offence.
- The level of culpability of the alleged offender.

The seriousness of the breach of the legislation will inform the decision on the appropriate enforcement action taken in response to the offence. This guideline sets out five levels of seriousness for breaches of legislation: low, minor, moderate, major, and serious. Outlined below are some criteria which can be used to assist the department in assessing the level of seriousness of a breach. The tables below regarding the impacts of the offence and the level of culpability of the alleged offender indicate the way the level of seriousness may be determined for each of these considerations. The final assigned level of seriousness of the breach will balance each of these considerations.

3.1.1 Objectives of legislation

The objectives or purpose of any legislation are generally outlined at the beginning of the legislation, and provide context to the following legislative provisions. To determine the purpose of the particular offence provision, often it is useful to refer to both the objectives of the legislation and to other documents such as the explanatory notes or Parliamentary speeches.

The seriousness with which the Legislature views an offence may often be apparent by maximum penalty or class of offence assigned to it in the legislation. Where legislation designates levels or classes of offence, this will be considered in deciding the appropriate enforcement response.

3.1.2 Impact

The impact of an offence can be characterised by reference to the effects or consequences of the offence and also by reference to the act or omission the offence provision has been designed to prevent or deter (see the objectives of the legislation discussed above).

To determine the level of impact, for example for the offence of contravention of an environmental authority condition, reference may be made to the level and extent of impact on the environment resulting from the breach. Similarly, the level of impact of an offence involving unauthorised works on a heritage place may be measured by the level and extent of impact to the building, structure or place. For conservation offences, the level of impact may be measured both by the impact on the specific wildlife or protected area involved, and by reference to impacts or potential impacts on the species or protected area.

An offence not involving environmental, heritage or conservation impacts, for example for the offence of the providing false or misleading information to the department, may be characterised as an administrative offence. This does not mean that the offence is not serious. The seriousness of the impacts for administrative offences can be measured by reference to the impact on the legislative scheme or records the administrative requirements support. For example, the wilful provision of false or misleading annual returns to the department seriously undermines its ability to effectively administer its legislation. Examples of administrative offences include:

- failure to notify the department of a breach or non-compliance with the legislation;
- fraud or a breach that undermines a legislative scheme (e.g. failure to pay financial assurance, registration or other fees etc.);
- the provision of false or misleading statements in applications or other material submitted to the department;
- fraud or breach in a reporting requirement (e.g. failure to notify the department of an environmental incident); and
- failure to implement preventative measures (e.g. failure to train staff on Environmental Management Plans and procedures).

There may be some overlap between administrative offences and environmental, heritage or conservation offences.

Five levels of impacts have been developed to assist the department in classifying the seriousness of an alleged offence and inform a decision on the appropriate enforcement response (refer to Table 1 – Criteria to be considered in determining impact of breach). These levels also include the risk or potential impact of an alleged offence. If an offence satisfies criteria across a range of the impact levels, generally, it will be assigned the highest applicable level. For example, if there is an incident which has caused permanent impacts on the environment (which falls into the serious level), however the level of public concern is low (which falls into the minor level); the matter will be regarded as serious.

3.1.3 Culpability

Culpability refers to the blame and responsibility of the alleged offender for the alleged offence. Three levels of culpability have been developed which, along with the levels of impact, will assist the department in classifying the seriousness of an alleged offence and therefore determine the appropriate enforcement response (refer to Table 2 – Criteria to be considered in determining culpability of alleged offender). Again, if an alleged offender has satisfied criteria across a range of the levels, the most serious category will be assigned.

Table 1. Criteria to be considered in determining impact of breach

IMPACT	**5** **Serious impact or risk of impact**	**4** **Major impact or risk of impact**	**3** **Moderate impact or risk of impact**	**2** **Minor impact or risk of impact**	**1** **Low impact or risk of impact**
	• permanent, or potential for permanent, long-term impact on the environment, heritage or animal; • impact on the environment or heritage is on or potentially on a wide-scale, or of great intensity; • widespread or high level of public concern about the incident; and/or • where offence is of an administrative nature, it severely undermines the legislative scheme or the offender wilfully provides false or misleading information.	• medium to long-term impact, or potential impact, on the environment, heritage or animal; • impact on the environment or heritage is on or potentially on a medium to wide-scale, or of medium to great intensity; • high level of public concern; and/or • where the offence is of an administrative nature, it undermines the legislative scheme or the offender conceals information or avoids liability for fees or taking necessary actions to prevent offence.	• temporary to medium-term impact, or potential impact, on the environment, heritage or animal; • impact on the environment or heritage is on or potentially on a localised to medium scale, or is of a low to medium intensity; • moderate level of public concern; and/or • where the offence is of an administrative nature, it has a moderate impact on the legislative scheme, or the offender recklessly fails to comply with administrative requirement.	• transient impact, or potential impact, on the environment, heritage, or animal; • impact on the environment or heritage is on or potentially on a localised scale, or is of a low intensity; • low level of public concern; and/or • where the offence is of an administrative nature, it has no impact on the legislative scheme or is of an inadvertent nature.	• no impact, or potential impact, on the environment, heritage or animal; • no public concern; and/or • where the offence is of an administrative nature, it could not have been prevented.

Table 2. Criteria to be considered in determining culpability of alleged offender

CULPABILITY	3 Serious culpability	2 Moderate culpability	1 Low culpability
	• intentional or wilful acts; • past non-compliances or convictions involving the same or similar legislative provisions; • non-compliances of an ongoing duration; • no attempt at clean-up or remedial action undertaken; • motivated by profit or clearly benefits from the non-compliance; • involves fraud or serious misleading conduct; • failure to notify the department effectively or notification outside of reasonable timeframes; • wilful ignorance of clear directions or warnings (from either employees, consultants, the department, or other government officers) which may have prevented or mitigated the impact; and/or • the impact or risk of impact was obvious and/or preventable by implementing or following accepted industry standards.	• careless acts; • isolated prior non-compliances with legislation or similar legislation; • non-compliance of an medium duration; • genuine attempt at remediation or remediation partially effective; • attempt at notification of department of incident within reasonable timeframe; • may have benefitted from the non-compliance; • was aware of the risk of impact or the impact was foreseeable; and/or • the impact or risk of impact may have been prevented by following accepted industry standards.	• inadvertent acts; • no prior non-compliances with legislation or similar legislation; • non-compliance of short-term duration; • remediation effective; • notification of department of incident within reasonable timeframe; • did not benefit from the non-compliance; • the impact or risk of impact was not foreseeable; and/or • the impact or risk of impact was not prevented by high standards of operation (greater than accepted industry standards).

3.2 Application of objectives of legislation, impact, and culpability to offence

The department will exercise its discretion to take any enforcement action it considers appropriate in the circumstances, taking into account the seriousness of the breach of the legislation. The goal of some enforcement actions may be considered punitive, whilst others may be aimed at preventing, deterring or rectifying impacts of offences. Some enforcement actions do both; for example a prosecution may result in a fine (being punitive or a deterrent) and orders to remediate an affected area (rectifying the impacts of the offence).

There are seven general categories of enforcement actions available to the department:

- warning notices and letters;
- infringement notices;
- administrative notices and orders made under legislation;
- proceedings for court orders provided for under legislation;
- enforceable undertakings;
- prosecution; and
- suspension or cancellation of permit, licence or authority.

The choice of the enforcement action will be determined by reference to the seriousness of the breach of legislation and the desired outcome at the conclusion of the action.

As a guide, warning notices and letters are generally reserved for low or minor breaches; infringements notices for minor breaches, administrative notices and orders (with the exception of cancellation of licences or permits) for moderate to serious breaches; enforceable undertakings are considered to be an alternative enforcement action for moderate breaches; and court orders, prosecutions and cancellation of permits or licences are generally reserved for major or serious breaches of legislation.

4 Warning notices and letters

Warning notices and letters are generally not provided for in legislation, but are a response that the department may take in response to minor breaches of legislation where the imposition of a financial penalty is not considered appropriate, and where a warning that the offender's conduct is a breach of the legislation is considered a sufficient response.

Warning notices should be used for the most minor breaches of the department's legislation, involving little or no environmental or heritage impact and where the offender has a low level of culpability. They are not appropriate for ongoing or repeated minor breaches to legislation.

5 Infringement notices

Infringement notices are a means of dealing with minor breaches of legislation administered by the department which warrant some form of sanction, but which are not serious enough to warrant a prosecution. Such breaches might include a minor contravention of a licence or permit condition, littering of rubbish or cigarette butts, or illegal dumping of waste. Infringement notices have the advantage of allowing an offence to be dealt with quickly and without the time and cost involved in a prosecution.

The issuing of infringement notices is governed by the *State Penalties Enforcement Act 1999*. The offences for which infringement notices can be issued, and the associated penalties, are set out in the State Penalties Enforcement Regulation 2000.

While an infringement notice is issued because a person has committed an offence, payment of the penalty does not lead to the recording of a criminal conviction against the person (although the department will record the infringement notice against the person's compliance history). Non-payment of the penalty is recoverable as a debt.

If a person elects to contest the infringement notice, the department will review the matter, confirm that the evidence establishes that an offence has been committed, and if so, commence a prosecution in the Magistrates Court. If a person who contests an infringement notice is found guilty, the Court may impose a penalty higher than the amount of the infringement notice, and may order the payment of costs and the recording of a conviction.

In making decisions about issuing an infringement notice, the department will be guided by the following principles:

- Infringement notices should be issued where the breach is minor and the scale of the impact is known and small.
- An infringement notice will generally not be appropriate where the breach is ongoing.
- Infringement notices should not be issued for multiple offences arising out of the same course of conduct, unless the offences go to separate and distinct aspects of that conduct.
- Infringement notices should be issued only where the facts of the offence are apparently indisputable.
- Infringement notices should be issued only where the infringement notice is likely to act as a deterrent. If an infringement notice is not likely to deter the offender from committing a similar offence in the future, consideration should be given to whether prosecution is a more appropriate response. For example, an infringement notice should not be issued where the benefit gained by the commission of the offence is greater than the fine imposed.
- Infringement notices should be issued as soon as reasonably possible after the offence comes to the attention of the department.

6 Administrative actions

Administrative actions are enforcement actions that include the range of notices and orders that the department may issue under legislation it administers in order to secure compliance with obligations under that legislation. They are generally used in response to moderate to serious breaches of the legislation. Administrative actions differ from prosecutions and infringement notices in that they are usually aimed at preventing or rectifying a breach of the legislation, while prosecutions and infringement notices are usually aimed at punishing and/or deterring unlawful conduct.

The department may take an administrative action where:

- it is the most effective means of preventing or rectifying impacts on the environment or heritage; and
- it is reasonable and proportionate in light of all of the relevant circumstances.

The taking of a particular administrative action by the department does not preclude it from taking other enforcement action (including other administrative actions). In order to properly and effectively address breaches of the legislation, a number of enforcement actions may need to be taken either simultaneously or over time as part of a strategy for addressing the offending conduct and achieving a sound environmental or heritage management outcome.

For example, it may be appropriate to issue a notice to conduct an environmental evaluation to a corporation to determine the cause of a particular equipment failure which led to an unlawful emission; however this administrative action does not prevent the department from prosecuting the company for the unlawful emission associated with the equipment failure. In this example, the environmental evaluation informs the necessary steps to rectify and prevent the equipment failure in the future, whilst the prosecution will punish and deter the conduct that resulted in the unlawful emission.

In some situations it may not be appropriate to take more than one enforcement action in response to a situation. For example, it may not be appropriate to issue an environmental protection order to require certain actions by the recipient where a transitional environmental program is in force (and is being complied with) to rectify the same issue.

When deciding whether to take or not take administrative action, the department will comply with the requirements of the legislation that authorises the action, the principles of natural justice and any other requirements of a lawful administrative decision.

7 Civil proceedings for court orders

Most of the legislation administered by the department administers enables it to apply for civil court orders requiring a person to stop committing an offence, or to remedy or rectify the consequences of an offence. Applications for court orders are generally appropriate in circumstances where there has been a major or serious breach of the legislation.

These applications are civil proceedings (governed by civil procedures and burdens of proof) as opposed to criminal proceedings as is the case with prosecutions. In commencing and conducting proceedings for court orders, the department will adhere to the Model Litigant Principles (refer to section 0 of these guidelines).

The department may commence proceedings for such orders where:

- sufficient evidence exists to satisfy the requirements of the legislation under which the proceedings are to be brought;
- the department has reasonable prospects of success; and
- the orders sought by the department will likely address the offending behaviour or the consequences of the offence.

8 Enforceable Undertakings

An enforceable undertaking is a published agreement between the department and a person which can require the person to carry out a wide range of actions to achieve compliance with the *Environmental Protection Act 1994* and further improve the protection of the environment. An enforceable undertaking can be suggested by the department or initiated by a person where there has been a breach or breaches of the *Environmental Protection Act 1994*, provided the breach or breaches are not indictable offences.

An enforceable undertaking is essentially an alternative to prosecution and whilst it does not require an admission to be made in relation to a contravention(s), it does require the inclusion of a statement of regret and must detail the circumstances that led to the contravention(s). For further information on enforceable undertakings, refer to the Guideline – Enforceable undertakings under the *Environmental Protection Act 1994* (EM1388) available on the EHP website.

9 Prosecution

Prosecution is part of the department's strategy for achieving its legislative and policy objectives, however as outlined in these guidelines it is usually not the only enforcement action available and will be used after careful consideration. If an alternative to prosecution may be more effective in achieving the objects of the legislation, then that alternative will be considered. Prosecutions may be an appropriate enforcement action in response to major or serious breaches of the legislation.

9.1 The decision to prosecute

The decision to prosecute is generally made by the Deputy Director-General of the Environmental Services and Regulation division on behalf of the department. The decision is based on:

- whether the available evidence provides reasonable prospects of successfully obtaining a conviction; and
- if so, whether it is in the public interest to exercise the discretion to commence a prosecution.

9.1.1 Prospects of success

The determination of prospects of success of a proposed prosecution will consider whether:

- the available evidence is capable of proving each element of the offence beyond reasonable doubt;
- the admissibility of evidence;
- the credibility of available witnesses;
- the availability or strength of any expert evidence required to prove the offence; and
- any defences that are plainly open to the alleged offender.

9.1.2 Public interest considerations

The commencement of a prosecution is discretionary, and the dominant factor in the exercise of that discretion is the public interest. When deciding whether to commence a prosecution the department may take into account the following public interest considerations:

- the seriousness of the offence including the impacts or potential impacts the environment or heritage caused by the alleged offence;
- the degree of culpability of the alleged offender including any mitigating or aggravating circumstances (including notification, cooperation or a display of contrition);
- the availability and effectiveness of any alternatives to prosecution;
- the alleged offender's compliance history;
- whether the alleged breach is a continuing or subsequent offence;
- the prevalence of the alleged offence and the need for general deterrence;
- the length of time since the alleged offence occurred;
- the age and physical or mental health of the alleged offenders;
- whether there are counter-productive features of the prosecution;
- in cases involving Aboriginal and Torres Strait Islander use or management of natural resources, the views of the traditional owners of the area;
- the length and expense of any court hearing;
- the likely outcome in the event of a conviction having regard to the sentencing options available to the court;
- any precedent which may be set by not instituting proceedings;
- whether the consequences of a prosecution would be unduly harsh or oppressive;
- whether proceedings are to be instituted against others arising out of the same incident;
- the sentencing principles set out in the *Penalties and Sentences Act 1992;* and

- the extent to which the alleged offender cooperates in the investigation or prosecution of other offenders.1

In addition to the public interest factors, the decision to commence a prosecution will also take account of the principles in section 0 of these guidelines.

Once a decision has been made to prosecute, the department must present the evidence fairly and impartially to the court. The department's only interest in procuring a conviction is to ensure that the right person is convicted, that the truth is known and that justice is done.

9.2 Choice of charges

The charges against an alleged offender must reflect the nature and extent of the conduct disclosed by the evidence, with the aim of providing a basis for the court to impose an appropriate penalty and make appropriate orders. There will be occasions where the same conduct is prohibited under separate statutes and involves an offence under each. In circumstances where it would be inappropriate to lay both charges, the department will consider the legislation and exercise its discretion to lay charges for a breach of one of the offence provisions taking into account the seriousness of the alleged conduct and the penalties available for each offence provision. Where another prosecuting agency is involved, the department will liaise with the other agency to ensure the most appropriate charge(s) are made (refer to section 1.3 of these guidelines).

9.3 Mode of trial – summary or indictable proceedings

Most offences under legislation administered by the department are summary offences which are heard and dealt with by a magistrate. However, some offences are indictable and may be heard in the District Court at the election of the prosecution, the defendant or the magistrate.

Proceeding summarily on an indictable offence may have the effect of limiting the custodial or financial penalty that may be sought by the prosecution and imposed by the Magistrates Court. For prosecutions commenced by the department, the decision as to whether to proceed on indictment rests with the Office of the Director of Public Prosecutions (ODPP). Before referring the matter to the ODPP, the department will consider the ODPP's guidelines which set out the test to be applied to determine whether a prosecution should proceed on indictment.

9.4 Charge negotiations

Once a prosecution has commenced, the department may enter into discussions with a defendant about which charges should proceed to a hearing. No agreement can be reached with a defendant who is not prepared to take responsibility for the impacts of their unlawful conduct. When taking part in discussions, the department will take into consideration the public interest considerations outlined in section 9.1.2, and:

- any new information received by the department that was not available when the original decision to prosecute was made;
- whether the potential penalty, the remaining charges, or remaining defendants set an unsatisfactory precedent for the conduct; and
- whether a negotiated response provides an adequate deterrent for similar conduct, and adequately reflects the seriousness of the matter.

[1] The department does not have the power to grant indemnity from prosecution to accomplices; this power resides with the Attorney General. The Office of the Director of Public Prosecutions (ODPP) Guidelines set out how an application for an indemnity from prosecution can be made. The ODPP Guidelines are available online at http://www.justice.qld.gov.au. An accomplice who pleads guilty and agrees to testify against an alleged co-offender may receive a sentencing discount for that co-operation.

9.5 Sentencing considerations

The *Penalties and Sentences Act 1992* outlines the general factors that can be considered by a court at sentence. The following is a non-exhaustive list of factors which may be considered by the department in preparing sentence submissions:

- The impacts or potential impacts resulting from the offence, including:
  - the seriousness of the impact, or risk of impact, on the environment, heritage and/or community (the 'victim' of the offence);
  - the potential for the impacts to be rectified or mitigated.
- The culpability of the offender, including:
  - the steps taken by the defendant to rectify or mitigate the impacts;
  - the level of cooperation by the defendant with the department;
  - any prior convictions of the defendants relevant to environmental or heritage protection;
  - any benefit or profit derived by the defendant due to the offence.
- The level of penalty sufficient to deter others from similar conduct.
- The prevalence of the offence.
- The availability and appropriateness of alternative sentencing orders.
- The maximum penalty for the offence.
- Any relevant sentencing precedents or comparative cases.

9.6 Sentencing orders

In addition to any penalties, fines or orders which may be made by the courts under the *Penalties and Sentences Act 1992*, legislation administered by the department provides for additional specific orders upon sentencing an offender for an environmental or heritage offence. The premise of these additional orders is to provide court with the flexibility to impose a penalty that:

- is proportionate and tailored to the particular circumstances of the case;
- will enhance compliance with the environmental or heritage management legislation; and
- will allow for remediation of any impacts caused and/or compensation paid to those affected.

Many other jurisdictions around Australia have incorporated these types of orders into their environmental protection legislation, and have been successfully applying them for some time. The department will seek such orders in appropriate circumstances, and with reference to any applicable policies.

9.7 Recording of Convictions

Section 12(2) of the *Penalties and Sentences Act 1994* (the PSA) gives the Court the discretion to decide to record or not record a conviction for an offence.

The decision about whether a conviction is recorded lies entirely within the discretion of the Magistrate or Judge presiding over a particular case. Some factors which the PSA states must be considered by the Magistrate or Judge in exercising their discretion are:

- the nature of the offence;
- the offender's character and age; and
- the impact that recording a conviction will have on the offender's economic or social wellbeing, and their chance of finding employment.

EHP will always consider the individual circumstances of the case when deciding whether to ask the Court to record a conviction.

Subject to the individual circumstances of the case, EHP will ask the Court to record a conviction where:

- there is a wilful element to the offence; or
- the nature of the offence is serious – such as for serious environmental harm, material environmental harm, or providing false or misleading information or documentation to EHP; or
- the defendant has previously been successfully prosecuted by EHP or found guilty of a similar offence in Queensland or another jurisdiction; or
- there is a commercial element to the offence, that is, the offender was likely to have obtained a commercial gain as a result of the offence.

EHP may also ask the Court to record a conviction where:

- the defendant is a corporation; or
- the defendant failed to notify EHP of an offence where it was required to do so by legislation or other document (such as environmental authority, transitional environmental program or temporary emissions licence); or
- the defendant has a compliance history with EHP; or
- there is rehabilitation required as a result of the offence.

Whenever EHP asks the Court to record a conviction, it will do within the ambit of the PSA and will take into account the factors that the Court must consider under section 12(2) of the PSA.

9.8 Appeals against sentence

While the department may appeal against a sentence imposed by a court, such appeals are generally rare. In considering whether to appeal against a sentence, the department will have regard to the principles regarding appeals against sentence set out in the ODPP guideline's, as well as the Model Litigant Principles (refer to section 1.4 of the Enforcement Guidelines). An appeal will only be instituted where the department considers that the appeal is likely to succeed.

10 Suspension or cancellation of licence, permit or authority

Legislation administered by the department usually contains a list of grounds for the suspension or cancellation of permits, licences or authorities. These grounds might include a failure to perform administrative requirements such as payment of fees or lodging of returns. They might also include the holder being convicted of an offence under that legislation or not meeting the legislative suitability criteria for the permit, licence or authority.

Payment of fees due under legislation is a fundamental obligation of someone who holds an approval from the department. Operators who fail to pay fees obtain a commercial advantage over their competitors, and can undermine the legitimacy of the regulatory regime. Where legislation administered by the department permits, the department may suspend the relevant permit, licence or authority of an operator with overdue fees until the fees are paid.

When deciding whether to cancel or suspend a licence, permit or authority, the department may consider any suitability criteria or standards and the following matters:

- the seriousness of the breach of legislation;
- the connection of the breach to the permit, licence or authority conditions;
- the culpability of the permit, licence or authority holder in relation to the breach;
- the likelihood that further breaches of legislation will be committed by the permit, licence or authority holder; and
- the need to protect the environment and community from further potential breaches.

The aim of cancellation or suspension of a permit, licence or authority is not punitive; rather it is based on the need to protect the environment and community from unsuitable operators.

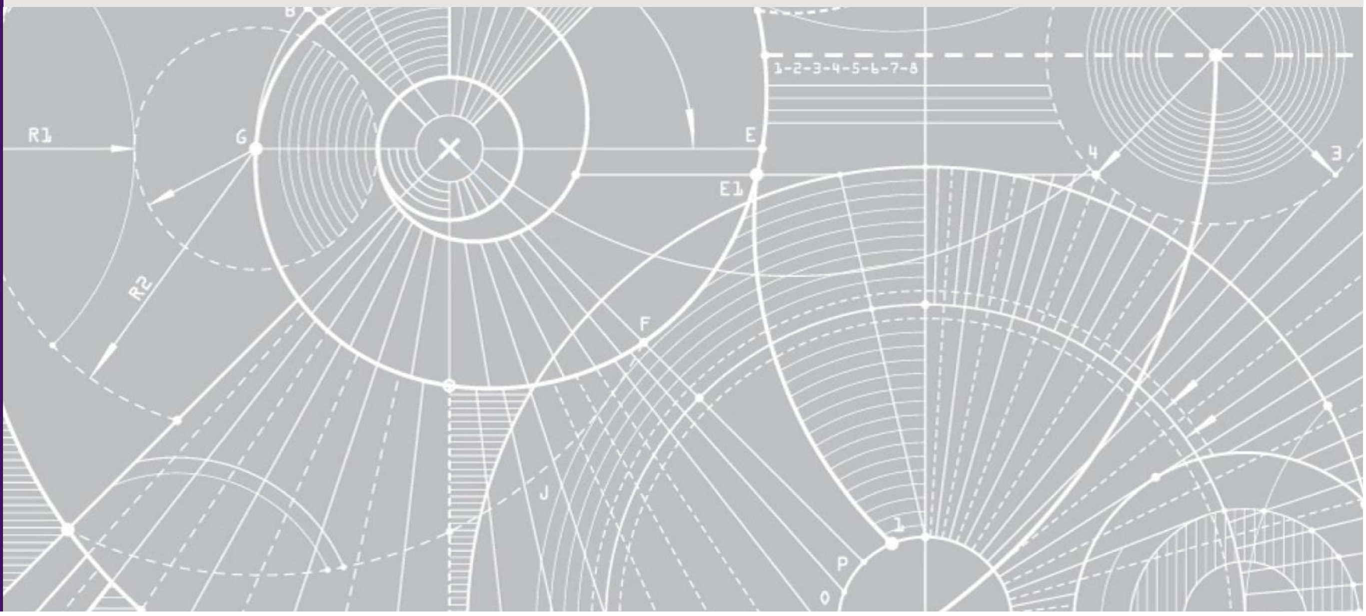
Collinsville Optimisation Project

GLENCORE COAL QUEENSLAND PTY LTD

Air quality impact assessment

EN04357 | Final

4 Jul 2014



SINCLAIR KNIGHT MERZ

SKM

Collinsville Optimisation Project

Project no: EN04357
Document title: Air quality impact assessment
Document no: EN04357
Revision: Final
Date: 4 Jul 2014
Client name: Glencore Coal Queensland Pty Ltd
Client no: -
Project manager: Shane Lakmaker
Author: Shane Lakmaker
File name: I:\ENVR\Projects\EN04357\Deliverables\Reports\EN04357_SKM_Air quality_Final.docx

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Document history and status

Revision	Date	Description	By	Review	Approved
1	20/2/14	First draft	S Lakmaker	M Davies	E Ebert
2	3/3/14	Second draft	S Lakmaker	COL	E Ebert
Final draft 1	28/3/14	Final draft	S Lakmaker	COL	E Ebert
Final draft 2	6/6/14	Final draft	S Lakmaker	COL	E Ebert
Final	4/7/14	Final	S Lakmaker	COL	E Ebert

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Executive summary

This report provides an assessment of potential air quality impacts due to a proposed increase in mining rate at the Collinsville Mine (hence forth referenced as the Project). The main objectives of this assessment were to identify potential air quality issues for the existing and proposed mining activities, and quantify potential air quality impacts.

The key potential air quality issues were identified as:

- Dust from the general mining activities;
- Fume from blasting; and
- Odour and other substances due to potential spontaneous combustion of coal.

The computer-based dispersion model known as CALPUFF was used to predict air quality impacts at the nearest sensitive receptors. The dispersion modelling took account of meteorological conditions, landuse and terrain information and used dust emission estimates to predict the off-site air quality impacts. The significance of the model predictions were assessed by comparing results with Queensland air quality objectives.

A review of the existing environment showed that winds in the Collinsville area are generally favourable for transporting emissions from the mine away from sensitive receptors.

In regards to the Project, the main conclusions of the assessment were as follows:

- TSP and $PM_{2.5}$ concentrations are predicted to comply with the respective air quality objectives at all sensitive receptor locations, for existing and proposed mining scenarios.
- Existing and proposed mining activities, on their own, will comply with the PM_{10} objective (50 $\mu g/m^3$). However, there is a potential risk that proposed activities will contribute, cumulatively, to more than five exceedances of the 24-hour average PM_{10} objective at two locations ("Hillview Station" and "Emohruo Station"), especially if background PM_{10} levels are higher than average.
- Model predictions of dust deposition were found to be overly conservative and not representative of potential existing and future impacts. Maximum monthly dust deposition was predicted to exceed the 120 mg/m^2/day objective at "Hillview Station" for existing and proposed mining scenarios, and at "Emohruo" for the proposed 9.9 Mtpa scenario. However, monitored dust deposition at these locations have not exceeded the 120 mg/m^2/day objective in the past ten years even with existing mining operations. The model predictions for the existing scenario were nearly double the monitored levels so it was anticipated that dust deposition would not be the most critical particulate matter classification.
- Post-blast fume is not expected to cause adverse impacts at any sensitive receptor, based on model predictions which complied with the relevant air quality objective and assuming appropriate management procedures are in place.
- There will be an increased focus on the management of potential air quality issues associated with spontaneous combustion. This was demonstrated by the development of a detailed hierarchy of management controls, specific monitoring of ambient air quality, development of a trigger action response plan, and implementation of a forecasting system to identify potential risks.

It is important to note that non-sensitive location agreements (in accordance with condition A24 of the Environmental Authority) have been entered into with the owners of both "Hillview" and "Emohruo" and, hence, these places are therefore not considered to be sensitive places for the purposes of the Environmental Authority. Nonetheless, the conclusions above indicate that emissions will need to be appropriately managed in order to maintain off-site dust concentrations and deposition levels at or below existing levels including at the potentially most impacted receptor, Hillview Station.

Collinsville Mine is proposing further emphasis on dust management as part of the Project. A dust management Trigger Action Response Plan (TARP), which defines "trigger" levels and actions, has been developed and will

be implemented. The TARP defines trigger levels based on visual, meteorological, ambient air quality and forecast dust conditions, with associated actions for controlling dust emissions.

Modelling was undertaken to determine the effectiveness of this TARP approach. It was found that a dust management TARP will be an effective strategy to minimise off-site air quality impacts. It was also anticipated that the additional combination of real-time PM_{10} concentration monitors, meteorological data, a predictive dust system, and visual observations will further improve the effectiveness of the TARP.

Existing air quality and “background levels” were determined from long-term monitoring records collected prior to 2014. Collinsville Mine has recently (February 2014) commenced the installation of seven real-time PM_{10} concentration monitoring units in various locations around the site. It is anticipated that these units will issue alerts (based on the TARP) if short-term concentrations exceed trigger levels, so that mining activities can be modified as required to make sure off-site impacts are kept within acceptable levels at all sensitive receptors.

1. Introduction

Glencore Coal Assets Australia (Glencore) is currently reviewing a number of long term mine planning scenarios for Collinsville Coal Mine. This report provides an assessment of air quality impacts associated with one potential scenario involving an increase in the annual production rate from the current Run of Mine (ROM) approved 5.9 million tonnes per annum (Mtpa) licensed under Collinsville's current Environmental Authority (EA) (EPML00332013) to 9.9 Mtpa (hence forth referenced as the Project).

The main objectives of this assessment were to:

- Identify potential air quality issues for the existing and proposed mining activities;
- Quantify potential air quality impacts; and
- Identify suitable air quality management measures, as appropriate, to minimise impacts.

The assessment was based on the use of an air dispersion model to predict concentrations of substances emitted to air due to the mining activities. Model predictions have been compared with air quality objectives referred to by the Queensland Department of Environment and Heritage Protection (DEHP) in order to assess the effect that the Project may have on the existing air quality environment.

In summary, the report provides information on the following:

- Existing and proposed mining activities (**Section 2**);
- Potential air quality issues (**Section 3**);
- Relevant air quality objectives (**Section 4**);
- Sensitive receptors and existing meteorological and air quality conditions (**Section 5**);
- Emissions to air from existing and proposed mining activities (**Section 6**);
- Methods used to predict air quality impacts (**Section 7**);
- Expected air quality impacts, as determined by a comparison of model results with air quality assessment objectives (**Section 8**); and
- Suitable air quality management measures to be implemented such that potential impacts are avoided as far as practicable (**Section 9**).

2. Project Description

Glencore operates the Collinsville Mine, at the northern tip of the Bowen Basin. The mine is an open cut operation producing a variety of coking and steaming coal products for both overseas and domestic markets. Collinsville Mine is seeking approval to increase production from the existing approved rate of 5.9 Mtpa to 9.9 Mtpa ROM coal (the Project). This would be done by an increase to the existing mining fleet. There would be no change to the extent of approved mine disturbance areas or methods of mining.

The location of Collinsville Mine is shown in **Figure 1**. This figure also identifies the nearest sensitive receptors where Collinsville and Scottsville represent the towns. One of the main objectives of this assessment was to determine how air quality may change at these nearest receptors as a result of the Project. This was done by quantifying the potential impacts of both existing (approved) and proposed mining activities. It is acknowledged that there are sensitive receptors outside the extent of **Figure 1** but potential impacts from the mine on these receptors would be much lower than those presented in this report for the nearest receptors.

Figure 1 Location of Collinsville Mine

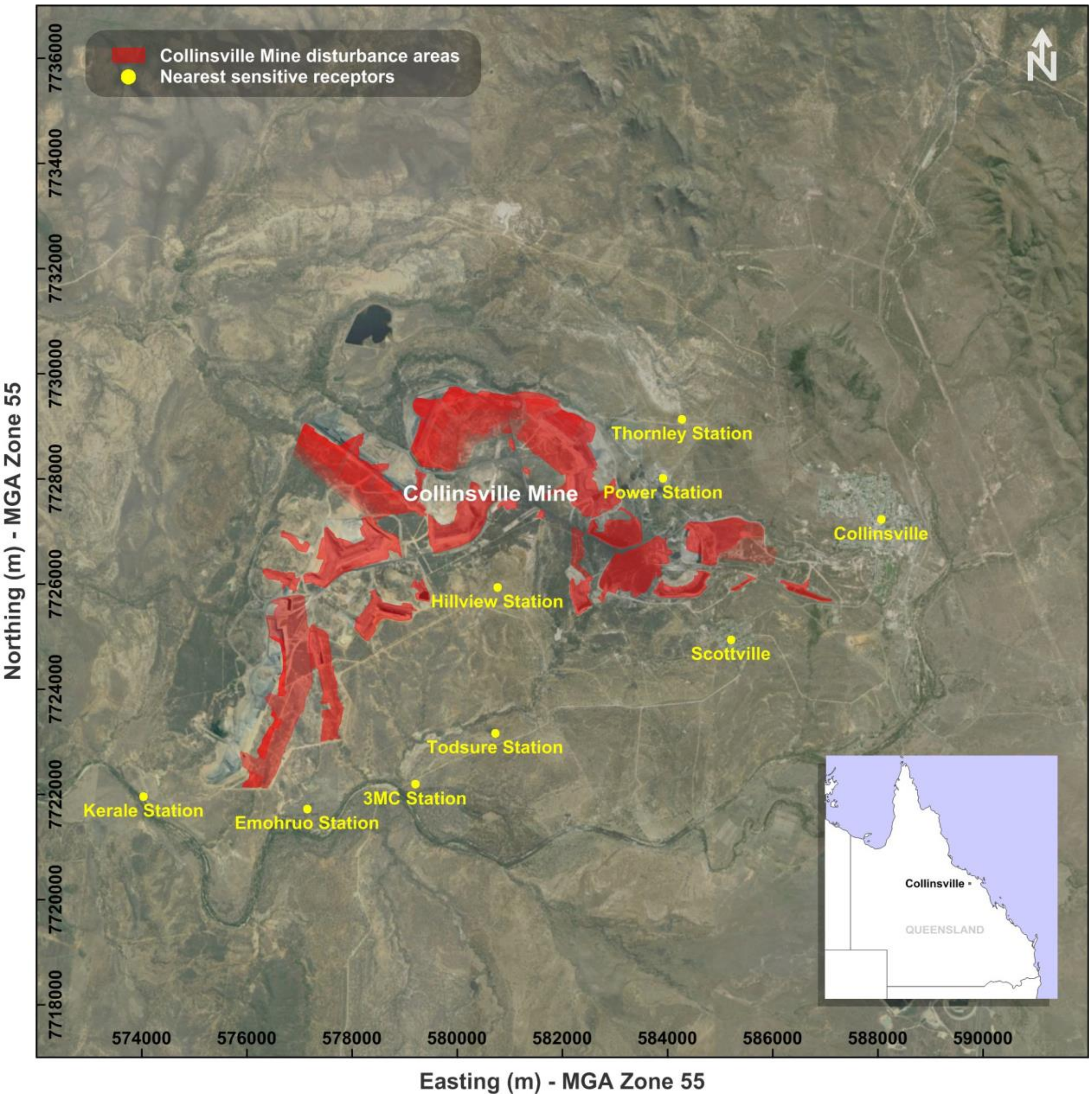
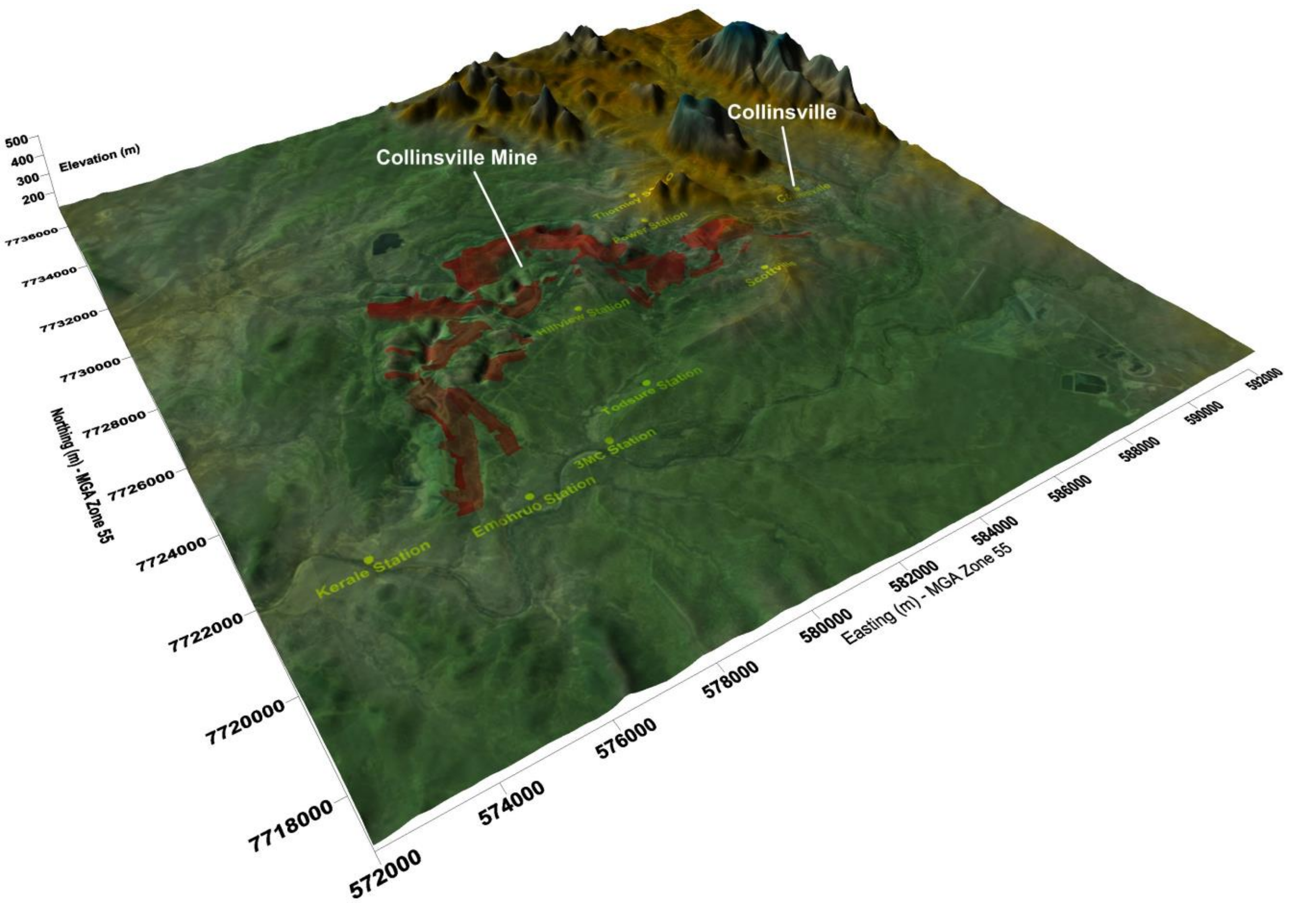


Figure 2 shows the topography in the vicinity of Collinsville Mine. The most significant topographical features are the hills in the northeast of the study area which rise to around 500 m AHD. Collinsville is to the south of these hills, at around 200 m AHD. This topographical information has been used in the development of the air quality models, discussed further in **Section 7**.

Figure 2 Topography in the vicinity of Collinsville Mine



Mining activities are planned to be open cut surface extraction undertaken by conventional truck and shovel activities, and assisted by draglines for overburden removal. Activities will continue to be conducted for up to 24-hours per day, except in the case of blasting which will be restricted to day time hours.

In general, the mining activities will include:

- Removal of vegetation and topsoil in advance of each mining strip;
- Drilling and blasting of overburden prior to excavation;
- Strip mining using excavators and draglines, assisted by dozers to uncover the coal seams;
- Loading to rear dump trucks for transport to emplacement areas or ROM pad; and
- Progressive rehabilitation of the overburden emplacements.

Glencore is also proposing two rehabilitation and closure projects which will be undertaken on a campaign basis. The activities associated with these project are described and assessed in **Section 8.2**.

Further details on the Project can be obtained from Collinsville Mine[1].

[1] http://www.xstratacoal.com/EN/Operations/Pages/CollinsvilleCoal.aspx

3. Air Quality Issues

Air quality issues can arise when emissions from an industry or activity lead to deterioration in the ambient air quality. Potential air quality issues have been identified from a review of the Project and associated activities. This identification process has considered the types of emissions to air and proximity of these emission sources to sensitive receptors.

Emissions to air would be from a variety of activities including material handling, material transport, processing, wind erosion, blasting and potentially spontaneous combustion of coal. These emissions would mainly comprise of particulate matter (TSP, PM_{10} and $PM_{2.5}$) although there could also be minor emissions (relatively) from machinery exhausts such as carbon monoxide (CO) and oxides of nitrogen (NO_x), and to a lesser extent carbon dioxide (CO_2), sulphur dioxide (SO_2), hydrogen sulphide (H_2S) and a range of volatile organic compounds from the potential spontaneous combustion of coal.

In summary, the key air quality issues associated with the existing and proposed mining activities have been identified as:

- Dust (that is, particulate matter in the form of TSP, PM_{10} or $PM_{2.5}$) from the general mining activities;
- Fume (that is, NO_x emissions) from blasting; and
- Odour and other substances (such as visible emissions or smoke / fine particulates) due to the potential spontaneous combustion of coal.

The issues identified above are the focus of this assessment.

4. Air Quality Objectives

Typically, air quality is quantified by the concentrations of air pollutants in the ambient air, where an air pollutant is a substance that is known to cause health, nuisance and/or environmental effects. With regard to human health and nuisance effects, the air pollutants most relevant to the Project would be those associated with the general mining activities, identified in **Section 3**.

The *Environmental Protection Act 1994* provides for the management of the air environment in Queensland and air quality objectives have been prescribed by the DEHP in the *Queensland Environmental Protection (Air) Policy 2008 (EPP (Air))*. The purpose of the EPP (Air) is to protect the air quality environment for human health and wellbeing, the health and biodiversity of ecosystems, the aesthetics of the environment and for agricultural use. The air quality objectives in the *EPP (Air)* which are relevant to the Project are presented in **Table 1**.

Table 1 Relevant air quality objectives

Pollutant	Averaging time	Objective	Allowable exceedances
Particulate matter (TSP)	Annual	90 µg/m^3	-
Particulate matter (PM_{10})	24-hour	50 µg/m^3	5 days each year
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m^3	-
	Annual	8 µg/m^3	-
Deposited dust	Monthly	120 mg/m^2/day	-
Nitrogen dioxide (NO_2)	1-hour	250 µg/m^3	1 day each year
	Annual	62 µg/m^3	-
Carbon monoxide (CO)	8-hour	11 mg/m^3	1 day each year
Sulphur dioxide (SO_2)	1-hour	570 µg/m^3	1 day each year
	24-hour	230 µg/m^3	1 day each year
	Annual	57 µg/m^3	-
Hydrogen sulphide (H_2S)	24-hour	160 µg/m^3 (health)	-
	30-minute	7.5 µg/m^3 (aesthetic)	-

Most of the DEHP objectives are drawn from national standards for air quality set by the National Environmental Protection Council of Australia (NEPC) as part of the National Environment Protection Measures (NEPM). The NEPM describes their $PM_{2.5}$ standards as "advisory reporting standards" which are designed to facilitate the collection of data. As part of the *EPP (Air)* the DEHP has adopted these standards for assessment purposes.

The *EPP (Air)* does not prescribe any objectives for deposited dust, for the protection against nuisance impacts. In the absence of such objective the value adopted for deposited dust was derived from the *Environmental management of mining activities* (EPA 2003). This value (120 mg/m^2/day expressed as a monthly average) is the same as the value prescribed in Collinsville Mine's EA however it is noted that the DEHP has more recently referred to a value of 133 mg/m^2/day for coal dust management[2] which is also equivalent to the dust deposition criteria used in NSW; namely, 4 g/m^2/month.

Finally, the objectives listed in **Table 1** relate to the total concentration of air pollutant in the air (that is, cumulative) and not just the contribution from project-specific sources. Therefore, some consideration of

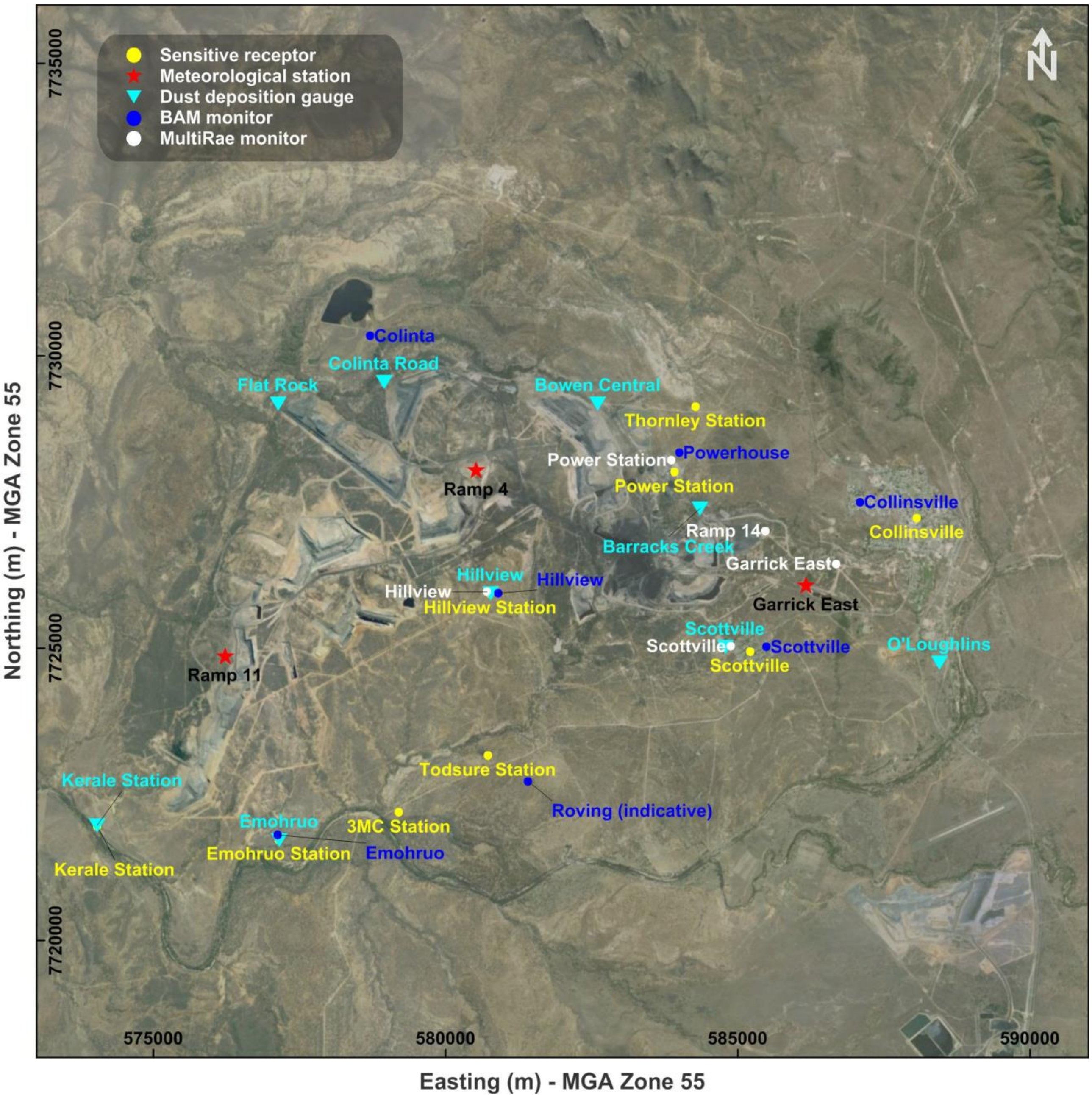
[2] see http://www.ehp.qld.gov.au/management/coal-dust/index.html

background levels needs to be made when using these criteria to assess impacts. Further discussion of background levels in the study area is provided in **Section 5.2**.

5. Existing Environment

This section provides a description of the environmental characteristics in the area, including a review of the local meteorological and ambient air quality conditions. The review considers data collected from Collinsville Mine's existing meteorological and dust deposition monitoring network, the locations of which are shown below in **Figure 3**. There are currently three meteorological stations and twelve dust deposition gauges. Two DustTrak monitors were installed late 2013 (at Scottville and Collinsville) as an interim management measure prior to the installation of seven beta attenuation mass monitors, which commenced in February 2014.

Figure 3 Location of meteorological and air quality monitoring sites



5.1 Dispersion Meteorology

Meteorological conditions are important for determining the direction and rate at which emissions from a source will disperse. The key meteorological requirements of air dispersion models are, typically, hourly records of wind speed, wind direction, temperature, atmospheric stability class and mixing layer height. For air quality assessments, a minimum one year of hourly data is usually required, which means that almost all possible meteorological conditions, including seasonal variations, are considered in the simulations.

For reasons identified below, the data used for this assessment were simulated by meteorological modelling (TAPM), discussed in detail in **Section 7.2**. The data consisted of hourly records of temperature, wind speed and wind direction, among other parameters, and information for three years (2011, 2012 and 2013) was simulated in order to examine the variability in meteorology from year to year, and to identify a representative meteorological dataset for use in the final meteorological modelling (CALMET) and air dispersion modelling (CALPUFF).

Annual wind-roses for 2011, 2012 and 2013 (as simulated by TAPM) are provided in **Figure 4**. These figures show the simulated frequency and speed of winds from each direction. The wind-roses show that, in the Collinsville area, the prevailing winds are from the southeast and east. This pattern of winds is evident for all years of data suggesting that there is little variation in wind patterns from year to year.

Figure 5 and **Figure 6** show the wind patterns in 2013 as measured by the Garrick East and Ramp 11 meteorological stations respectively. Data from the Ramp 4 meteorological station were also reviewed but there was a six month period of zero wind direction so these data were not processed further. It should be noted that the wind sensors at all three meteorological stations were 3 m above the ground, which is lower than the 10 m recommended measurement height for air quality applications in AS3580.14-2011. This means that the measured winds would tend to be lower than if the measurements were taken at 10 m. Nevertheless, the wind-roses from **Figure 5** and **Figure 6** show consistency with the simulated patterns, whereby the prevailing winds are from the eastern sector. This pattern of wind is favourable for minimising the transport of emissions from Collinsville mine towards the town.

Rainfall records from the Bureau of Meteorology show that, at Collinsville Post Office, the average rainfall from 75 years of data is 714 mm (BoM 2014). The annual rainfall for 2011, 2012 and 2013 was 858, 783 and 647 mm respectively.

Meteorological data from the 2013 calendar year have been chosen for the modelling. This selection was based on consistency of wind patterns with other years, consistency with operational information for the “existing” scenario, and slightly lower than average rainfall which may represent a conservative year in terms of emission generation. Although production in 2013 was lower than other years, the modelling has assumed that operations were at the approved maximum rate of 5.9 Mtpa.

Methods used for the meteorological and dispersion modelling are described in **Section 7**.

Figure 4 Simulated wind patterns at Collinsville Mine / Garrick East (2011, 2012 and 2013)

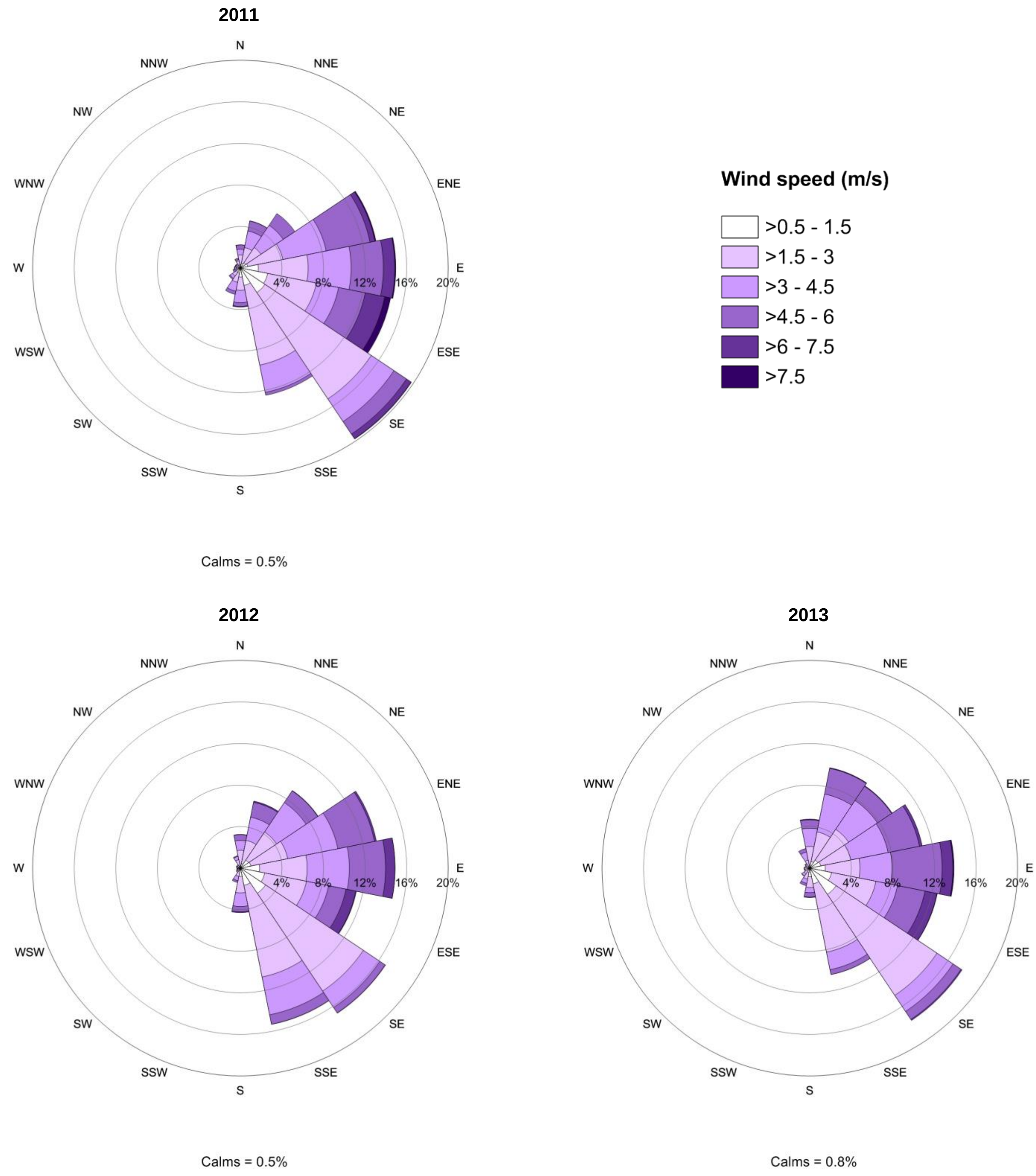


Figure 5 Measured wind patterns from the Garrick East meteorological station (2013)

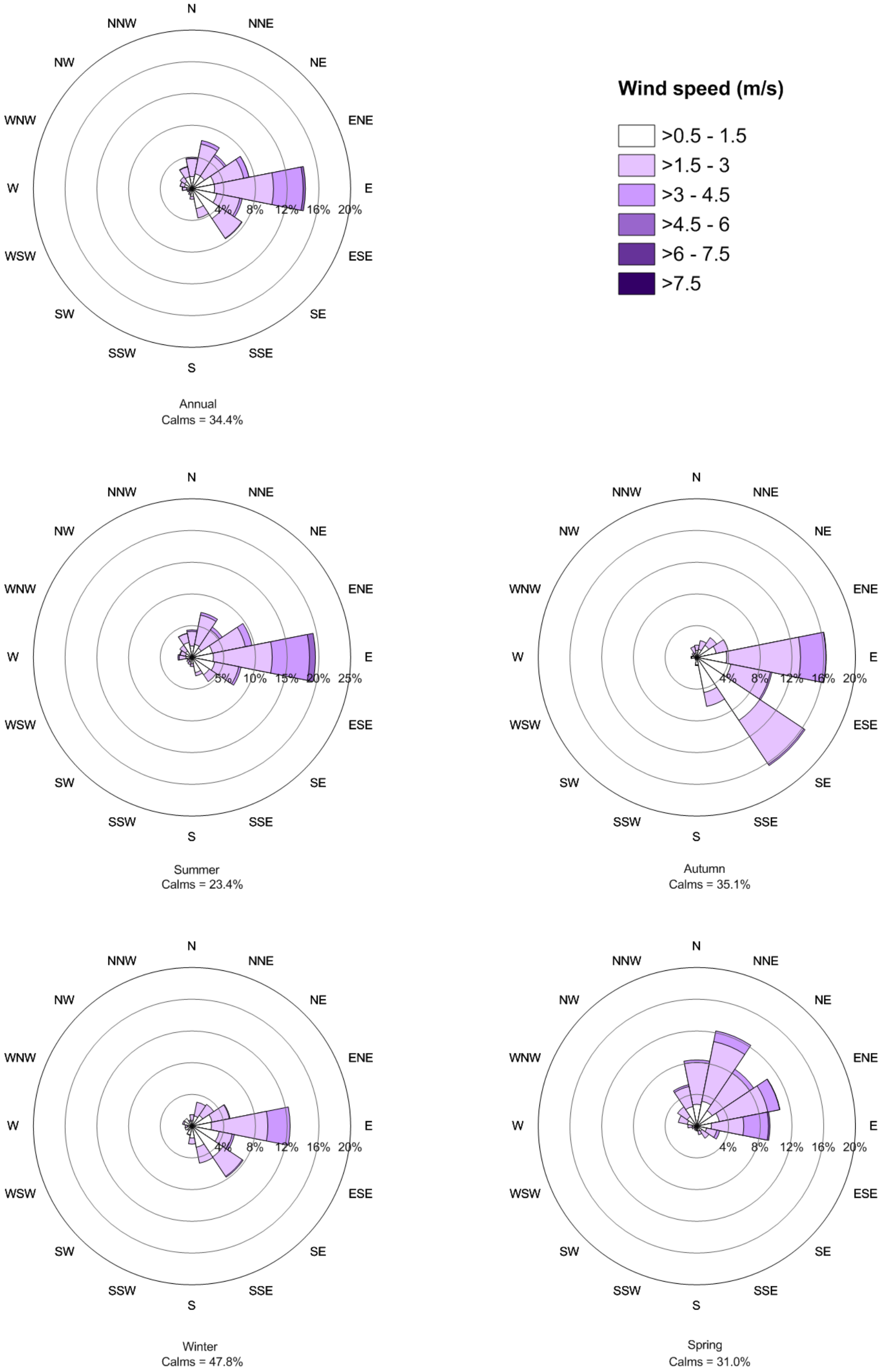


Figure 6 Measured wind patterns from the Ramp 11 meteorological station (2013)

5.2 Existing Air Quality

The DEHP air quality objectives refer to levels which generally include the Project and existing sources. To fully assess impacts against all the relevant air quality objectives (see **Section 4**) it is necessary to have information or estimates on existing air pollutant levels in the area in which the Project is likely to contribute to these levels. This section provides a description of the existing air quality.

Dust deposition levels are measured by a network of dust deposition gauges as shown in **Figure 3**. The monitoring data include contributions from all sources of particulate matter relevant to the monitoring locations, such as existing mining activities, traffic on unsealed roads, and rural land uses including farming and animal grazing activities.

There are 12 dust deposition gauges (10 being directly relevant to Collinsville Mine) which are analysed for insoluble solids and ash residue once per month. Concentrations of TSP, PM_{10} and $PM_{2.5}$ have not historically been recorded in the Collinsville area, however Collinsville Mine has installed seven beta attenuation mass (BAM) monitors to collect continuous air quality information. These BAM units will provide an “alert” function in the event of elevated off-site PM_{10} concentrations and will be part of the dust management plan to assist with operations management. The BAM monitoring data may also be used to assess compliance (of the mine) with the DEHP air quality objectives, once they have been set, after the collection of 2 years of representative data.

Annual average dust deposition records, expressed as mg/m^2/day, are shown in **Table 2**. The data show that six of the ten sites have recorded average levels above the 120 mg/m^2/day objective on at least one occasion in the past ten years. However many of these sites are situated close to the mining operations and are not representative of levels experienced at sensitive receptors (refer to **Figure 3** for the monitoring sites).

Table 2 Summary of dust deposition data

Year	Annual average dust deposition expressed as mg/m^2/day									
	Bowen Central	Colinta	Emohruo	Flat Rock	Garrick East	Karale Station	O'Loughlin	Scottville	Hillview	Barracks Creek
2004	66	182	-	168	39	53	25	58	56	73
2005	78	216	-	291	53	56	63	59	60	51
2006	167	268	-	2540	75	66	44	39	58	49
2007	179	285	37	308	100	50	68	78	39	140
2008	88	225	48	174	57	53	59	83	62	51
2009	128	168	53	-	45	122	87	59	59	134
2010	141	121	49	126	50	158	110	214	82	211
2011	173	396	62	90	32	78	75	62	62	132
2012	118	385	114	61	36	155	70	62	55	73
2013	82	112	30	221	33	28	85	36	88	41
Average for the last 5 years										
Average	129	236	61	124	39	108	86	86	69	118

The main goal of reviewing existing air quality monitoring data was to determine appropriate background levels to be added to model predictions for the assessment of potential cumulative impacts. For this goal, the most suitable approach was to select the monitor which is potentially the least influenced by mining activities. Emohruo has been chosen to be representative of background levels, since it is not generally downwind of the mining operations or towns. The estimated background levels that apply at sensitive receptors are shown below in **Table 3** and these have been added to model predictions to determine potential cumulative impacts. The levels which were recorded prior to 2014 have been taken to represent the existing background air quality.

Table 3 Assumed background levels that apply at sensitive receptors

Pollutant	Averaging time	Assumed background level that applies at sensitive receptors	Notes
Deposited dust	Monthly	61 mg/m^2/day	Five year average of Emohruo results
Particulate matter (TSP)	Annual	41 µg/m^3	Based on five year average of Emohruo dust deposition result and assumes that a fallout level of 133 mg/m^2/day equates to 90 µg/m^3 TSP (NSW Minerals Council, 2000).
Particulate matter (PM_{10})	24-hour / annual	16 µg/m^3	40% of TSP (NSW Minerals Council, 2000). The daily variability in PM_{10} could not be quantified by the existing monitoring data so it has been assumed that an average applies for every day of the year.
Particulate matter ($PM_{2.5}$)	24-hour	10 µg/m^3	Estimated
	Annual	5 µg/m^3	Estimated
Nitrogen dioxide (NO_2)	1-hour	0 µg/m^3	No significant sources
	Annual	0 µg/m^3	No significant sources
Carbon monoxide (CO)	All	0 µg/m^3	No significant sources
Sulphur dioxide (SO_2)	All	0 µg/m^3	No significant sources
Hydrogen sulphide (H_2S)	All	0 µg/m^3	No significant sources

It is anticipated that the data collected by the BAM monitors, in association with concurrent meteorological information, will be valuable for confirming Collinsville Mine’s contribution to local air quality as well as confirming the assumed levels from **Table 3**.

6. Emissions to Air

The most significant emissions to air from open-cut coal mining are from material handling, material transport, processing, wind erosion, and blasting (Donnelly *et al*, 2010). Estimates of these emissions are required by the dispersion model. Total dust emissions have been estimated by analysing the material handling schedule, equipment listing and mine plans and identifying the location and intensity of dust generating activities. Operations have been combined with emissions factors developed both locally and by the US EPA.

The emission factors used for this assessment have been drawn largely from the following sources:

- *Emission Estimation Technique Manual for Mining* (NPI, 2012); and
- AP 42 (US EPA, 1985 and updates).

The mine plans have been used to determine haul road distances and routes, stockpile areas and locations, activity operating hours, truck sizes and other details necessary to estimate dust emissions for the assessment scenarios. **Table 4** shows the annual dust emission estimates, as TSP and PM_{10}, for the existing (at the approved 5.9 Mtpa) and proposed (9.9 Mtpa) scenarios. Emissions of $PM_{2.5}$ were assumed to be 5% of the TSP. It can be seen from these estimates that the dragline and wind erosion from exposed areas are likely to be the most significant sources of dust. **Appendix A** provides details of the dust emission calculations, including assumed emission controls and allocation of emissions to locations.

As can be seen from **Table 4**, dust emissions have been estimated for production rates at 5.9 and 9.9 Mtpa ROM coal for three scenarios. The scenarios referred to in this report are defined as follows:

- **Existing 5.9 Mtpa**: Approved operations prior to 2013 whereby the mine was contractor-operated.
- **Proposed 5.9 Mtpa**: Approved operations post 2013 whereby the mine will be Glencore-operated.
- **Proposed 9.9 Mtpa**: Proposed operations for which Glencore is seeking approval, as per the Project description (**Section 2**).

The "proposed" 5.9 Mtpa scenario reflects the changes to the way in which the mine will be operated, compared to a contractor-operated mine ("existing" scenario). These changes will result primarily in the handling of less overburden by dragline, and lower total site dust emissions for the same production rate.

Table 4 Dust emission estimates

Activity	Annual emissions (kg/y)					
	Existing (5.9 Mtpa)		Proposed (5.9 Mtpa)		Proposed (9.9 Mtpa)	
	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
Stripping topsoil (scraper)	4407	1109	7535	1897	11963	3011
Drilling overburden	3936	2068	3936	2068	3428	1801
Blasting overburden	18127	9393	18127	9393	15788	8181
Excavators loading overburden to trucks	7467	3532	8160	3859	18153	8586
Dragline (on overburden)	2158906	349512	1010460	163587	1771053	286721
Hauling overburden to dumps	322291	95240	352192	104076	783478	231524
Unloading overburden to dumps	283616	101629	309929	111058	689460	247057
Dozers working on overburden	79504	16959	79504	16959	110180	23502
Drilling coal	6629	3483	6629	3483	8236	4328
Blasting coal	9648	5000	9648	5000	11987	6212
Dozers ripping coal	76296	24321	76296	24321	128118	40841
Excavators loading coal to trucks	192579	30472	193753	30658	323385	51170
Hauling ROM coal to stockpile / bin	414639	122529	362753	107197	605457	178917
Unloading ROM coal at stockpile / bin	17700	7434	17808	7479	29722	12483
ROM coal rehandle to bin	2950	1239	2968	1247	4954	2081

Activity	Annual emissions (kg/y)					
	Existing (5.9 Mtpa)		Proposed (5.9 Mtpa)		Proposed (9.9 Mtpa)	
	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
Handling coal at CHPP	1636	774	1646	778	2747	1299
Loader pushing ROM coal	148825	47441	148825	47441	167428	53372
Loader pushing product coal	148825	47441	148825	47441	167428	53372
Loading product coal stockpile	13907	5910	13991	5946	23353	9925
Wind erosion from overburden dumps	2396836	1198418	2396836	1198418	2503005	1251503
Wind erosion from all pits / topsoil piles	1011757	505878	1011757	505878	1064842	532421
Wind erosion from ROM coal stockpiles	140014	70007	140014	70007	140014	70007
Wind erosion from product coal stockpiles	17520	8760	17520	8760	21024	10512
Loading coal to trains	556	236	560	238	934	397
Grading roads	12032	4912	12032	4912	12032	4912
Total (kg)	**7,490,602**	**2,663,698**	**6,351,702**	**2,482,101**	**8,618,167**	**3,094,133**

7. Approach to Assessment

7.1 Overview

The computer-based dispersion model known as CALPUFF has been used to predict ground-level dust concentration and deposition levels due to the identified emission sources, and the model predictions have been compared with relevant air quality objectives. Details of the modelling are provided below.

7.2 Meteorological Modelling

The air dispersion model used for this assessment, CALPUFF, requires information on the meteorological conditions in the modelled region. This information is typically generated by the meteorological pre-processor, CALMET, using surface observation data from local weather stations and upper air data from radiosondes or numerical models, such as the CSIRO's prognostic model known as TAPM (The Air Pollution Model). CALMET also requires information on the local land-use and terrain. The result of a CALMET simulation is a year-long, three-dimensional output of meteorological conditions that can be used as input to the CALPUFF air dispersion model.

There are no known upper air stations in the Collinsville region that collect suitable data to be used as observations in CALMET. The Bureau of Meteorology operates a climatic station at Collinsville Post Office but this station does not collect continuous wind data. Also, as noted in **Section 5.1**, the data from the Collinsville Mine weather stations were not deemed suitable for air quality applications since the wind information was collected at 3 m above ground, compared to the recommended 10 m from AS3580.14-2011. As of 2014, the masts are 10 m high. The meteorological modelling therefore followed the guidance of TRC (2011) whereby gridded prognostic data from TAPM were used as the initial guess wind field for CALMET. This approach is referred to as "No-Obs" mode. Key model settings for TAPM are shown in **Table 5**.

Table 5 Model settings and inputs for TAPM

Parameter	Value(s)
Model version	4.0.5
Number of grids (spacing)	3 (30 km, 10 km, 3 km, 1 km)
Number of grids point	35 x 35 x 25
Year(s) of analysis	2011, 2012, 2013, with one "spin-up" day. 2013 was selected for the CALMET modelling
Centre of analysis	Collinsville (20°33' S, 147°47' E)
Meteorological data assimilation	None

Table 6 lists the model settings and input data for CALMET. This information has been provided so that the user can reproduce the results if required.

Table 6 Model settings and inputs for CALMET

Parameter	Value(s)
Model version	6.334
Terrain data source(s)	SRTM and site DTM
Land-use data source(s)	USGS and digitized from aerial imagery
Meteorological grid domain	20 km x 20 km
Meteorological grid resolution	0.25 km
Meteorological grid dimensions	80 x 80 x 9
Meteorological grid origin	572000 mE, 7717000 mN AGD66
Surface meteorological stations	None. The 3-dimensional meteorological output from TAPM was used as the initial guess wind-field for CALMET.
Upper air meteorological stations	None. The 3-dimensional meteorological output from TAPM was used as the initial guess wind-field for CALMET.
Simulation length	8760 hours (1 Jan 2013 to 31 Dec 2013)

Terrain information was extracted from both the NASA Shuttle Research Topography Mission database (which has global coverage at approximately 90 metre resolution) and the DTM information provided by Collinsville Mine. Land use data were extracted from aerial imagery.

Figure 7 shows the model grid, land-use and terrain information, as used by CALMET.

Figure 8 shows a snapshot of winds as simulated by the CALMET model under stable conditions. This plot shows the effect of the topography on local wind flows (for this particular hour), and highlights the non-uniform wind patterns in the area, especially around the hills to the north of Collinsville.

Figure 7 Model grid, land-use and terrain information

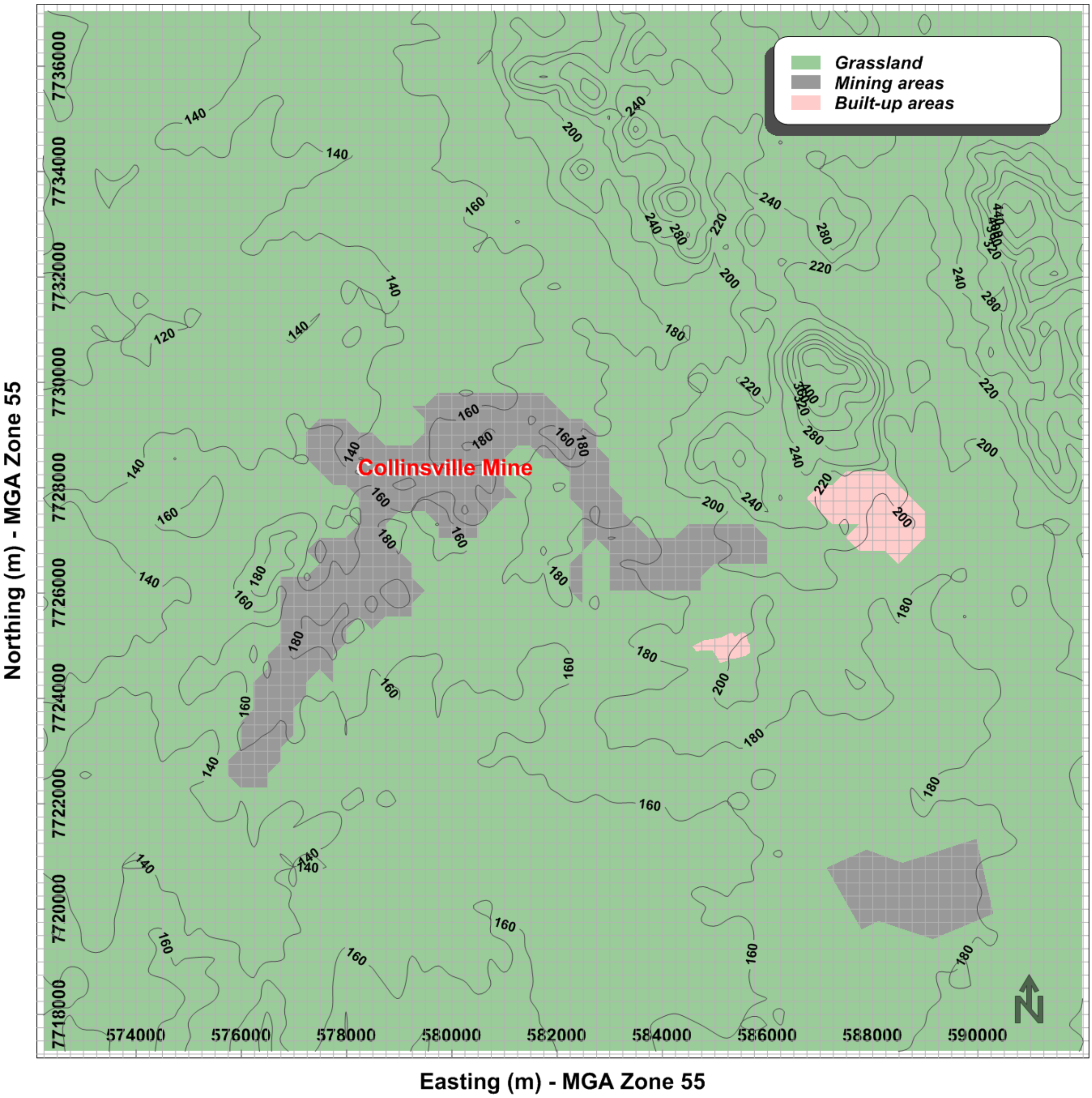
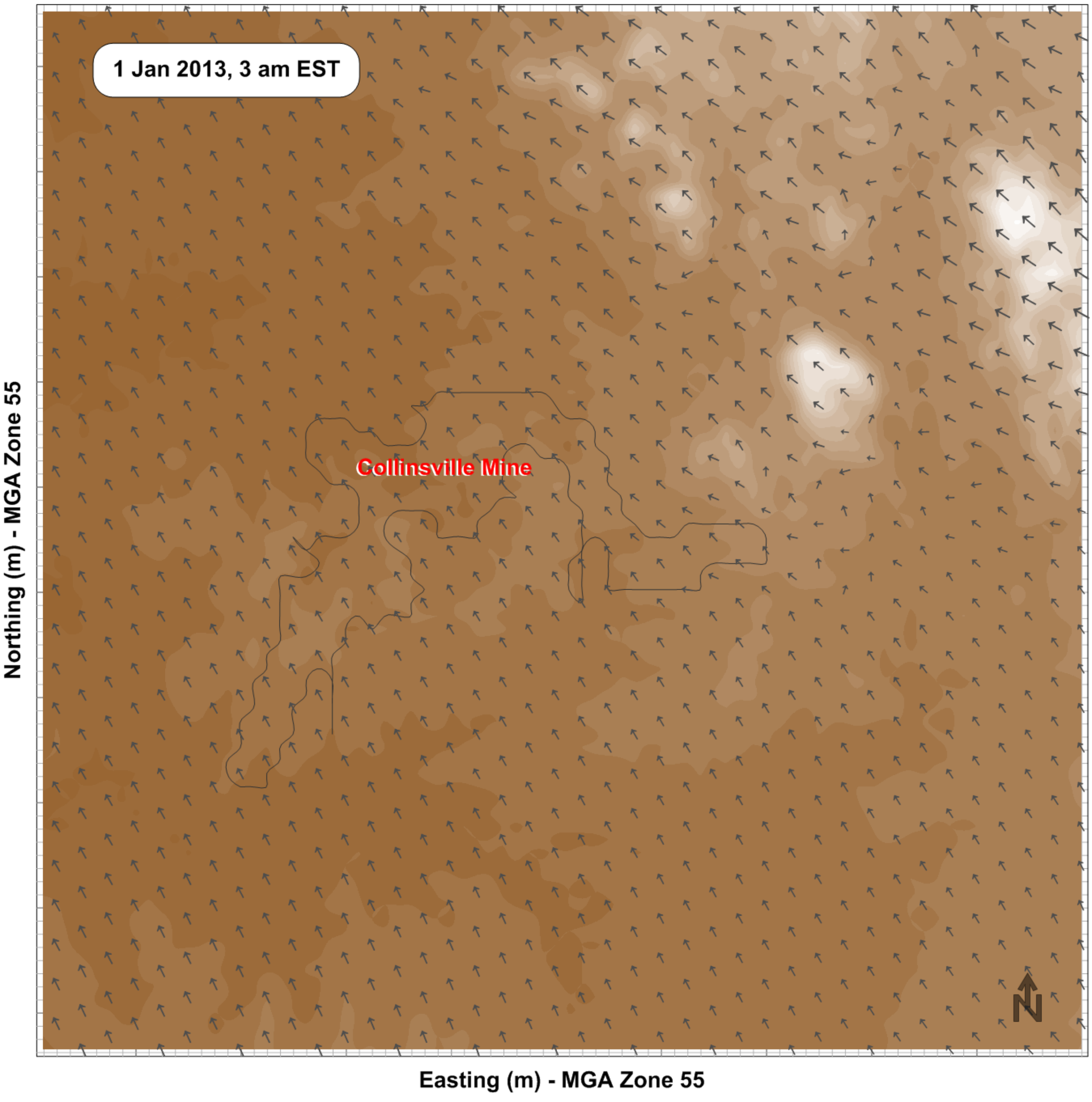


Figure 8 Example of simulated ground-level wind flows



7.3 Dispersion Modelling

Ground-level TSP, PM_{10}, $PM_{2.5}$, deposited dust and, in the case of the blast fume assessment, NO_2, due to the emission sources have been predicted using the air dispersion model known as CALPUFF (Version 6.42). CALPUFF is a Lagrangian dispersion model that simulates the dispersion of pollutants within a turbulent atmosphere by representing emissions as a series of puffs emitted sequentially. Provided the rate at which the puffs are emitted is sufficiently rapid, the puffs overlap and the serial release is representative of a continuous release.

The CALPUFF model differs from traditional Gaussian plume models (such as AUSPLUME and ISCST3) in that it can model spatially varying wind and turbulence fields that are important in complex terrain, long-range transport and near calm conditions. It is the preferred model of the United States Environmental Protection Agency for the long-range transport of pollutants and for complex terrain (TRC 2007). CALPUFF has the ability to model the effect of emissions entrained into the thermal internal boundary layer that forms over land, both through fumigation and plume trapping.

The modelling was performed using the emission estimates from **Section 6** and using the meteorological information provided by the CALMET model, described in **Section 7.2**. Predictions were made at 658 discrete receptors (including sensitive receptors) to allow for the contouring of results. The list of receptors can be provided on request.

Mining operations were represented by a series of volume sources located according to the location of activities for each modelled scenario. **Figure 9** shows the location of the modelled sources, where the emissions from the dust generating activities listed in **Table 4** were assigned to one or more of these source locations (refer to **Appendix A** for details of the allocations). The 9.9 Mtpa scenario represents the potential worst-case operational scenario and would not be typical of mining operations at Collinsville.

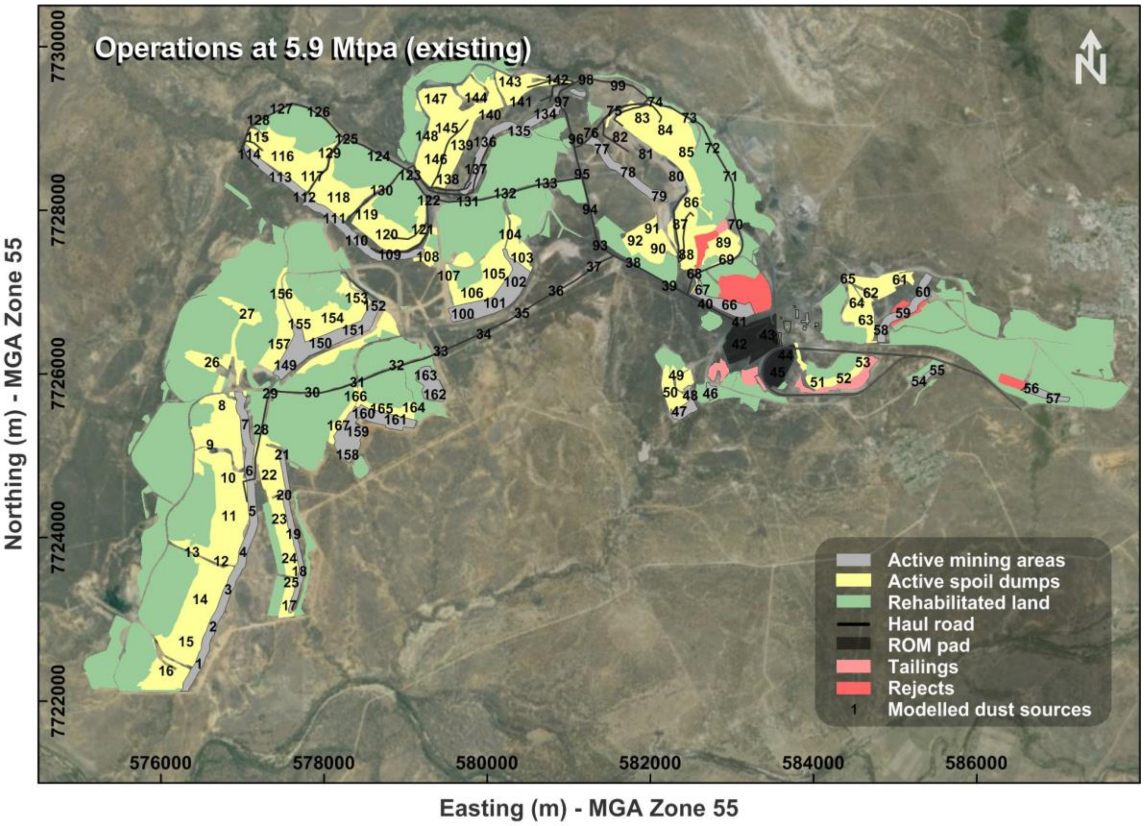
Dust emissions for all modelled mine-related sources have been considered to fit in one of three categories, as follows:

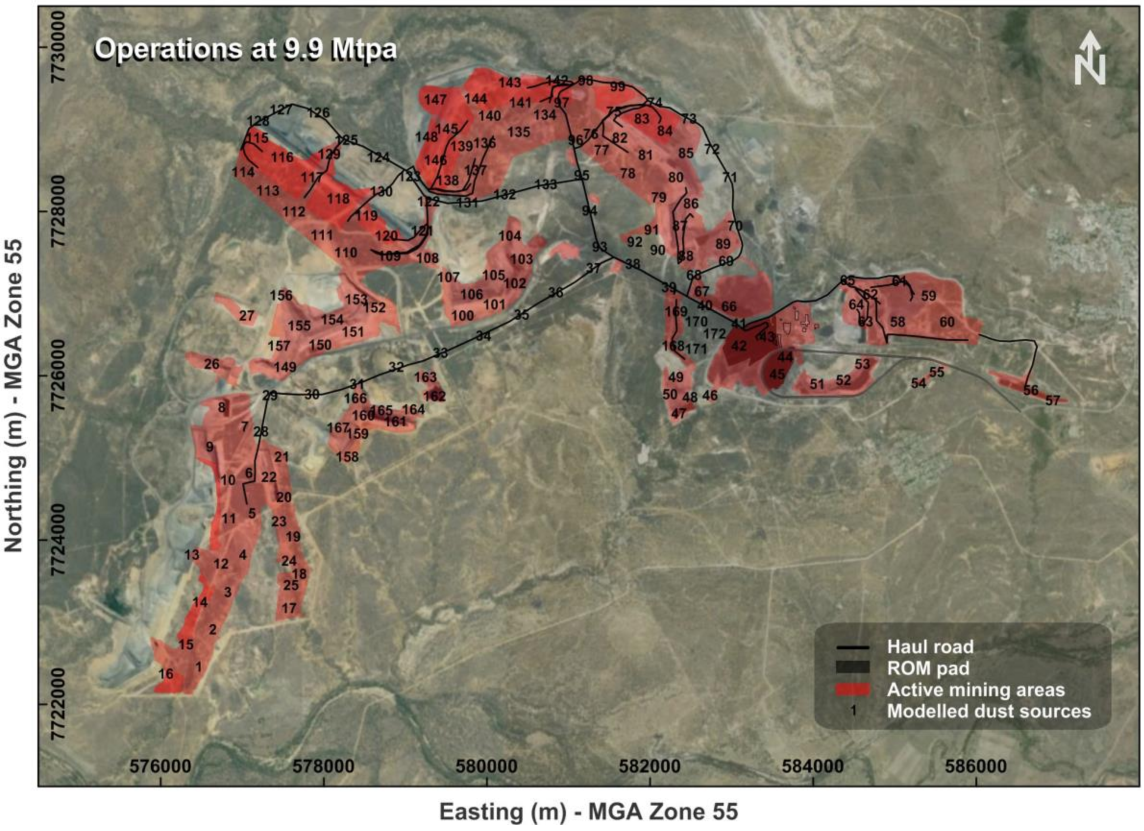
- Wind insensitive sources, where emissions do not vary with wind speed (for example, dozers);
- Wind sensitive sources, where emissions vary with the hourly wind speed, raised to the power of 1.3 (for example, loading and unloading of waste to/from trucks) (US EPA 1987); and
- Wind sensitive sources, where emissions also vary with the hourly wind speed, but raised to the power of 3 (for example, wind erosion from stockpiles, overburden dumps or active pits) (Skidmore 1998).

Emissions from each volume source were developed on an hourly time step, taking into account the level of activity at that location and, in some cases, the hourly wind speed. This approach ensured that light winds corresponded with lower dust generation and higher winds, with higher dust generation.

Project emissions associated with blasting activities were assumed to take place only during daylight hours (9 am to 5 pm for the purposes of the modelling) while all other activities have been modelled for 24 hours per day.

Figure 9 Mine plans and locations of modelled sources for existing and proposed operations





Pit retention (that is, retention of dust particles within the open pits) has been included in the model simulations. The pit retention calculation determines the fraction of dust emitted in the pit that may escape the pit. The "escaped fraction" is a function of the gravitational settling velocity of the particles and the wind speed and is shown by the following relationship (US EPA, 1995).

Equation 1:

$$\varepsilon = \frac{1}{\left(1 + \frac{v_g}{(\alpha U_r)}\right)}$$

where:

ε = escaped fraction for the particle size category

V_g = gravitational settling velocity (m/s)

U_r = approach wind speed at 10 m (m/s)

α = proportionality constant in the relationship between flux from the pit and the product of U_r and concentration in the pit (0.029)

To model the effect of pit retention, the emissions from Project sources within the open pits have been reduced, as per the calculation above. This approach means that much of the coarser dust would remain trapped in the pits. Typically five percent of the PM_{10} emission is trapped in the pit by this calculation.

Model predictions at identified sensitive receptors were then compared with the air quality objectives, previously discussed in **Section 4**. Contour plots have also been created to show the spatial distribution of model predictions.

Key model settings and inputs for CALPUFF are provided in **Table 7**.

Table 7 Model settings and inputs for CALPUFF

Parameter	Value(s)
Model version	6.42
Computational grid domain	50 x 50
Chemical transformation	None
Dry deposition	Yes
Wind speed profile	ISC rural
Puff element	Puff
Dispersion option	Turbulence from micrometeorology
Time step	3600 seconds (1 hour)
Terrain adjustment	Partial plume path
Number of volume sources	Existing / approved (5.9 Mtpa) scenarios: 167 Proposed (5.9 and 9.9 Mtpa) scenarios: 172
Number of discrete receptors	658

8. Assessment of Impacts

This section provides an assessment of the key air quality issues associated with the Project.

8.1 Dust From Mining

The main objective of this study was to predict the extent of air quality impacts due to the Project, and to identify potential changes in air quality over existing levels. The extent of impacts has been determined by a comparison of the air dispersion model predictions with relevant air quality objectives. Contour plots have also been prepared to show the areas in which adverse dust impacts are predicted.

Table 8 shows the model results at identified sensitive receptors. The air quality objectives used for deciding which locations are likely to experience air quality impacts are also included in this table. Shaded cells represent predictions above the associated air quality objective.

Table 8 Predicted dust concentrations and deposition levels at sensitive receptors

Location	Predicted mine contribution			Cumulative			Objective
	Existing (5.9 Mtpa)	Proposed (5.9 Mtpa)	Proposed (9.9 Mtpa)	Existing (5.9 Mtpa)	Proposed (5.9 Mtpa)	Proposed (9.9 Mtpa)	
Predicted annual average TSP concentrations (µg/m³)							
Scottville	1.0	1.3	1.6	42	42	43	90
Power Station	2.3	3.7	5.3	43	45	46	90
Collinsville	0.1	0.1	0.1	41	41	41	90
Hillview Station	11.1	11.8	16.1	52	53	57	90
Emohruo Station	4.6	4.1	5.1	46	45	46	90
Kerale Station	3.7	3.1	3.8	45	44	45	90
Thornley Station	0.6	0.6	0.8	42	42	42	90
Todsure Station	3.4	3.6	4.8	44	45	46	90
3MC Station	2.7	2.5	3.4	44	44	44	90
Predicted maximum 24-hour average PM_{10} concentrations (µg/m³) (plus number of days above 50 µg/m³)							
Scottville	17.0	15.6	20.1	33	32	36	50 (5 days)
Power Station	14.5	17.2	22.1	30	33	38	50 (5 days)
Collinsville	2.3	2.2	3.0	18	18	19	50 (5 days)
Hillview Station	26.3	35.0	44.2	42	51 (1)	60 (9)	50 (5 days)
Emohruo Station	38.4	34.6	40.7	54 (2)	51 (1)	57 (6)	50 (5 days)
Kerale Station	27.0	26.7	29.6	43	43	46	50 (5 days)
Thornley Station	8.4	8.0	10.6	24	24	27	50 (5 days)
Todsure Station	13.7	16.1	19.8	30	32	36	50 (5 days)
3MC Station	17.7	15.7	19.8	34	32	36	50 (5 days)
Predicted maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)							
Scottville	4.4	3.5	4.8	14	13	15	25
Power Station	3.3	2.6	3.8	13	13	14	25
Collinsville	0.7	0.5	0.7	11	10	11	25
Hillview Station	9.2	5.2	8.3	19	15	18	25
Emohruo Station	5.8	4.7	6.1	16	15	16	25
Kerale Station	3.9	3.2	4.1	14	13	14	25
Thornley Station	1.7	1.4	2.0	12	11	12	25
Todsure Station	4.9	2.7	4.6	15	13	15	25
3MC Station	4.4	2.6	4.2	14	13	14	25
Predicted annual average $PM_{2.5}$ concentrations (µg/m³)							
Scottville	0.1	0.1	0.2	5	5	5	8

Location	Predicted mine contribution			Cumulative			Objective
	Existing (5.9 Mtpa)	Proposed (5.9 Mtpa)	Proposed (9.9 Mtpa)	Existing (5.9 Mtpa)	Proposed (5.9 Mtpa)	Proposed (9.9 Mtpa)	
Power Station	0.3	0.4	0.6	5	5	6	8
Collinsville	0.0	0.0	0.0	5	5	5	8
Hillview Station	1.5	1.5	2.1	7	6	7	8
Emohruo Station	0.9	0.7	1.0	6	6	6	8
Kerale Station	0.7	0.6	0.7	6	6	6	8
Thornley Station	0.1	0.1	0.1	5	5	5	8
Todsure Station	0.5	0.5	0.7	6	6	6	8
3MC Station	0.5	0.4	0.6	6	5	6	8
Predicted maximum monthly dust deposition (g/m^2/day)							
Scottville	15	20	25	76	81	86	120
Power Station	19	28	39	80	89	100	120
Collinsville	1	1	2	62	62	63	120
Hillview Station	93	99	134	154	160	195	120
Emohruo Station	56	49	61	117	110	122	120
Kerale Station	50	44	54	111	105	115	120
Thornley Station	7	9	11	68	70	72	120
Todsure Station	38	40	54	99	101	115	120
3MC Station	31	30	40	92	91	101	120

Figure 10 to **Figure 15** provide a summary of the model results, comparing the existing and proposed scenarios, and which show the predicted extent of the air quality objective for each dust classification. These predictions include background levels, as discussed in **Section 5.2**. Plots showing more contour levels of concentration and deposition levels across the model domain are provided in **Appendix B**.

The following conclusions have been drawn from the model results:

- Predicted impacts of the proposed 5.9 Mtpa operation are similar to those of the existing 5.9 Mtpa operation.
- Concentrations and deposition levels are predicted to increase (in most instances) at all locations under the proposed, 9.9 Mtpa scenario. This is due to a likely increase in dust emissions as a result of an increased intensity of mining activities.
- TSP and $PM_{2.5}$ concentrations are predicted to comply with the respective air quality objectives at all sensitive receptor locations, for existing and proposed mining scenarios.
- Existing and proposed mining activities, on their own, will comply with the PM_{10} objective (50 μg/m^3). However, there is a potential risk that proposed activities will contribute to, cumulatively, more than five exceedances of the 24-hour average PM_{10} objective at two locations (“Hillview Station” and “Emohruo Station”), especially if background levels are higher than average. Non-sensitive location agreements (in accordance with condition A24 of the Environmental Authority) have been entered into with the owners of both “Hillview” and “Emohruo” and management measures are being implemented.
- Maximum monthly dust deposition is predicted to exceed the 120 mg/m^2/day objective at “Hillview Station” for existing and proposed mining scenarios, and at Emohruo for the proposed 9.9 Mtpa scenario. However, the model results over-estimated impacts since the monitored dust deposition at these locations have not exceeded the 120 mg/m^2/day objective in the past ten years even with existing mining operations (refer to the Hillview monitor in **Section 5.2**). The model predictions of dust deposition for the existing scenario are nearly double the monitored levels.

Potential cumulative impacts of emissions from Collinsville Mine with emissions from Sonoma mine (six kilometres to the south of Collinsville) have also been assessed. No significant cumulative impacts are expected since there are no sensitive receptors that would be positioned downwind of both mines at any one time.

Collinsville Mine has recognised a potential increase in dust emissions and will be placing more emphasis on dust management as part of the Project. Further discussion of the model results and management of potential impacts, particularly at Hillview and Emohruo, is provided after **Figure 15**.

Figure 10 Extent of annual average TSP concentration objective including background (µg/m³)

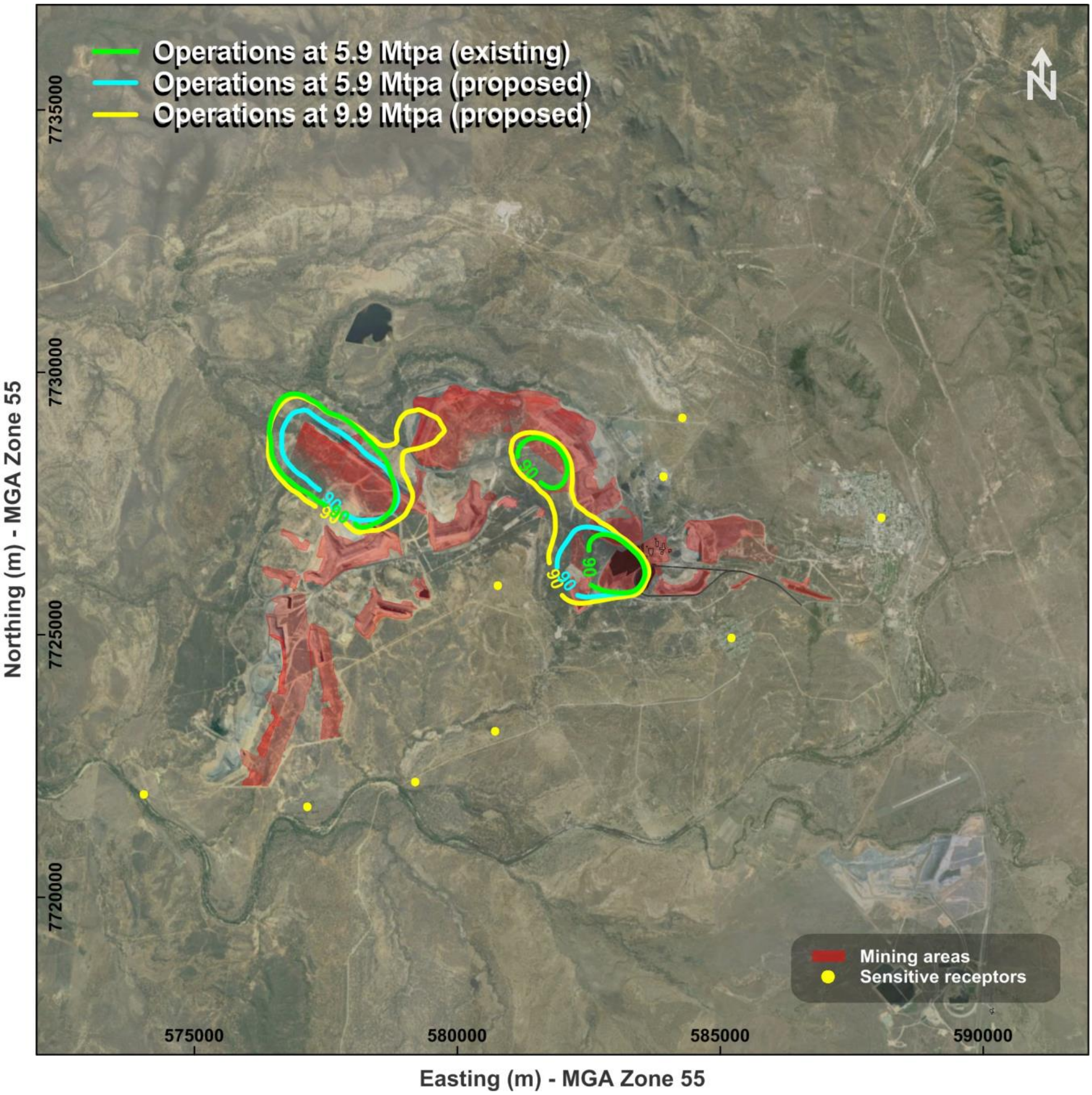


Figure 11 Extent of maximum 24-hour average PM_{10} concentration objective including background (µg/m³)

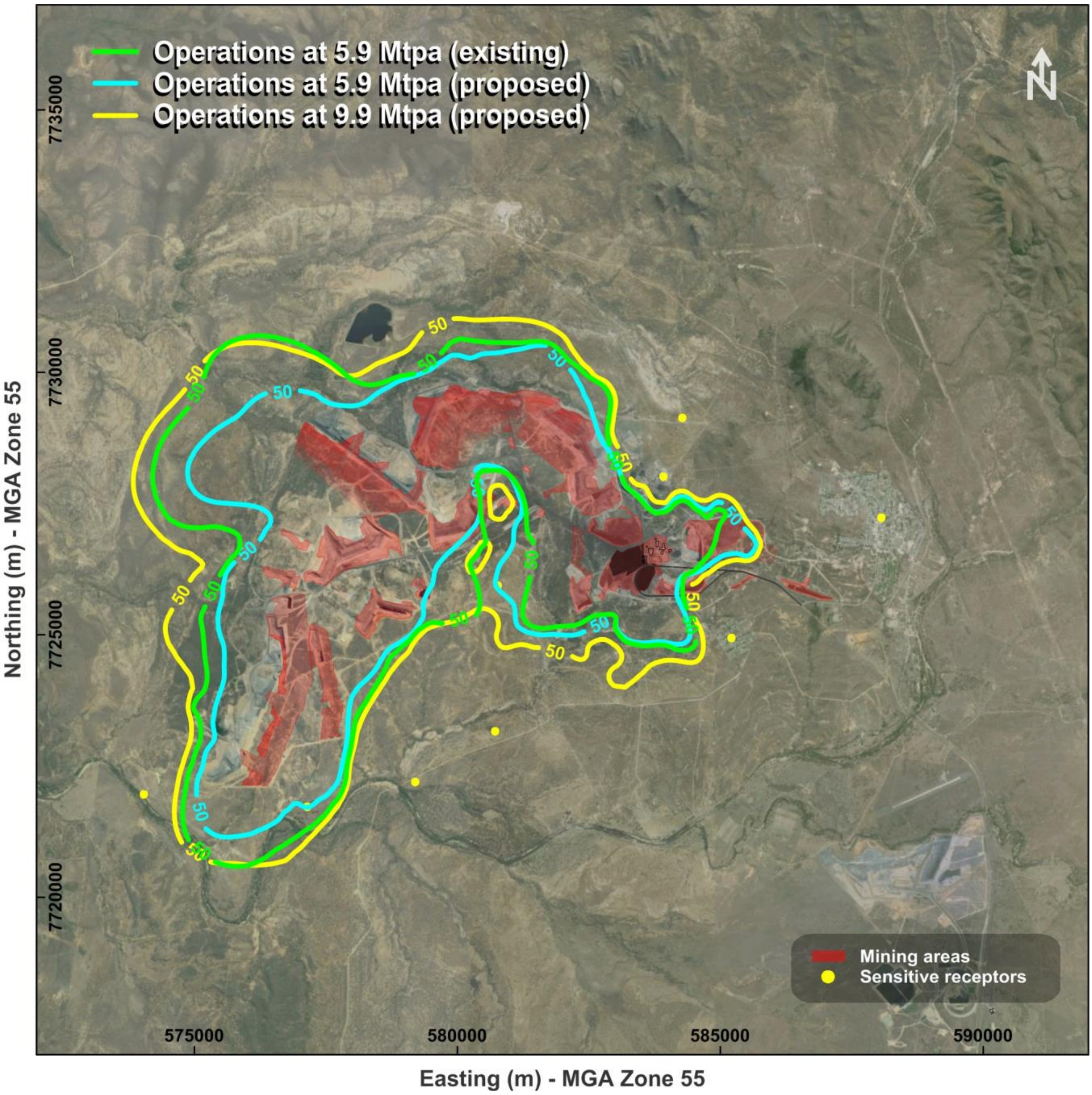


Figure 12 Extent of allowable days above 24-hour average PM_{10} objective including background (days)

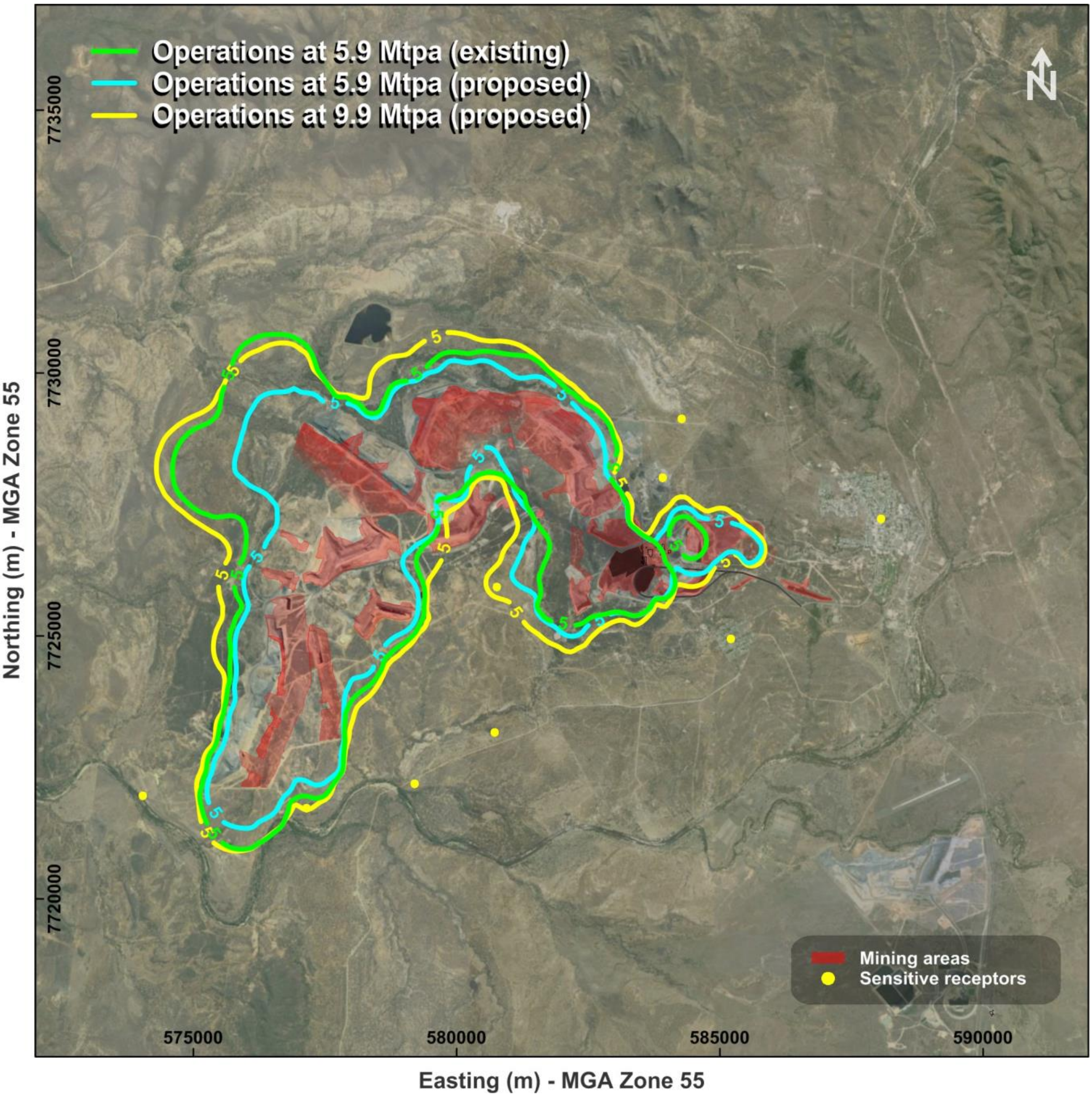


Figure 13 Extent of maximum 24-hour average $PM_{2.5}$ concentration objective including background (µg/m³)

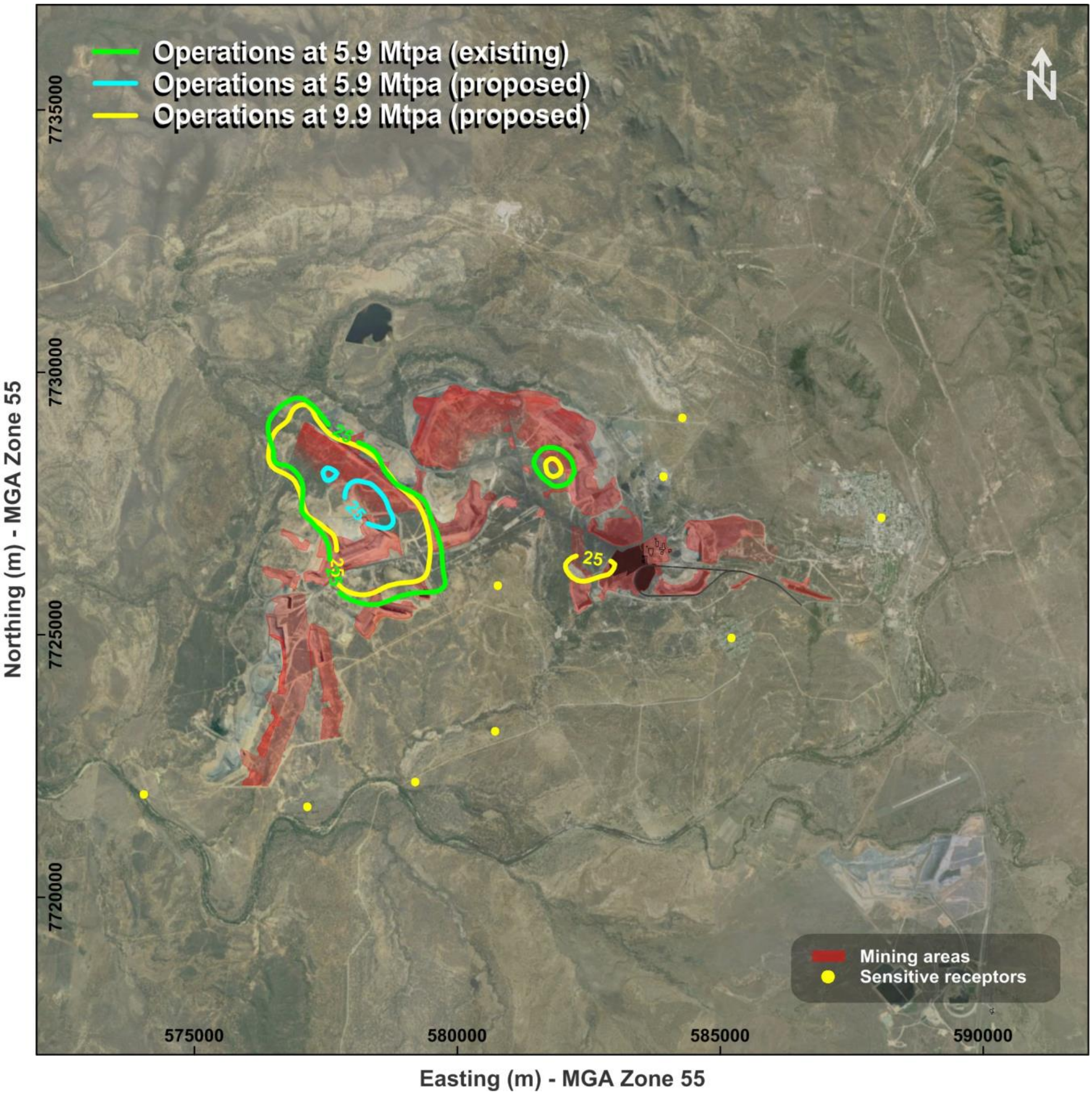


Figure 14 Extent of annual average $PM_{2.5}$ concentration objective including background ($\mu g/m^3$)

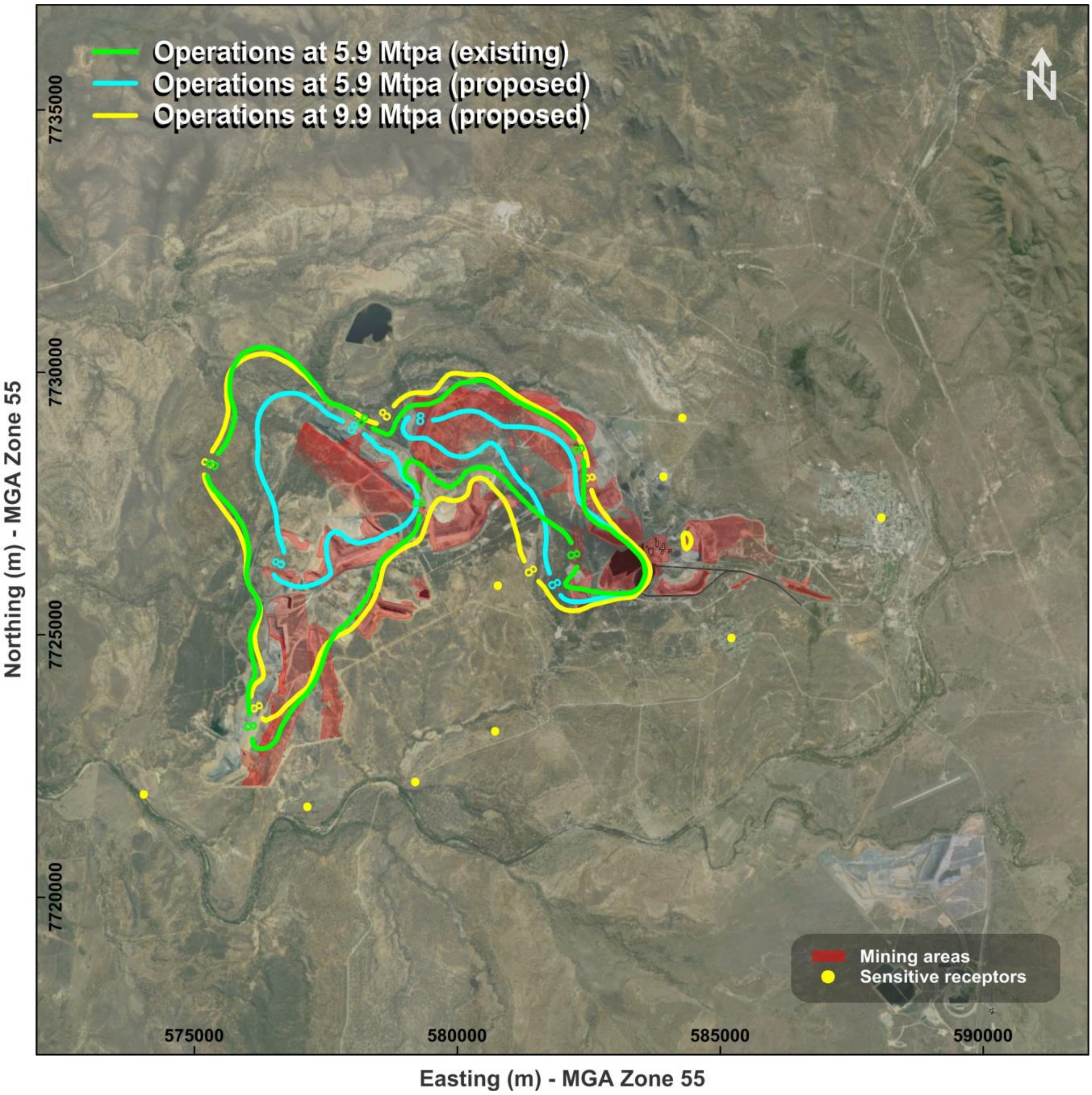
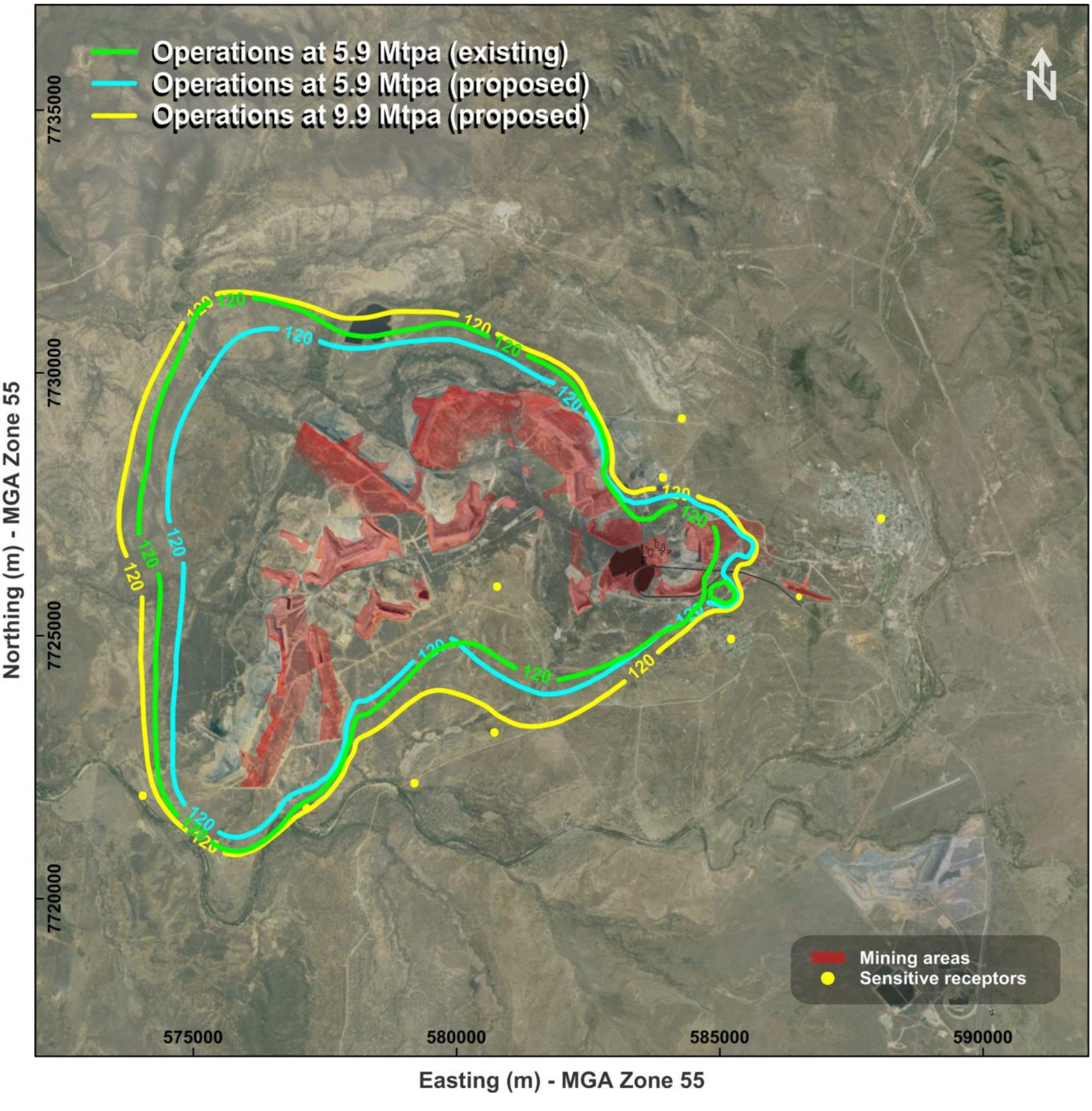
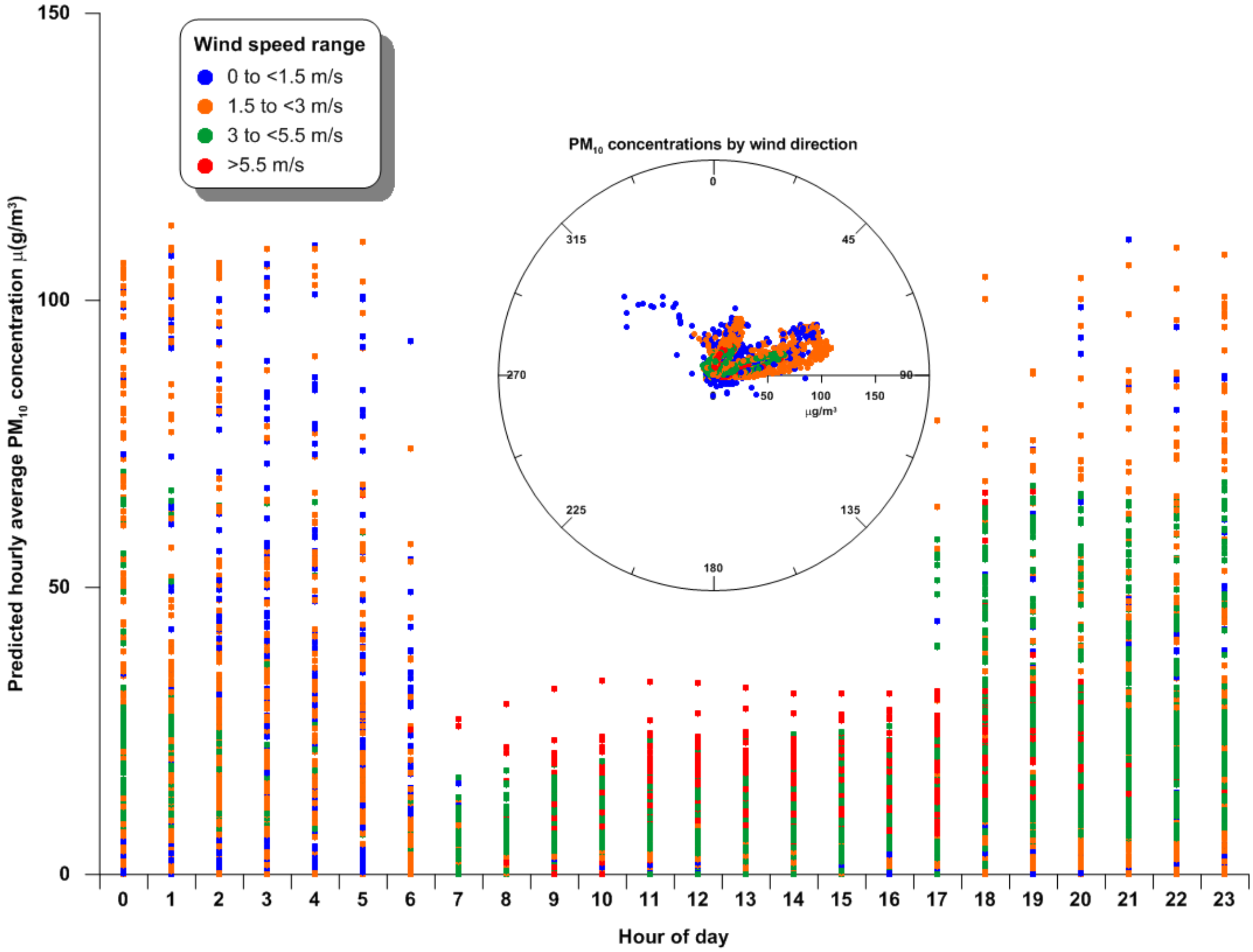


Figure 15 Extent of maximum monthly dust deposition objective including background (g/m²/day)



These results highlight a need to appropriately manage emissions in order to maintain off-site dust concentrations and deposition levels at or below existing levels. To further understand the potential impacts of the mine's emissions, the predicted hourly average PM_{10} concentrations at Hillview Station have been analysed against time of day, wind speed and wind direction. **Figure 16** shows the results from this analysis (for the 9.9 Mtpa scenario).

Figure 16 Hourly PM10 concentrations at Hillview Station by time of day, wind speed and wind direction



The main observations from the data in **Figure 16** were as follows:

- The highest hourly average PM_{10} concentrations are predicted to occur at night or in the early morning, usually when the wind is light (less than 3 m/s) and from the northwest (Blake West Pit) and east-northeast (No. 2 Mine). These conditions are representative of a stable atmosphere whereby dispersion is poor and dust plumes can stay relatively concentrated for long periods of time.
- During the day, the highest hourly average PM_{10} concentrations were predicted under strong wind conditions (that is, greater than 5.5 m/s).

To identify potential air quality impacts and the appropriate response, the Project will implement the Dust Management Trigger Action Response Plan (TARP). This plan has been designed to provide a guideline as to the acceptable standards to minimise the impact of airborne dust on the environment and local community. It will be updated during and after 2 years of representative data have been obtained.

The TARP defines “trigger” levels which require action for managing dust, which are indicatively as shown in **Table 9** below. These classifications are subject to refinement during and after 2 years of representative monitoring data have been obtained.

Table 9 Indicative trigger level classifications

Normal state	Reasonably expected conditions in day to day operations. No cause for review or action, but routine dust management to be continued.
Level 1 Triggers	Change from normal indicating a potential risk. Not of a serious nature, but acts as an alert and requires monitoring to detect further trends.
Level 2 Triggers	Moderate risk of dust related impacts occurring. Remedial action needs to be planned and executed.
Level 3 Triggers	High risk of dust related impacts occurring. A situation has occurred that poses an immediate risk and remedial action must be undertaken.

The trigger level will be determined by either:

- visual conditions;
- meteorological conditions;
- ambient air quality conditions (that is, PM_{10} concentrations); or
- forecast dust risk conditions.

An additional 9.9 Mtpa scenario has been developed which assumes the implementation of a TARP and trigger levels based on real-time PM_{10} concentrations at selected sensitive receptors. The indicative PM_{10} concentrations triggers would be as per **Table 10** below, subject to refinement during and after 2 years of representative data have been obtained. The levels have been used to identify alert states at sensitive and non-sensitive receptors for the purposes of the modelling. It should be noted that these levels may need to be refined as real-time PM_{10} concentration data are collected and the conditions leading to elevated concentrations are further understood.

Table 10 Indicative PM_{10} concentration triggers

Level 1 dust alert	Level 2 dust alert	Level 3 dust alert
1-hour rolling average greater than 80 µg/m^3 (up to 3 consecutive 15-minute periods) Or 3-hour rolling average greater than 60 µg/m^3 (up to 5 consecutive 15-minute periods) Or 24-hour rolling average greater than 35 µg/m^3 (up to 5 consecutive 15-minute periods)	1-hour rolling average greater than 80 µg/m^3 (3 or more consecutive 15-minute periods) Or 3-hour rolling average greater than 60 µg/m^3 (5 or more consecutive 15-minute periods) Or 24-hour rolling average greater than 35 µg/m^3 (5 or more consecutive 15-minute periods)	1-hour rolling average greater than 200 µg/m^3 (3 or more consecutive 15-minute periods) Or 3-hour rolling average greater than 100 µg/m^3 (3 or more consecutive 15-minute periods) Or 24-hour rolling average greater than 50 µg/m^3 (5 or more consecutive 15-minute periods)

Table 11 shows the percentage occurrence of dust alert trigger levels based on analysis of the predicted PM_{10} concentrations at Hillview Station and Emohruo Station under the 9.9 Mtpa scenario. The dust alert level (0, 1, 2 or 3) has been determined for every hour in the modelled year.

Table 11 Percentage occurrence of dust alert trigger levels at Hillview Station and Emohruo Station

Dust alert trigger level	Percentage of time triggered in the modelled year
Level 0 or 1	94%
Level 2	6%
Level 3	<1%

The results from **Table 11** show that:

- A normal state or Level 1 alert (not triggering an additional action) would occur about 94% of the time.
- Level 2 or 3 alerts (triggering an additional action) would occur about 7% of the time.

In the event of level 2 or level 3 triggers, the actions and dust control measures that are assumed to apply are shown below in **Table 12**. Again, these have been developed for the purposes of simulating the effect of a TARP and, while consistent with information in the *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and / or Minimise Emissions of Particulate Matter from Coal Mining* (Donnelly *et al* 2010), are indicative until refined by operations.

Table 12 Trigger level actions and modelled control assumptions

Activity	Level 2 Trigger	Level 3 Trigger
Haul trucks	**Triggered action:** Additional watering **Dust control assumption:** 40% additional control on emissions, based on an increase in dust control from 75% to 85%. Current literature suggests that up to 90% control of dust emissions is achievable by watering.	**Triggered action:** Cease activity **Dust control assumption:** 100%
Grading	**Triggered action:** Additional watering **Dust control assumption:** 50%	**Triggered action:** Cease activity **Dust control assumption:** 100%
Dozer operations on overburden & topsoil	**Triggered action:** Limited travel speeds, reduced drop height **Dust control assumption:** 60%	**Triggered action:** Cease activity **Dust control assumption:** 100%
Drilling operations	**Triggered action:** Monitor situation. No additional action. Watering and dust extraction system already in place. **Dust control assumption:** 0%	**Triggered action:** Cease activity **Dust control assumption:** 100%
Topsoil stripping, handling, stockpiling	**Triggered action:** Watering before disturbance **Dust control assumption:** 50%	**Triggered action:** Cease activity **Dust control assumption:** 100%
Dragline	**Triggered action:** Managing drop height to around 8 m instead of 15 m **Dust control assumption:** 50%	**Triggered action:** Cease activity **Dust control assumption:** 100%
Dozers / loaders on ROM / product stockpiles	**Triggered action:** Reduced activity **Dust control assumption:** 50%	**Triggered action:** Cease activity **Dust control assumption:** 100%

An additional model scenario has been developed to test the effectiveness of implementing a TARP for dust management, where the focus is on minimising elevated PM_{10} concentrations at Hillview Station and Emohruo Station. **Table 13** shows the model results at identified sensitive receptors assuming a TARP is in place.

Table 13 Predicted dust concentrations and deposition levels at sensitive receptors with TARP

Location	Predicted mine contribution		Cumulative		Objective
	Proposed (9.9 Mtpa)	Proposed (9.9 Mtpa) with TARP	Proposed (9.9 Mtpa)	Proposed (9.9 Mtpa) with TARP	
Predicted annual average TSP concentrations (µg/m^3)					
Scottville	1.6	1.6	43	43	90
Power Station	5.3	5.2	46	46	90
Collinsville	0.1	0.1	41	41	90
Hillview Station	16.1	15.3	57	56	90
Emohruo Station	5.1	5.0	46	46	90
Kerale Station	3.8	3.8	45	45	90
Thornley Station	0.8	0.8	42	42	90
Todsure Station	4.8	4.7	46	46	90
3MC Station	3.4	3.4	44	44	90
Predicted maximum 24-hour average PM_{10} concentrations (µg/m^3) (plus number of days above 50 µg/m^3)					
Scottville	20.1	15.9	36	32	50 (5 days)
Power Station	22.1	22.1	38	38	50 (5 days)
Collinsville	3.0	2.7	19	19	50 (5 days)
Hillview Station	44.2	38.6	60 (9)	55 (3)	50 (5 days)
Emohruo Station	40.7	38.3	57 (6)	54 (3)	50 (5 days)
Kerale Station	29.6	29.6	46	46	50 (5 days)
Thornley Station	10.6	10.1	27	26	50 (5 days)
Todsure Station	19.8	19.8	36	36	50 (5 days)
3MC Station	19.8	19.8	36	36	50 (5 days)
Predicted maximum 24-hour average $PM_{2.5}$ concentrations (µg/m^3)					
Scottville	4.8	3.8	15	14	25
Power Station	3.8	3.3	14	13	25
Collinsville	0.7	0.7	11	11	25
Hillview Station	8.3	8.1	18	18	25
Emohruo Station	6.1	5.3	16	15	25
Kerale Station	4.1	4.1	14	14	25
Thornley Station	2.0	1.8	12	12	25
Todsure Station	4.6	4.4	15	14	25
3MC Station	4.2	3.8	14	14	25
Predicted annual average $PM_{2.5}$ concentrations (µg/m^3)					
Scottville	0.2	0.2	5	5	8
Power Station	0.6	0.6	6	6	8
Collinsville	0.0	0.0	5	5	8
Hillview Station	2.1	1.9	7	7	8
Emohruo Station	1.0	0.9	6	6	8
Kerale Station	0.7	0.7	6	6	8
Thornley Station	0.1	0.1	5	5	8
Todsure Station	0.7	0.7	6	6	8
3MC Station	0.6	0.6	6	6	8
Predicted maximum monthly dust deposition (g/m^2/day)					
Scottville	25	25	86	86	120
Power Station	39	39	100	100	120
Collinsville	2	2	63	63	120
Hillview Station	134	129	195	190	120
Emohruo Station	61	60	122	121	120
Kerale Station	54	54	115	115	120

Location	Predicted mine contribution		Cumulative		Objective
	Proposed (9.9 Mtpa)	Proposed (9.9 Mtpa) with TARP	Proposed (9.9 Mtpa)	Proposed (9.9 Mtpa) with TARP	
Thornley Station	11	11	72	72	120
Todsure Station	54	53	115	114	120
3MC Station	40	40	101	101	120

The results from **Table 13** show that a dust management TARP will be an effective strategy to minimise off-site air quality impacts, compared to the scenario without a TARP, most notably for PM_{10} at Hillview Station and Emohruo Station which were the focus of the TARP model. For example, at Hillview Station, the number of days when PM_{10} exceeds 50 µg/m^3 is predicted to decrease from 9 to 3 days. This has resulted from identification of the conditions leading to elevated PM_{10} concentrations and appropriately managing operations under those conditions.

It is also anticipated that as the TARP is further refined and targeted towards other locations then impacts at these locations will also be more effectively managed. The additional combination of real-time PM_{10} concentration monitors, meteorological data, a predictive dust system, and visual observations would further improve the effectiveness of the TARP. In the case of predictive systems, the knowledge of potentially adverse weather or dust conditions will allow operators to better prepare for additional emission management or necessary modifications to site activities.

8.2 Rehabilitation and Closure Projects

Rehabilitation and closure activities for the Blake A South and Garrick East mining areas are proposed as two separate campaign projects. This section describes the activities and potential air quality impacts.

Each campaign project would occur concurrently with the existing mining operation and would primarily include:

- Loading overburden to (nominally) 220 tonne trucks;
- Transporting overburden to the emplacements (from Ramp 2 to Blake A South and from Ramp 14 to Garrick East); and
- Shaping the emplacement areas by dozer.

The rehabilitation and closure activities are anticipated to occur in 2016 (Blake A South) and 2018 (Garrick East). Activities are proposed for up to 24 hours per day. **Table 14** shows the estimated overburden volumes that would be required for each project, as well as the expected timing and duration.

Table 14 Estimated overburden volumes for rehabilitation and closure projects

Haul string	Overburden volume	Year	Duration
Ramp 2 to Blake A South for rehabilitation and closure of Blake A South.	1,054,722	2016	6 months
Ramp 14 to Garrick East for Rehabilitation and closure of Garrick East.	2,506,274	2018	12 months

The potential air quality impacts of each project have been determined by:

- Estimating the annual particulate matter emissions.
- Comparing emissions to those modelled for the broader mining operation.
- Determining the potential change in currently modelled impacts, and risk of affecting compliance with objectives.

Dust emissions (as PM_{10}) have been estimated by combining emission factors with haul route distances, truck sizes and overburden handling quantities. These emissions have been estimated using the same emission factors as described in **Section 6**. **Table 15** shows the annual emission estimates for each campaign project.

Table 15 Dust emission estimates for rehabilitation and closure projects

Activity	Annual PM_{10} emissions (kg/y)	
	Ramp 2 to Blake A South for rehabilitation and closure of Blake A South (2016)*	Ramp 14 to Garrick East for Rehabilitation and closure of Garrick East (2018)
Excavators loading overburden to trucks	824	693
Hauling overburden to dumps	22,219	18,701
Unloading overburden to dumps	23,709	19,955
Dozers working on overburden	4,487	4,487
Total (kg)	**51,239**	**43,837**
Percentage change compared to broader mining operation emissions (%)	**2.1%**	**1.4%**

** Estimated for a 12 month period to allow for comparison with annual emissions.*

It can be seen from **Table 15** that total site emissions are predicted to be up to 2.1% higher with these rehabilitation and closure activities. These changes in emissions are considered to be negligible in terms of affecting off-site air quality impacts since a corresponding increase to the model results (refer **Table 8**) would not lead to any change in predicted compliance with air quality objectives.

Nevertheless, it will be important that emissions from the rehabilitation and closure activities are subject to a similar level of management as for the broader mining activities. The emission and control strategies would include:

- Scheduling rehabilitation and closure activities to occur when meteorological conditions are favourable, where possible. The prevailing winds in most seasons are from the east, which is favourable for transporting mining emissions away from most sensitive receptors. Meteorological conditions will be monitored in real-time and used for the management of activities.
- Applying dust mitigation measures which are consistent with those applied for the operational mining activities (described in **Section 9**).
- Subjecting the rehabilitation and closure activities to the same controls that are defined under the dust management TARP (described in **Section 8.1**).

Finally, it should be noted that the completion of the rehabilitation and closure projects will lead to an overall positive air quality outcome since there will ultimately be less exposed areas susceptible to wind erosion.

8.3 Post-Blast Fume

Blasting activities have the potential to result in fume and particulate matter emissions. Particulate matter emissions from blasting are included in the dispersion modelling results presented in **Section 8.1**. Post-blast blast fume can be produced in non-ideal explosive conditions of the ammonium nitrate/fuel oil (ANFO) and visible as an orange / brown plume.

Post-blast fumes comprise of oxides of nitrogen (NO_x) including nitric oxide (NO) and nitrogen dioxide (NO_2). In general, at the point of emission, NO will comprise the greatest proportion of the total emission. Typically this is 90% by volume of the NO_x. The remaining 10% will comprise mostly NO_2. It is the NO_2 which has been linked to adverse health effects.

Ultimately however, much of the NO emitted into the atmosphere is oxidised to NO_2. The rate at which this oxidisation takes place depends on prevailing atmospheric conditions including temperature, humidity and the presence of other substances in the atmosphere such as ozone. It can vary from a few minutes to many hours. The rate of conversion is quite important because from the point of emission to the point of maximum ground-level concentration there will be an interval of time during which some oxidation will take place. If the dispersion is sufficient to have diluted the plume to the point where the concentration is very low then the level of oxidation is unimportant. However, if the oxidation is rapid and the dispersion is slow then high concentrations of NO_2 can occur.

In NO_x monitoring data near significant emission sources (for example, power stations and motorways) the percentage of NO_2 in the NO_x is (as a rule) inversely proportional to the total NO_x concentration, and when NO_x concentrations are high, the percentage of NO_2 in the NO_x is typically of the order of 20%.

For assessment of post-blast fume the applicable DEHP air quality objective for NO_2 is 250 µg/m^3 as a 1-hour average.

The CALPUFF dispersion model has been used to quantify potential NO_2 concentrations due to blasting. The methodology was as follows:

- Blasts modelled as single volume sources in the Blake North, Blake Under Bowen, Blake West, Ramp 2 and Ramp 14 pits.
- Release heights of 20 m, effective plume heights of 40 m, initial horizontal spread (sigma y) of 25 m and initial vertical spread (sigma z) of 10 m.
- Emissions assumed to occur between the hours of 9 am and 5 pm.
- Blasting could be on any day of the week (a conservative assumption as, in accordance with the EA requirements, blasting cannot occur on Sundays or public holidays).
- Restrictions on blasting due to wind direction, including:
  - No blasting when the winds are from the west (270±22.5 degrees) (assumed to apply to Blake North, Blake Under Bowen, Blake West, and Ramp 14 pits).
  - No blasting when the winds are from the west (270±22.5 degrees) or towards Hillview Station (90±10 degrees) (assumed to apply to Ramp 2 pit).
- NO_x emissions based on data presented in the Queensland *Guidance Note for the management of oxides in open cut blasting* (DEEDI, 2011). It was conservatively assumed that the initial NO_2 concentration in the plume would be 17 ppm (34.9 mg/m^3) based on the Rating 3 Fume Category in the Queensland Guidance Note.
- The initial NO_2 concentration in the plume was converted to a total NO_x emission rate based on a detailed measurement program of NO_x in blast plumes in the Hunter Valley made by Attalla *et al*. (2008) which found that the NO:NO_2 ratio was typically 27:1, giving a NO_x:NO_2 ratio of approximately 18.6 g NO_x/g NO_2.
- Emission release time of 5 minutes.
- Calculated emission of 1,046 g/s of NO_x per blast.
- 30% of the NO_x is NO_2 at the sensitive receptors.

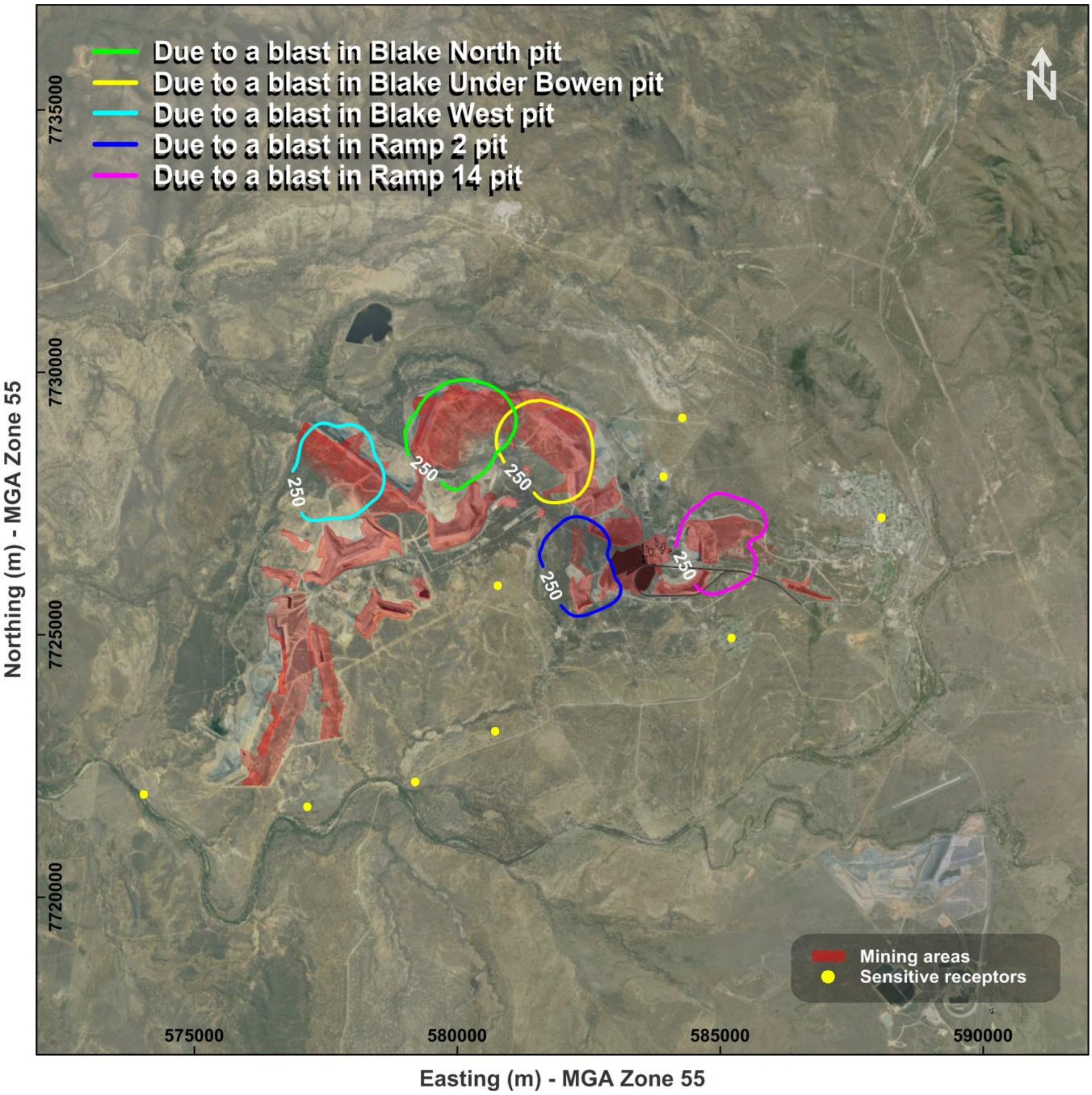
Figure 17 shows the predicted maximum 1-hour average NO_2 concentrations due to post-blast fume, based on the methodology outlined above. These results show that the post-blast fume concentrations (as NO_2) would be expected to comply with the DEHP air quality objective at all sensitive receptors, assuming appropriate management procedures are in place.

Collinsville Mine has developed a fume management procedures which will continue to be implemented during operations. Key fume management actions include:

- Inhibiting product;
- Assessment of sleep time;
- Risk assessment prior to firing;
- Implementation of blasting contractor QA systems; and
- Defining risk zone based upon weather patterns and permission to fire.

In addition to general fume management practices, Collinsville Mine continues to work closely with its explosive suppliers to minimise the potential for post-blast fume.

Figure 17 Predicted maximum 1-hour average NO_2 concentrations due to blasting (µg/m^3)



8.4 Spontaneous Combustion

"Self-heating" occurs when coal and other carbonaceous materials undergo an exothermic reaction when exposed to oxygen in the air, to generate heat. This process causes the temperature of the material to rise which in turn accelerates the oxidation and, in turn, the heat generation process. As the material temperature rises above about 70^{o}C the temperature acceleration is rapid enough to result in ignition of the material. This ignition is referred to as spontaneous combustion.

The propensity of coal (or carbonaceous material) to self-heat and potentially combust is governed by many factors but most commonly by the type of coal, the carbon content, the size of the particles, the material temperature, the presence of oxygen and quantity of coal. Spontaneous combustion results in the emission of noxious gases including carbon dioxide, carbon monoxide, sulphur dioxide, hydrogen sulphide, nitrogen oxides and a range of volatile organic compounds.

The emissions to air have the potential to lead to the following hazards:

- Adverse health effects due to inhalation;
- Nuisance effects due to odour;
- Fire and hot material;
- Subsidence;
- Smoke and effects on visibility.

Uniquest has undertaken a spontaneous combustion assessment of various core samples taken from Collinsville Mine (Uniquest 2012). This assessment noted that the tests rated the coal as having a low intrinsic spontaneous combustion reactivity for Queensland conditions. In addition, the self-heating rates from old workings of the mine are much lower that for coals in the Hunter Valley, which leads on to the effective management of historic spontaneous combustion.

Nevertheless Collinsville Mine continues to evaluate and manage potential issues associated with spontaneous combustion. More specifically, Glencore's *Spontaneous Combustion Management Plan* (Glencore 2013a) provides guidelines for eliminating or minimising the risk of incidents as a result of spontaneous combustion.

Collinsville Mine is committed to an increased focus on the management of potential air quality issues associated with spontaneous combustion. This commitment is demonstrated by:

- Application of a hierarchy of management controls. Collinsville Mine's hierarchy of controls applied to spontaneous combustion are as follows:
    1) **Elimination** – processing and shipping of coal for its end use before the oxidation reaction that leads to spontaneous combustion occurs.
    2) **Separation** – Where material has or is showing signs of spontaneous combustion it is stockpiled separate from other inert coals to avoid spreading the heating.
    3) **Engineering** – Controls that minimise the impact of hot material such as establishing sprinklers/bench flooding to cool material prior to mining and selective digging and/or burying.
    4) **Procedures** – Including early identification of spontaneous combustion; dealing with heated materials; provision of protective or first response capacity; and preparing for / cleaning up after spontaneous combustion.
    5) **Personnel skills and training** – Personnel training and education on the effects of spontaneous combustion and how to prevent incident to all people who work in affected areas.
    6) **PPE** – Including gas monitors, masks, respirators and eye protection are required when potentially exposed to spontaneous combustion.
- Monitoring of ambient air quality at five locations (refer to **Figure 3**) to detect emissions that may be associated with spontaneous combustion. Collinsville Mine has a network of MultiRae monitors which are used for the measurement and management of potential emissions associated with spontaneous combustion. The monitors measure real-time concentrations of CO, SO_2, H_2S, O_2 and VOCs (benzene) at 10 to 60 second recording intervals and measurements are used in a TARP to issue alerts in the event that concentrations trigger levels which may require action.
- The development of a specific non particulate emission management TARP, which is informed by visual monitoring, ambient air quality monitoring, and forecasts of emission transport from Collinsville Mine. The

TARP defines trigger levels based on ambient SO_2 concentrations, with associated management actions. These trigger levels are also dependent on wind direction.

- Implementation of Glencore's Air Quality Control System which will produce site-specific daily forecasts of meteorological conditions and air emissions transport. The potential risks associated with emissions (dust and odour) being transported from Collinsville Mine to sensitive receptors will be reviewed by mining supervisors prior to each shift.

Potential air quality issues associated with spontaneous combustion at Collinsville Mine and the specific measures employed to manage these issues are also documented in Collinsville Mine's *Air Quality Management Plan*, *Air Quality Monitoring Program*, *Spontaneous Combustion Management Plan* (Glencore 2013a) and *Prevention and Maintenance of Spontaneous Combustion Guideline* (Glencore 2013b).

9. Air Quality Management Measures

Collinsville Mine has developed air quality management procedures and dust mitigation measures to cover operational mining activities. These procedures and measures are outlined in Collinsville Mine's *Air Quality Management Plan*, *Air Quality Monitoring Program* and *Dust Management Program.* The procedures and measures also consider the *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and / or Minimise Emissions of Particulate Matter from Coal Mining* (Donnelly et al 2010).

The key measures to minimise emissions to air from Collinsville Mine are outlined in **Table 16**.

Table 16 Air quality management measures

Activity / source	Management measures
Wind erosion from dumps / pits / topsoil piles	Management measures may include: • Minimising the size of disturbed areas. • Undertaking timely rehabilitation of such areas in accordance with the operation's annual rehabilitation plan. • Planning the pre-strip areas to minimise the time of exposure following clearing in advance of mine development. • Watering exposed areas/active areas if dust generation is observed. • Applying temporary rehabilitation to overburden emplacement areas that are to be in place for one to three years. • Preventing unauthorised clearing of non-mining areas. • Checking actual rehabilitation rates against annual targets.
Hauling on unsealed roads	Management measures may include: • Ripping and re-vegetating obsolete roads. • Managing and maintaining temporary haul roads and other unsealed roads on a risk-based approach to reduce dust generation by applying measures such as reducing vehicle speed, water spraying, chemical suppression or gravel surfacing. • Providing timely clean up and removal of material deposited on roads and hardstand areas. • Restricting vehicle speed on unsealed haul roads. • Requiring operational personnel and support staff to call for additional dust suppression if considerable dust is visible for a sustained period above wheel height. • Conducting regular haul road maintenance to provide for compact surfaces with low silt contents.
Dragline	Management measures may include: • Avoiding over-dragging material when filling the bucket. • Lifting bucket cleanly away from the dig face. • Keeping the bucket clear of all walls and batters and hoist up with minimum spillage where applicable. • Maintaining drop heights to a practical minimum when emptying the bucket. • Exercising particular care when material being moved is dry and contains excessive fines. • Modifying, and if necessary ceasing operations during dry, windy conditions when its activities are significantly affecting sensitive receptors.
Material extraction and handling	Management measures may include: • Modifying operations during adverse weather conditions (for example, dry windy conditions). • Minimising double handling of material. • Identifying material types that contain fine and/or friable material, and implement a risk-based approach for effective dust mitigation. • Preparing work areas prior to commencement of mining, e.g. watering of extraction areas. • Conducting sheltered dumping during high winds (e.g. dumping within the pit). • Minimising the drop distance of overburden materials during loading and tipping. • Watering overburden loading operations, including soaking of the bench and wetting dry materials prior to extraction
Dozers on coal stockpiles	Management measures may include: • Avoiding dozer operations at wind-exposed areas during dry, windy conditions. • Designating and maintaining dozer routes between work areas.

Activity / source	Management measures
	• Ceasing or modifying dozer operations (e.g. by reducing dozer tramming speeds) when elevated dust levels are detected by trained personnel or under adverse meteorological conditions.
Coal handling	Management measures may include: • Applying automated sprays on hoppers. • Applying conveyor belt cleaning to remove debris.
Drilling	Management measures may include: • Fitting drill rigs with dust suppression systems. • Ceasing drill operations when dust suppression systems are not operating and have the potential to significantly affect sensitive receptors. • Wetting down drill cuttings, including dust cones, to prevent dust generation. • Watering drill patterns during hot, dry or windy conditions if feasible to do so (eg. not on reactive ground). • Adequate stemming at all times.
Blasting	Management measures may include: • Identifying site-specific adverse meteorological conditions for blasts and establish procedures to avoid blasts during such conditions. • Implementing automated, real-time meteorological assessment procedures linked to on-site meteorological monitoring to inform blast personnel of blasting opportunities. • Watering blast areas prior to shot loading to suppress fine, dry material and form crusting on drill hole cuttings. • Using coarse material (gravel) or material with a lower dust generation potential as stemming material in overburden blasts. • Adequate stemming at all times. • Implementing Collinsville Mine's Explosives & Shotfiring Blast ***Fume Management Plan*** and ***Blast Management Program***.

Air quality and meteorological monitoring is also carried out in the vicinity of Collinsville Mine. This monitoring includes:

- Six (6) meteorological stations
- Seven (7) real-time beta attenuation mass monitors to measure PM_{10} concentrations.
- Twelve (12) dust deposition gauges.
- 15 MultiRae monitors (blast fume, spontaneous combustion).

The real-time monitors will be used in combination with real-time weather conditions for adaptive air quality management. Activities will be suspended or modified in response to the following triggers:

- Predicted increased dust risk from forecasts of Collinsville Mine's contribution to off-site air quality. The predictions will be produced on a daily basis by Glencore's Air Quality Control System.
- Warnings or exceedance alarms from the real time air quality monitoring system.
- Observation(s) of significant dust generation during visual monitoring.

Further information on the triggers is provided in the *Air Quality Monitoring Program*.

10. Conclusions

This report has assessed the potential air quality impacts associated with a proposed expansion of operations at the Collinsville Mine.

The key potential air quality issues were identified as:

- Dust from the general mining activities;
- Fume from blasting; and
- Odour and other substances due to potential spontaneous combustion of coal.

The computer-based dispersion model known as CALPUFF was used to predict air quality impacts at the nearest sensitive receptors. The dispersion modelling took account of meteorological conditions, landuse and terrain information and used dust emission estimates to predict the off-site air quality impacts.

A review of the existing environment showed that winds in the Collinsville area are generally favourable for transporting emissions from the mine away from sensitive receptors.

In regards to the Project, the main conclusions of the assessment were as follows:

- Predicted impacts of the proposed 5.9 Mtpa operation are similar to those of the existing 5.9 Mtpa operation.
- Concentrations and deposition levels are predicted to increase (in most instances) at all locations under the proposed, 9.9 Mtpa scenario. This is due to a likely increase in dust emissions as a result of an increased intensity of mining activities.
- TSP and $PM_{2.5}$ concentrations are predicted to comply with the respective air quality objectives at all sensitive receptor locations, for existing and proposed mining scenarios.
- Existing and proposed mining activities, on their own, will comply with the PM_{10} objective (50 $\mu g/m^3$). However, there is a potential risk that proposed activities will contribute, cumulatively, to more than five exceedances of the 24-hour average PM_{10} objective at two location ("Hillview Station" and "Emohruo Station"), especially if background levels are higher than average.
- Maximum monthly dust deposition is predicted to exceed the 120 mg/m^2/day objective at "Hillview Station" for existing and proposed mining scenarios, and at Emohruo for the proposed 9.9 Mtpa scenario. However, the model results over-estimated impacts since the monitored dust deposition at these locations have not exceeded the 120 mg/m^2/day objective in the past ten years even with existing mining operations. The model predictions of dust deposition for the existing scenario were nearly double the monitored levels, demonstrating an overly conservative model for predicting dust deposition.
- Post-blast fume is not expected to cause adverse impacts at any sensitive receptor, based on model predictions which complied with the relevant air quality objective and assuming appropriate management procedures are in place.
- There will be an increased focus on the management of potential air quality issues associated with spontaneous combustion. This was demonstrated by the development of a detailed hierarchy of management controls, specific monitoring of ambient air quality, development of a trigger action response plan, and implementation of a forecasting system to identify potential risks.

It is important to note that non-sensitive location agreements (in accordance with condition A24 of the Environmental Authority) have been entered into with the owners of both "Hillview" and "Emohruo" and, hence, these places are therefore not considered to be sensitive places for the purposes of the Environmental Authority. Nonetheless, Collinsville Mine has recognised a potential increase in dust emissions and is proposing further emphasis on dust management as part of the Project. A dust management Trigger Action Response Plan (TARP) which defines "trigger" levels and actions has been developed and will be implemented. The TARP defines trigger levels based on visual, meteorological, ambient air quality and forecast dust conditions, with associated actions for controlling dust emissions.

A model scenario was developed to provide an indication of the effectiveness of the TARP. It was found that a dust management TARP will be an effective strategy to minimise off-site air quality impacts, since the TARP is designed to identify the conditions leading to elevated PM_{10} concentrations and appropriately managing activities under those conditions. It is anticipated that the additional combination of real-time PM_{10} concentration monitors, meteorological data, a predictive dust system, and visual observations will further improve the effectiveness of the TARP.

Existing air quality and "background levels" were determined from long-term monitoring records collected prior to 2014. Collinsville Mine has recently (February 2014) commenced the installation of seven real-time PM_{10} concentration monitoring units in various locations around the site. It is anticipated that these units will issue alerts if short-term concentrations exceed trigger levels, so that mining activities can modified as required to make sure off-site impacts are kept within acceptable levels.

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Appendix A. Emission calculations

Existing 5.9 Mtpa: Intensities and emission factors ($PM_{2.5}$ emissions assumed to be 5% of TSP)

Activity	Control (%)	Level of activity		TSP		PM10	
		Intensity	Units	Factor	Units	Factor	Units
Stripping topsoil (scraper)	0	151965	t/y	0.029	kg/t	0.0073	kg/t
Drilling overburden	70	22238	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting overburden	0	62	blasts/y	292.4	kg/blast	151.5	kg/blast
Excavators loading overburden to trucks	0	23634674.8	t/y	0.00032	kg/t	0.00015	kg/t
Dragline (on overburden)	0	43681140.9	t/y	0.05	kg/t	0.01	kg/t
Hauling overburden to dumps	75	23634674.8	t/y	0.05455	kg/t	0.01612	kg/t
Unloading overburden to dumps	0	23634674.8	t/y	0.01200	kg/t	0.0043	kg/t
Dozers working on overburden	0	26485	h/y	3.0	kg/h	0.64031	kg/h
Drilling coal	0	11236	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting coal	0	33	blasts/y	292.4	kg/blast	151.5	kg/blast
Dozers ripping coal	0	5955	h/y	12.8	kg/h	4.1	kg/h
Excavators loading coal to trucks	0	5900000	t/y	0.03264	kg/t	0.00516	kg/t
Hauling ROM coal to stockpile / bin	75	5900000	t/y	0.28111	kg/t	0.08307	kg/t
Unloading ROM coal at stockpile / bin	70	5900000	t/y	0.01	kg/t	0.0042	kg/t
ROM coal rehandle to bin	0	295000	t/y	0.01	kg/t	0.0042	kg/t
Handling coal at CHPP	70	5900000	t/y	0.00092	kg/t	0.00044	kg/t
Loader pushing ROM coal	0	11616	h/y	12.8	kg/h	4.1	kg/h
Loader pushing product coal	0	11616	h/y	12.8	kg/h	4.1	kg/h
Loading product coal stockpile	25	4635577	t/y	0.00400	kg/t	0.0017	kg/t
Wind erosion from overburden dumps	0	684	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from all pits / topsoil piles	0	289	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from ROM coal stockpiles	0	40	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from product coal stockpiles	0	5	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Loading coal to trains	70	4635577	t/y	0.00040	kg/t	0.00017	kg/t
Grading roads	50	80261	VKT/y	0.29982	kg/VKT	0.1224	kg/VKT

Existing 5.9 Mtpa: Variables

Activity	Variables								
	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil (scraper)	-	-	-	-	-	-	-	-	-
Drilling overburden	-	-	-	-	-	-	-	-	-
Blasting overburden	12088	-	-	-	-	-	-	-	-
Excavators loading overburden to trucks	-	1.70	7.5	-	-	-	-	-	-
Dragline (on overburden)	-	-	7.5	15	-	-	-	-	-
Hauling overburden to dumps	-	-	-	-	4.0	220	3	-	-
Unloading overburden to dumps	-	-	-	-	-	-	-	-	-
Dozers working on overburden	-	-	7.5	-	-	-	-	10	-
Drilling coal	-	-	-	-	-	-	-	-	-
Blasting coal	12088	-	-	-	-	-	-	-	-
Dozers ripping coal	-	-	11	-	-	-	-	7	-
Excavators loading coal to trucks	-	-	11	-	-	-	-	-	-
Hauling ROM coal to stockpile / bin	-	-	-	-	4.0	180	12.65	-	-
Unloading ROM coal at stockpile / bin	-	-	-	-	-	-	-	-	-
ROM coal rehandle to bin	-	-	-	-	-	-	-	-	-
Handling coal at CHPP	-	1.70	11	-	-	-	-	-	-
Loader pushing ROM coal	-	-	11	-	-	-	-	7	-
Loader pushing product coal	-	-	11	-	-	-	-	7	-
Loading product coal stockpile	-	-	-	-	-	-	-	-	-
Wind erosion from overburden dumps	-	-	-	-	-	-	-	-	-
Wind erosion from all pits / topsoil piles	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpiles	-	-	-	-	-	-	-	-	-
Loading coal to trains	-	-	-	-	-	-	-	-	-
Grading roads	-	-	-	-	-	-	-	-	6

Existing 5.9 Mtpa: Activities and source allocations.

```
--------------------------------      27-Feb-2014 07:36
  DUST EMISSION CALCULATIONS XL1
 --------------------------------

 Output emissions file  : C:\Users\SLakmaker\Projects\EN04357_Collinsville\calpuff_r5\59Mtpa\emiss.vol
 Meteorological file    : NA
 Number of dust sources : 167
 Number of activities   : 24

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil (scraper)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4407 kg/y TSP  1109 kg/y PM10  220 kg/y PM2.5
 FROM SOURCES  : 13
77 78 79 109 110 111 112 113 114 134 135 136 137
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3936 kg/y TSP  2068 kg/y PM10  197 kg/y PM2.5
 FROM SOURCES  : 13
77 78 79 109 110 111 112 113 114 134 135 136 137
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 18127 kg/y TSP  9393 kg/y PM10  906 kg/y PM2.5
 FROM SOURCES  : 13
77 78 79 109 110 111 112 113 114 134 135 136 137
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Excavators loading overburden to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 7467 kg/y TSP  3532 kg/y PM10  373 kg/y PM2.5
 FROM SOURCES  : 13
77 78 79 109 110 111 112 113 114 134 135 136 137
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dragline (on overburden)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2158906 kg/y TSP  349512 kg/y PM10  107945 kg/y PM2.5
 FROM SOURCES  : 18
77 78 79 80 81 82 109 110 111 112 113 114 115 116 117 118 119 120
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden to dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 322291 kg/y TSP  95240 kg/y PM10  16115 kg/y PM2.5
 FROM SOURCES  : 38
76 77 78 79 80 81 82 83 84 85 86 87 88 109 110 111 112 113 114 115 116 117 118 119 120 134 135 136 137 138 139 140 141 142 143 144 145
146
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to dumps
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 283616 kg/y TSP  101629 kg/y PM10  14181 kg/y PM2.5
 FROM SOURCES  : 31
80 81 82 83 84 85 86 87 88 115 116 117 118 119 120 121 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 79504 kg/y TSP  16959 kg/y PM10  3975 kg/y PM2.5
 FROM SOURCES  : 31
80 81 82 83 84 85 86 87 88 115 116 117 118 119 120 121 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 6629 kg/y TSP  3483 kg/y PM10  331 kg/y PM2.5
 FROM SOURCES  : 13
77 78 79 109 110 111 112 113 114 134 135 136 137
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9648 kg/y TSP  5000 kg/y PM10  482 kg/y PM2.5
 FROM SOURCES  : 13
77 78 79 109 110 111 112 113 114 134 135 136 137
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0
```

```
 ACTIVITY NAME : Dozers ripping coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 76296 kg/y TSP  24321 kg/y PM10  3815 kg/y PM2.5
 FROM SOURCES  : 20
1 2 3 4 5 6 7 77 78 79 109 110 111 112 113 114 134 135 136 137
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading coal to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 192579 kg/y TSP  30472 kg/y PM10  9629 kg/y PM2.5
 FROM SOURCES  : 20
1 2 3 4 5 6 7 77 78 79 109 110 111 112 113 114 134 135 136 137
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal to stockpile / bin
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 414639 kg/y TSP  122529 kg/y PM10  20732 kg/y PM2.5
 FROM SOURCES  : 57
1 2 3 4 5 6 7 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 68 69 70 71 72 73 74 75 76 93 94 95 96 97 98 99 114 115 117 120 121 122 123
124 125 126 127 128 129 130 131 132 133 134
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM coal at stockpile / bin
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 17700 kg/y TSP  7434 kg/y PM10  885 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : ROM coal rehandle to bin
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2950 kg/y TSP  1239 kg/y PM10  148 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling coal at CHPP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1636 kg/y TSP  774 kg/y PM10  82 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loader pushing ROM coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 148825 kg/y TSP  47441 kg/y PM10  7441 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loader pushing product coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 148825 kg/y TSP  47441 kg/y PM10  7441 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product coal stockpile
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 13907 kg/y TSP  5910 kg/y PM10  695 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from overburden dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 2396836 kg/y TSP  1198418 kg/y PM10  119842 kg/y PM2.5
 FROM SOURCES  : 73
8 9 10 11 12 13 14 15 16 17 22 23 24 25 26 27 49 50 51 52 53 61 62 63 64 65 80 81 82 83 84 85 86 87 88 89 90 91 92 103 104 105 106 107
108 115 116 117 118 119 120 121 129 138 139 140 141 142 143 144 145 146 147 148 153 154 155 156 157 164 165 166 167
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from all pits
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1011757 kg/y TSP  505878 kg/y PM10  50588 kg/y PM2.5
 FROM SOURCES  : 51
1 2 3 4 5 6 7 17 18 19 20 21 46 47 48 54 55 56 57 58 59 60 66 67 76 77 78 79 100 101 102 109 110 111 112 113 114 134 135 136 137 149 150
151 152 158 159 160 161 162 163
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 140014 kg/y TSP  70007 kg/y PM10  7001 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : Wind erosion from product coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 17520 kg/y TSP  8760 kg/y PM10  876 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading coal to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 556 kg/y TSP  236 kg/y PM10  28 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 Pit retention sources:
1 2 3 4 5 6 7 17 18 19 20 21 46 47 48 58 59 60 76 77 78 79 100 101 102 109 110 111 112 113 114 134 135 136 137 149 150 151 152 158 159
160 161 162 163
```

Proposed 5.9 Mtpa: Intensities and emission factors ($PM_{2.5}$ emissions assumed to be 5% of TSP)

Activity	Control (%)	Level of activity		TSP		PM10	
		Intensity	Units	Factor	Units	Factor	Units
Stripping topsoil (scraper)	0	259838	t/y	0.029	kg/t	0.0073	kg/t
Drilling overburden	70	22238	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting overburden	0	62	blasts/y	292.4	kg/blast	151.5	kg/blast
Excavators loading overburden to trucks	0	25827409	t/y	0.00032	kg/t	0.00015	kg/t
Dragline (on overburden)	0	20444637	t/y	0.05	kg/t	0.01	kg/t
Hauling overburden to dumps	75	25827409	t/y	0.05455	kg/t	0.01612	kg/t
Unloading overburden to dumps	0	25827409	t/y	0.01200	kg/t	0.0043	kg/t
Dozers working on overburden	0	26485	h/y	3.0	kg/h	0.64031	kg/h
Drilling coal	0	11236	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting coal	0	33	blasts/y	292.4	kg/blast	151.5	kg/blast
Dozers ripping coal	0	5955	h/y	12.8	kg/h	4.1	kg/h
Excavators loading coal to trucks	0	5935958	t/y	0.03264	kg/t	0.00516	kg/t
Hauling ROM coal to stockpile / bin	75	5935958	t/y	0.24444	kg/t	0.07224	kg/t
Unloading ROM coal at stockpile / bin	70	5935958	t/y	0.01	kg/t	0.0042	kg/t
ROM coal rehandle to bin	0	296798	t/y	0.01	kg/t	0.0042	kg/t
Handling coal at CHPP	70	5935958	t/y	0.00092	kg/t	0.00044	kg/t
Loader pushing ROM coal	0	11616	h/y	12.8	kg/h	4.1	kg/h
Loader pushing product coal	0	11616	h/y	12.8	kg/h	4.1	kg/h
Loading product coal stockpile	25	4663829	t/y	0.00400	kg/t	0.0017	kg/t
Wind erosion from overburden dumps	0	684	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from all pits / topsoil piles	0	289	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from ROM coal stockpiles	0	40	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from product coal stockpiles	0	5	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Loading coal to trains	70	4663829	t/y	0.00040	kg/t	0.00017	kg/t
Grading roads	50	80261	VKT/y	0.29982	kg/VKT	0.1224	kg/VKT

Proposed 5.9 Mtpa: Variables

Activity	Variables								
	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil (scraper)	-	-	-	-	-	-	-	-	-
Drilling overburden	-	-	-	-	-	-	-	-	-
Blasting overburden	12088	-	-	-	-	-	-	-	-
Excavators loading overburden to trucks	-	1.70	7.5	-	-	-	-	-	-
Dragline (on overburden)	-	-	7.5	15	-	-	-	-	-
Hauling overburden to dumps	-	-	-	-	4.0	220	3	-	-
Unloading overburden to dumps	-	-	-	-	-	-	-	-	-
Dozers working on overburden	-	-	7.5	-	-	-	-	10	-
Drilling coal	-	-	-	-	-	-	-	-	-
Blasting coal	12088	-	-	-	-	-	-	-	-
Dozers ripping coal	-	-	11	-	-	-	-	7	-
Excavators loading coal to trucks	-	-	11	-	-	-	-	-	-
Hauling ROM coal to stockpile / bin	-	-	-	-	4.0	180	11	-	-
Unloading ROM coal at stockpile / bin	-	-	-	-	-	-	-	-	-
ROM coal rehandle to bin	-	-	-	-	-	-	-	-	-
Handling coal at CHPP	-	1.70	11	-	-	-	-	-	-
Loader pushing ROM coal	-	-	11	-	-	-	-	7	-
Loader pushing product coal	-	-	11	-	-	-	-	7	-
Loading product coal stockpile	-	-	-	-	-	-	-	-	-
Wind erosion from overburden dumps	-	-	-	-	-	-	-	-	-
Wind erosion from all pits / topsoil piles	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpiles	-	-	-	-	-	-	-	-	-
Loading coal to trains	-	-	-	-	-	-	-	-	-
Grading roads	-	-	-	-	-	-	-	-	6

Proposed 5.9 Mtpa: Activities and source allocations

```
--------------------------------     04-Apr-2014 15:30
  DUST EMISSION CALCULATIONS XL1
 --------------------------------

 Output emissions file  : C:\Users\SLakmaker\Projects\EN04357_Collinsville\calpuff_r6\59Mtpa_G\emiss.vol
 Meteorological file    : NA
 Number of dust sources : 172
 Number of activities   : 24

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil (scraper)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 7535 kg/y TSP  1897 kg/y PM10  377 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3936 kg/y TSP  2068 kg/y PM10  197 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 18127 kg/y TSP  9393 kg/y PM10  906 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Excavators loading overburden to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 8160 kg/y TSP  3859 kg/y PM10  408 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dragline (on overburden)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1010460 kg/y TSP  163587 kg/y PM10  50523 kg/y PM2.5
 FROM SOURCES  : 18
77 78 79 80 81 82 109 110 111 112 113 114 115 116 117 118 119 120
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden to dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 352192 kg/y TSP  104076 kg/y PM10  17610 kg/y PM2.5
 FROM SOURCES  : 51
47 48 58 59 60 61 62 63 64 76 77 78 79 80 81 82 83 84 85 86 87 88 109 110 111 112 113 114 115 116 117 118 119 120 134 135 136 137 138 139
140 141 142 143 144 145 146 168 170 171 172
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to dumps
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 309929 kg/y TSP  111058 kg/y PM10  15496 kg/y PM2.5
 FROM SOURCES  : 35
48 49 61 62 63 64 80 81 82 83 84 85 86 87 88 115 116 117 118 119 120 121 138 139 140 141 142 143 144 145 146 147 148 171 172
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 79504 kg/y TSP  16959 kg/y PM10  3975 kg/y PM2.5
 FROM SOURCES  : 35
48 49 61 62 63 64 80 81 82 83 84 85 86 87 88 115 116 117 118 119 120 121 138 139 140 141 142 143 144 145 146 147 148 171 172
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 6629 kg/y TSP  3483 kg/y PM10  331 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9648 kg/y TSP  5000 kg/y PM10  482 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0
```

```
 ACTIVITY NAME : Dozers ripping coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 76296 kg/y TSP  24321 kg/y PM10  3815 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading coal to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 193753 kg/y TSP  30658 kg/y PM10  9688 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal to stockpile / bin
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 362753 kg/y TSP  107197 kg/y PM10  18138 kg/y PM2.5
 FROM SOURCES  : 47
38 39 40 41 42 43 58 59 60 65 68 69 70 71 72 73 74 75 76 93 94 95 96 97 98 99 109 114 115 120 121 122 123 124 125 126 127 128 129 130 131
132 133 134 168 169 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM coal at stockpile / bin
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 17808 kg/y TSP  7479 kg/y PM10  890 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : ROM coal rehandle to bin
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2968 kg/y TSP  1247 kg/y PM10  148 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling coal at CHPP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1646 kg/y TSP  778 kg/y PM10  82 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loader pushing ROM coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 148825 kg/y TSP  47441 kg/y PM10  7441 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loader pushing product coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 148825 kg/y TSP  47441 kg/y PM10  7441 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product coal stockpile
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 13991 kg/y TSP  5946 kg/y PM10  700 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from overburden dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 2396836 kg/y TSP  1198418 kg/y PM10  119842 kg/y PM2.5
 FROM SOURCES  : 73
8 9 10 11 12 13 14 15 16 17 22 23 24 25 26 27 50 51 53 61 62 63 64 65 80 81 82 83 84 85 86 87 88 89 90 91 92 103 104 105 106 107 108 115
116 117 118 119 120 121 129 138 139 140 141 142 143 144 145 146 147 148 153 154 155 156 157 164 165 166 167 170 172
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from all pits / topsoil piles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1011757 kg/y TSP  505878 kg/y PM10  50588 kg/y PM2.5
 FROM SOURCES  : 53
1 2 3 4 5 6 7 17 18 19 20 21 46 47 48 54 55 56 57 58 59 60 66 67 76 77 78 79 100 101 102 109 110 111 112 113 114 134 135 136 137 149 150
151 152 158 159 160 161 162 163 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 140014 kg/y TSP  70007 kg/y PM10  7001 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : Wind erosion from product coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 17520 kg/y TSP  8760 kg/y PM10  876 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading coal to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 560 kg/y TSP  238 kg/y PM10  28 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 Pit retention sources:
1 2 3 4 5 6 7 17 18 19 20 21 46 47 48 58 59 60 76 77 78 79 100 101 102 109 110 111 112 113 114 134 135 136 137 149 150 151 152 158 159
160 161 162 163
```

Proposed 9.9 Mtpa: Intensities and emission factors ($PM_{2.5}$ emissions assumed to be 5% of TSP)

Activity	Control (%)	Level of activity		TSP		PM10	
		Intensity	Units	Factor	Units	Factor	Units
Stripping topsoil (scraper)	0	412522	t/y	0.029	kg/t	0.0073	kg/t
Drilling overburden	70	19369	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting overburden	0	54	blasts/y	292.4	kg/blast	151.5	kg/blast
Excavators loading overburden to trucks	0	57455023.2	t/y	0.00032	kg/t	0.00015	kg/t
Dragline (on overburden)	0	35833711.9	t/y	0.05	kg/t	0.01	kg/t
Hauling overburden to dumps	75	57455023.2	t/y	0.05455	kg/t	0.01612	kg/t
Unloading overburden to dumps	0	57455023.2	t/y	0.01200	kg/t	0.0043	kg/t
Dozers working on overburden	0	36703	h/y	3.0	kg/h	0.64031	kg/h
Drilling coal	0	13960	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting coal	0	41	blasts/y	292.4	kg/blast	151.5	kg/blast
Dozers ripping coal	0	10000	h/y	12.8	kg/h	4.1	kg/h
Excavators loading coal to trucks	0	9907473	t/y	0.03264	kg/t	0.00516	kg/t
Hauling ROM coal to stockpile / bin	75	9907473	t/y	0.24444	kg/t	0.07224	kg/t
Unloading ROM coal at stockpile / bin	70	9907473	t/y	0.01	kg/t	0.0042	kg/t
ROM coal rehandle to bin	0	495374	t/y	0.01	kg/t	0.0042	kg/t
Handling coal at CHPP	70	9907473	t/y	0.00092	kg/t	0.00044	kg/t
Loader pushing ROM coal	0	13068	h/y	12.8	kg/h	4.1	kg/h
Loader pushing product coal	0	13068	h/y	12.8	kg/h	4.1	kg/h
Loading product coal stockpile	25	7784213	t/y	0.00400	kg/t	0.0017	kg/t
Wind erosion from overburden dumps	0	714	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from all pits / topsoil piles	0	304	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from ROM coal stockpiles	0	40	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from product coal stockpiles	0	6	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Loading coal to trains	70	7784213	t/y	0.00040	kg/t	0.00017	kg/t
Grading roads	50	80261	VKT/y	0.29982	kg/VKT	0.1224	kg/VKT

Proposed 9.9 Mtpa: Variables

Activity	Variables								
	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)
Stripping topsoil (scraper)	-	-	-	-	-	-	-	-	-
Drilling overburden	-	-	-	-	-	-	-	-	-
Blasting overburden	12088	-	-	-	-	-	-	-	-
Excavators loading overburden to trucks	-	1.70	7.5	-	-	-	-	-	-
Dragline (on overburden)	-	-	7.5	15	-	-	-	-	-
Hauling overburden to dumps	-	-	-	-	4.0	220	3	-	-
Unloading overburden to dumps	-	-	-	-	-	-	-	-	-
Dozers working on overburden	-	-	7.5	-	-	-	-	10	-
Drilling coal	-	-	-	-	-	-	-	-	-
Blasting coal	12088	-	-	-	-	-	-	-	-
Dozers ripping coal	-	-	11	-	-	-	-	7	-
Excavators loading coal to trucks	-	-	11	-	-	-	-	-	-
Hauling ROM coal to stockpile / bin	-	-	-	-	4.0	180	11	-	-
Unloading ROM coal at stockpile / bin	-	-	-	-	-	-	-	-	-
ROM coal rehandle to bin	-	-	-	-	-	-	-	-	-
Handling coal at CHPP	-	1.70	11	-	-	-	-	-	-
Loader pushing ROM coal	-	-	11	-	-	-	-	7	-
Loader pushing product coal	-	-	11	-	-	-	-	7	-
Loading product coal stockpile	-	-	-	-	-	-	-	-	-
Wind erosion from overburden dumps	-	-	-	-	-	-	-	-	-
Wind erosion from all pits / topsoil piles	-	-	-	-	-	-	-	-	-
Wind erosion from ROM coal stockpiles	-	-	-	-	-	-	-	-	-
Wind erosion from product coal stockpiles	-	-	-	-	-	-	-	-	-
Loading coal to trains	-	-	-	-	-	-	-	-	-
Grading roads	-	-	-	-	-	-	-	-	6

Proposed 9.9 Mtpa: Activities and source allocations

```
--------------------------------      04-Apr-2014 14:05
  DUST EMISSION CALCULATIONS XL1
 --------------------------------

 Output emissions file  : C:\Users\SLakmaker\Projects\EN04357_Collinsville\calpuff_r6\99Mtpa\emiss.vol
 Meteorological file    : NA
 Number of dust sources : 172
 Number of activities   : 24

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Stripping topsoil (scraper)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 11963 kg/y TSP  3011 kg/y PM10  598 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3428 kg/y TSP  1801 kg/y PM10  171 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 15788 kg/y TSP  8181 kg/y PM10  789 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Excavators loading overburden to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 18153 kg/y TSP  8586 kg/y PM10  908 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dragline (on overburden)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1771053 kg/y TSP  286721 kg/y PM10  88553 kg/y PM2.5
 FROM SOURCES  : 18
77 78 79 80 81 82 109 110 111 112 113 114 115 116 117 118 119 120
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling overburden to dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 783478 kg/y TSP  231524 kg/y PM10  39174 kg/y PM2.5
 FROM SOURCES  : 51
47 48 58 59 60 61 62 63 64 76 77 78 79 80 81 82 83 84 85 86 87 88 109 110 111 112 113 114 115 116 117 118 119 120 134 135 136 137 138 139
140 141 142 143 144 145 146 168 170 171 172
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading overburden to dumps
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 689460 kg/y TSP  247057 kg/y PM10  34473 kg/y PM2.5
 FROM SOURCES  : 35
48 49 61 62 63 64 80 81 82 83 84 85 86 87 88 115 116 117 118 119 120 121 138 139 140 141 142 143 144 145 146 147 148 171 172
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozers working on overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 110180 kg/y TSP  23502 kg/y PM10  5509 kg/y PM2.5
 FROM SOURCES  : 35
48 49 61 62 63 64 80 81 82 83 84 85 86 87 88 115 116 117 118 119 120 121 138 139 140 141 142 143 144 145 146 147 148 171 172
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Drilling coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 8236 kg/y TSP  4328 kg/y PM10  412 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Blasting coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 11987 kg/y TSP  6212 kg/y PM10  599 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 0 1 0 1 0 1 0 1 0 0 0 0 0 0 0
```

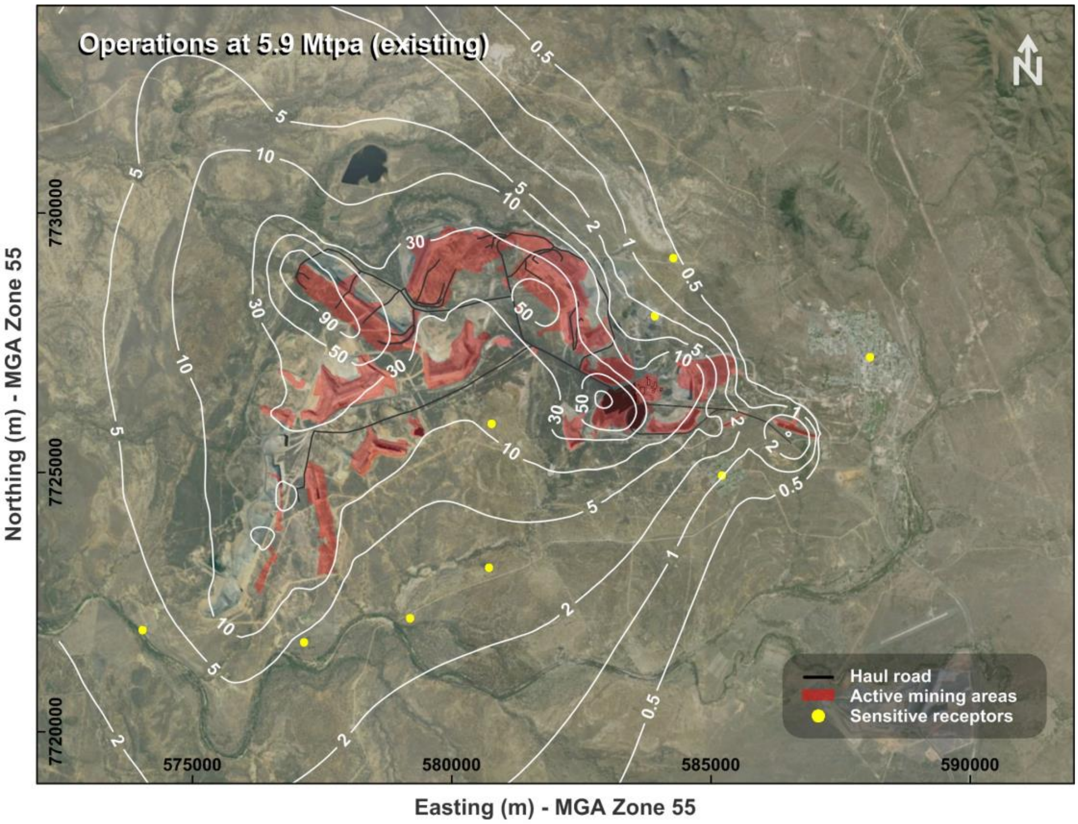
```
 ACTIVITY NAME : Dozers ripping coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 128118 kg/y TSP  40841 kg/y PM10  6406 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Excavators loading coal to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 323385 kg/y TSP  51170 kg/y PM10  16169 kg/y PM2.5
 FROM SOURCES  : 18
58 59 60 77 78 79 109 110 111 112 113 114 134 135 136 137 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling ROM coal to stockpile / bin
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 605457 kg/y TSP  178917 kg/y PM10  30273 kg/y PM2.5
 FROM SOURCES  : 47
38 39 40 41 42 43 58 59 60 65 68 69 70 71 72 73 74 75 76 93 94 95 96 97 98 99 109 114 115 120 121 122 123 124 125 126 127 128 129 130 131
132 133 134 168 169 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Unloading ROM coal at stockpile / bin
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 29722 kg/y TSP  12483 kg/y PM10  1486 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : ROM coal rehandle to bin
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 4954 kg/y TSP  2081 kg/y PM10  248 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Handling coal at CHPP
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2747 kg/y TSP  1299 kg/y PM10  137 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loader pushing ROM coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 167428 kg/y TSP  53372 kg/y PM10  8371 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loader pushing product coal
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 167428 kg/y TSP  53372 kg/y PM10  8371 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product coal stockpile
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 23353 kg/y TSP  9925 kg/y PM10  1168 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from overburden dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 2503005 kg/y TSP  1251503 kg/y PM10  125150 kg/y PM2.5
 FROM SOURCES  : 73
8 9 10 11 12 13 14 15 16 17 22 23 24 25 26 27 50 51 53 61 62 63 64 65 80 81 82 83 84 85 86 87 88 89 90 91 92 103 104 105 106 107 108 115
116 117 118 119 120 121 129 138 139 140 141 142 143 144 145 146 147 148 153 154 155 156 157 164 165 166 167 170 172
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from all pits / topsoil piles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1064842 kg/y TSP  532421 kg/y PM10  53242 kg/y PM2.5
 FROM SOURCES  : 53
1 2 3 4 5 6 7 17 18 19 20 21 46 47 48 54 55 56 57 58 59 60 66 67 76 77 78 79 100 101 102 109 110 111 112 113 114 134 135 136 137 149 150
151 152 158 159 160 161 162 163 168 171
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from ROM coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 140014 kg/y TSP  70007 kg/y PM10  7001 kg/y PM2.5
 FROM SOURCES  : 2
42 43
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : Wind erosion from product coal stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 21024 kg/y TSP  10512 kg/y PM10  1051 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading coal to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 934 kg/y TSP  397 kg/y PM10  47 kg/y PM2.5
 FROM SOURCES  : 2
44 45
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 Pit retention sources:
1 2 3 4 5 6 7 17 18 19 20 21 46 47 48 58 59 60 76 77 78 79 100 101 102 109 110 111 112 113 114 134 135 136 137 149 150 151 152 158 159
160 161 162 163
```

Appendix B. Contour plots of model results

The following contour plots show the predicted concentration and deposition levels due to Collinsville Mine activities only. No background levels are included in these plots.

Figure B.1 Predicted annual average TSP concentrations due to Collinsville Mine (µg/m³)



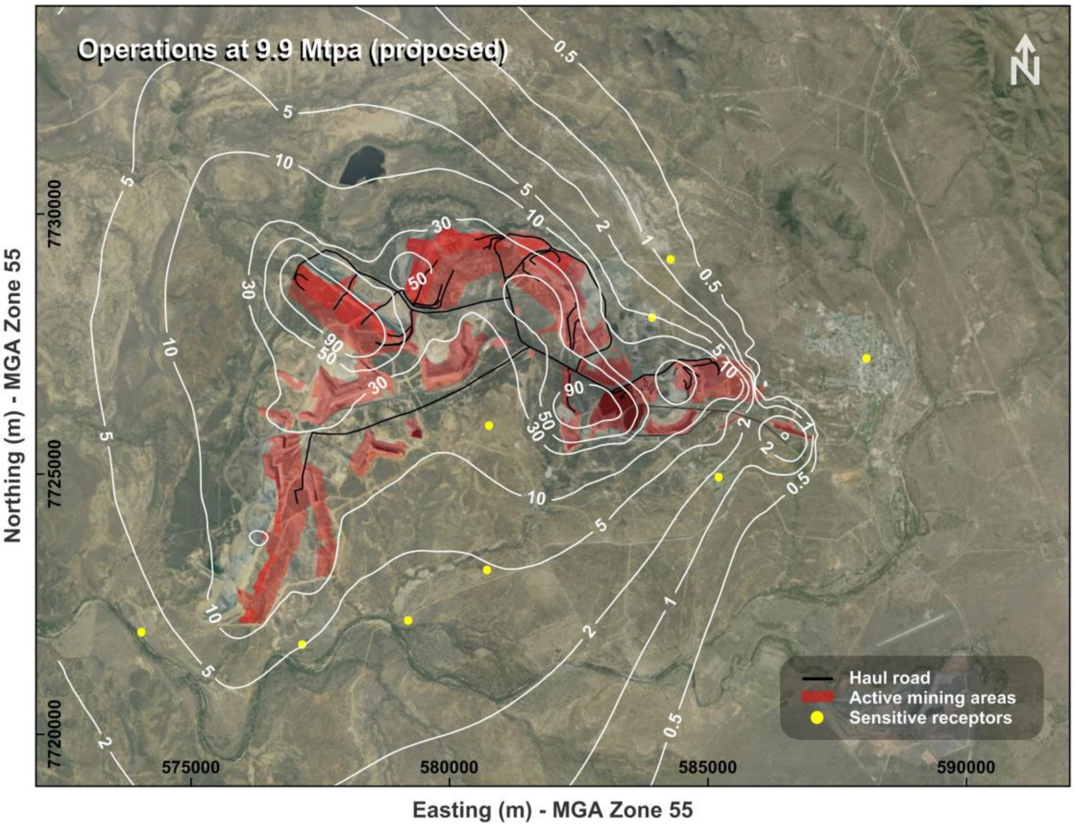
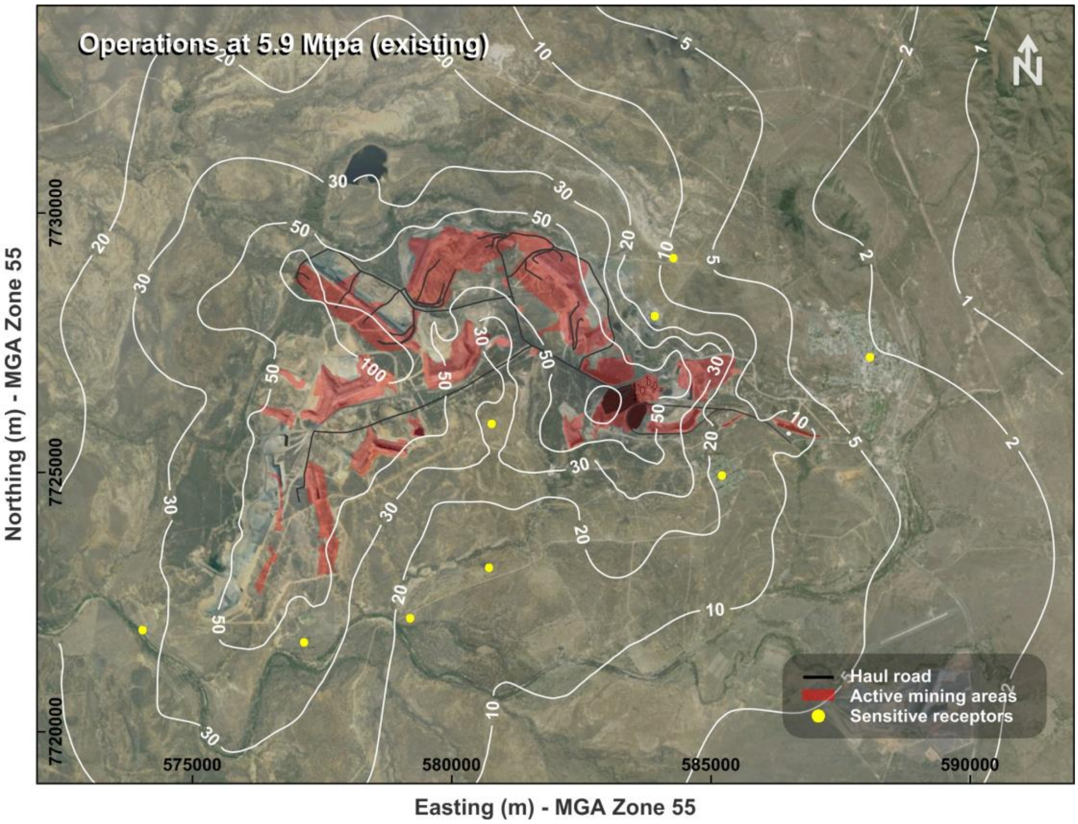


Figure B.2 Predicted maximum 24-hour average PM_{10} concentrations due to Collinsville Mine ($\mu g/m^3$)



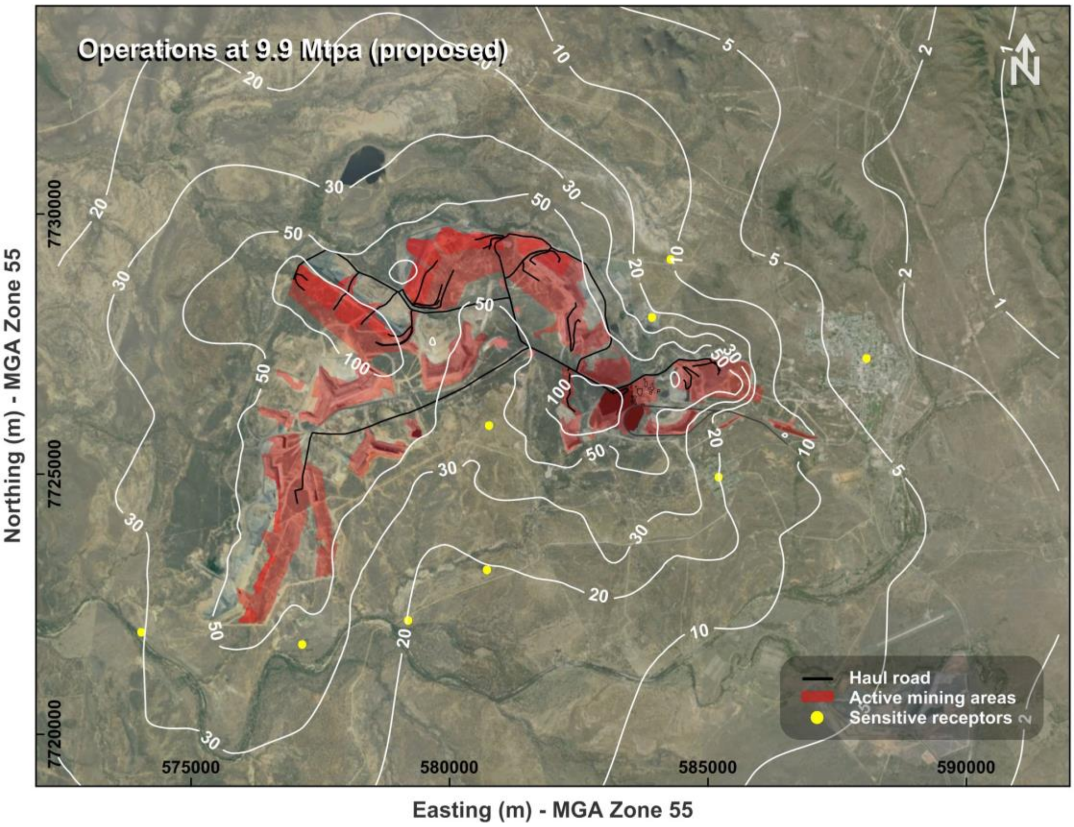
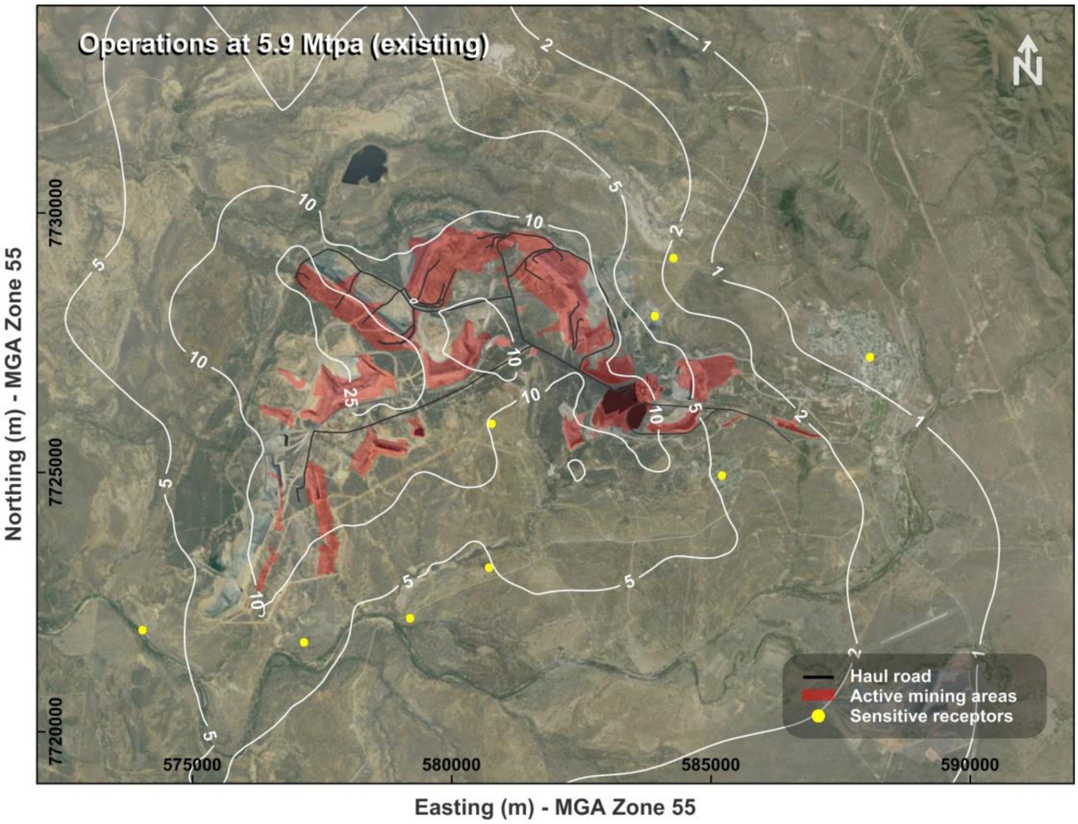


Figure B.3 Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to Collinsville Mine (μg/m³)



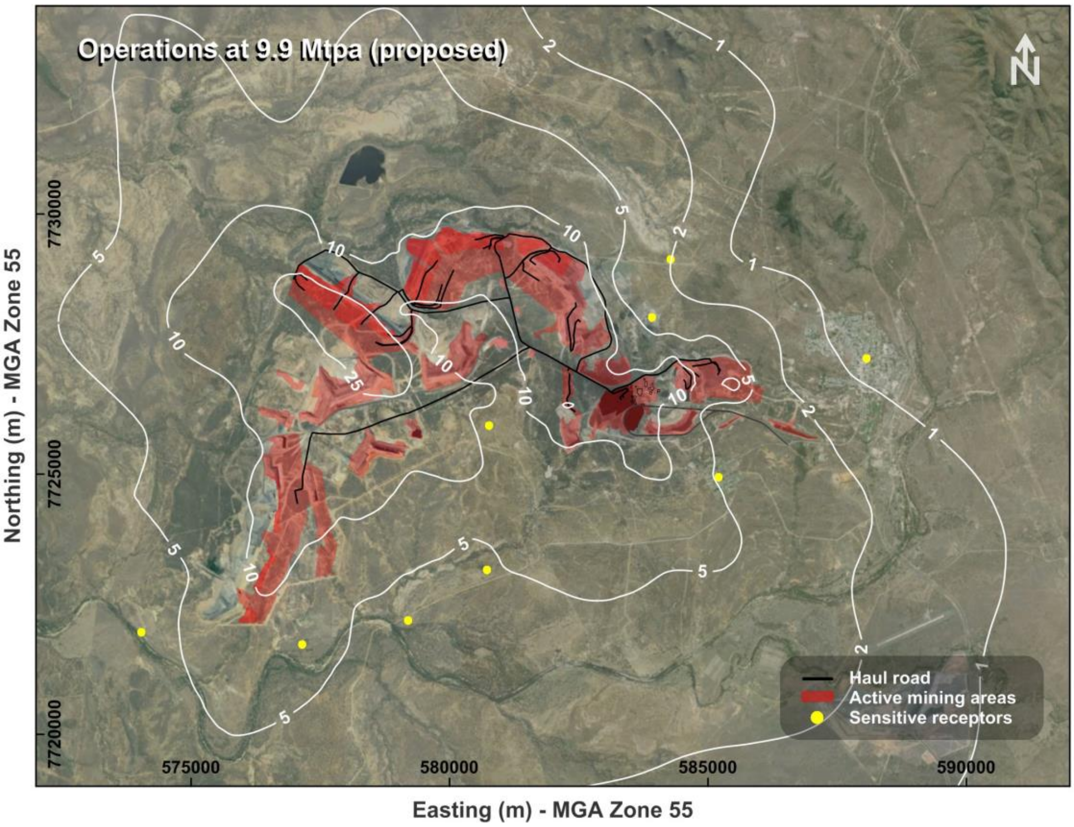
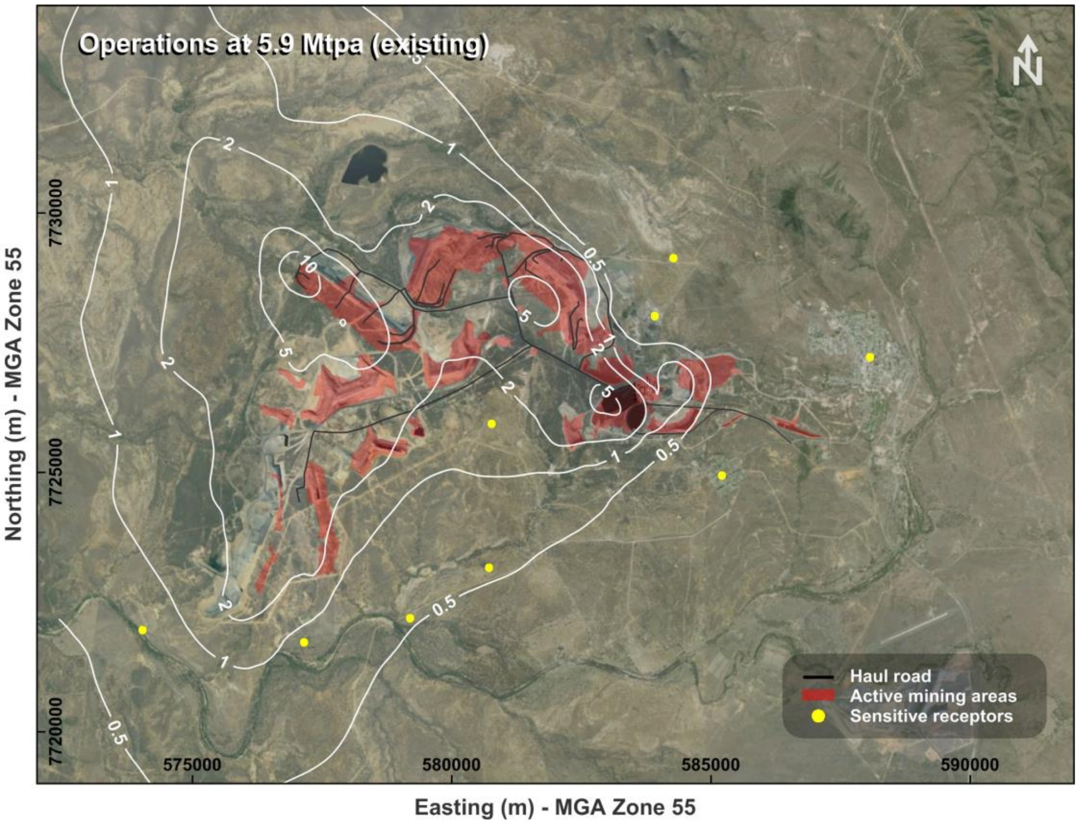


Figure B.4 Predicted annual average $PM_{2.5}$ concentrations due to Collinsville Mine (µg/m^3)



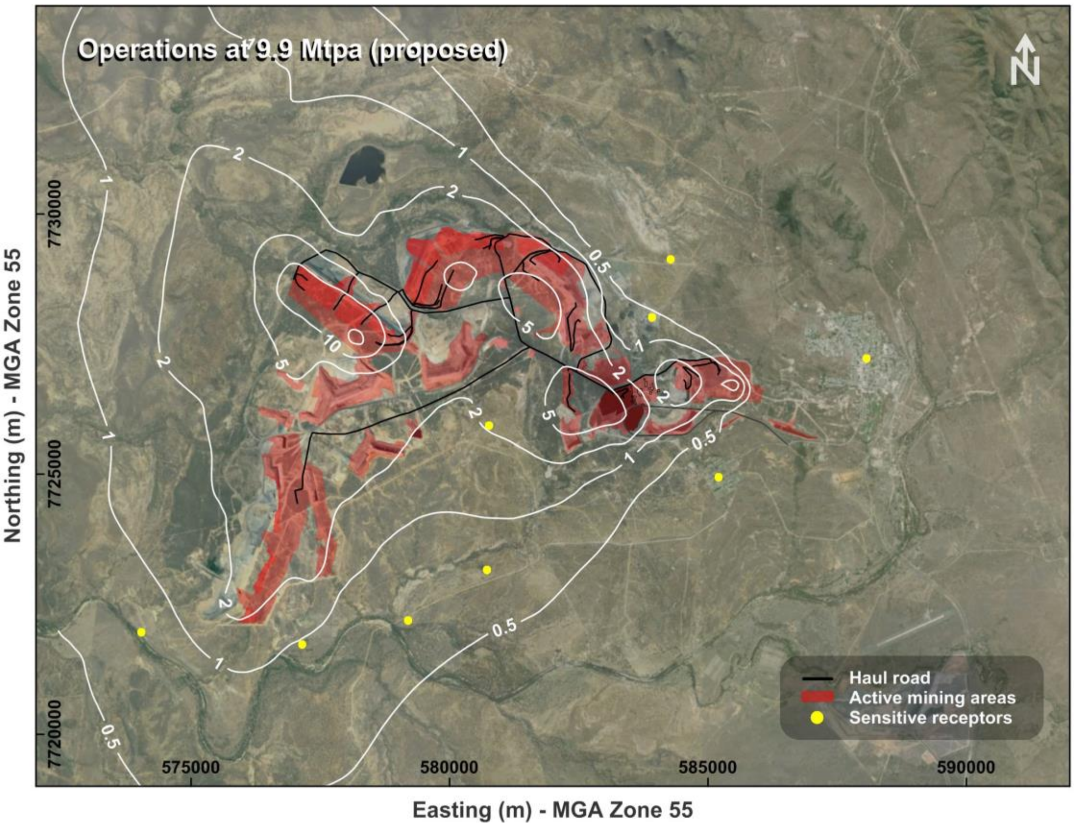
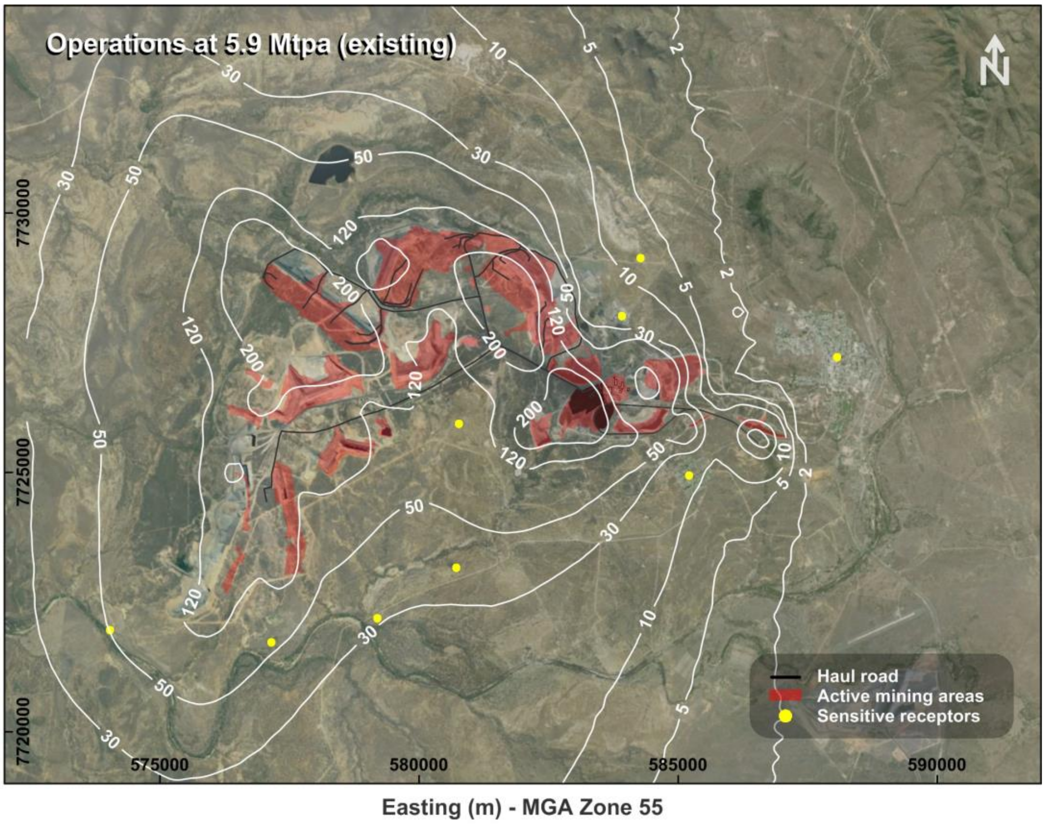
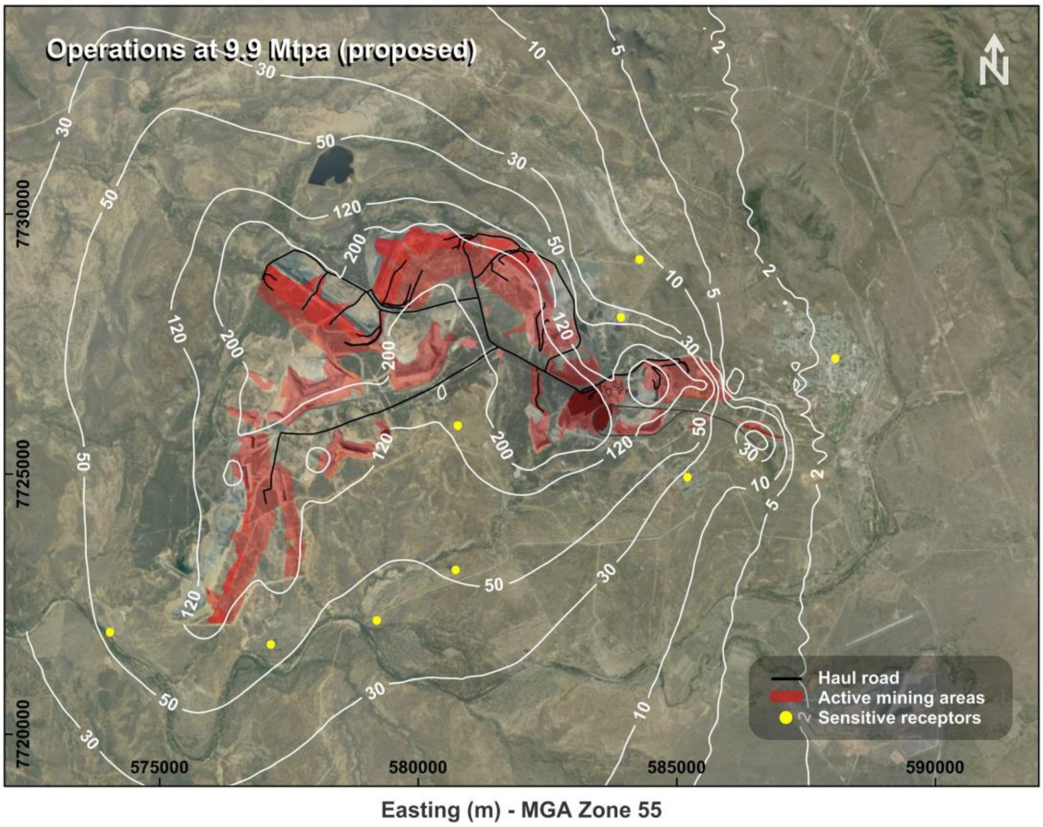


Figure B.5 Predicted maximum monthly dust deposition due to Collinsville Mine (g/m²/day)



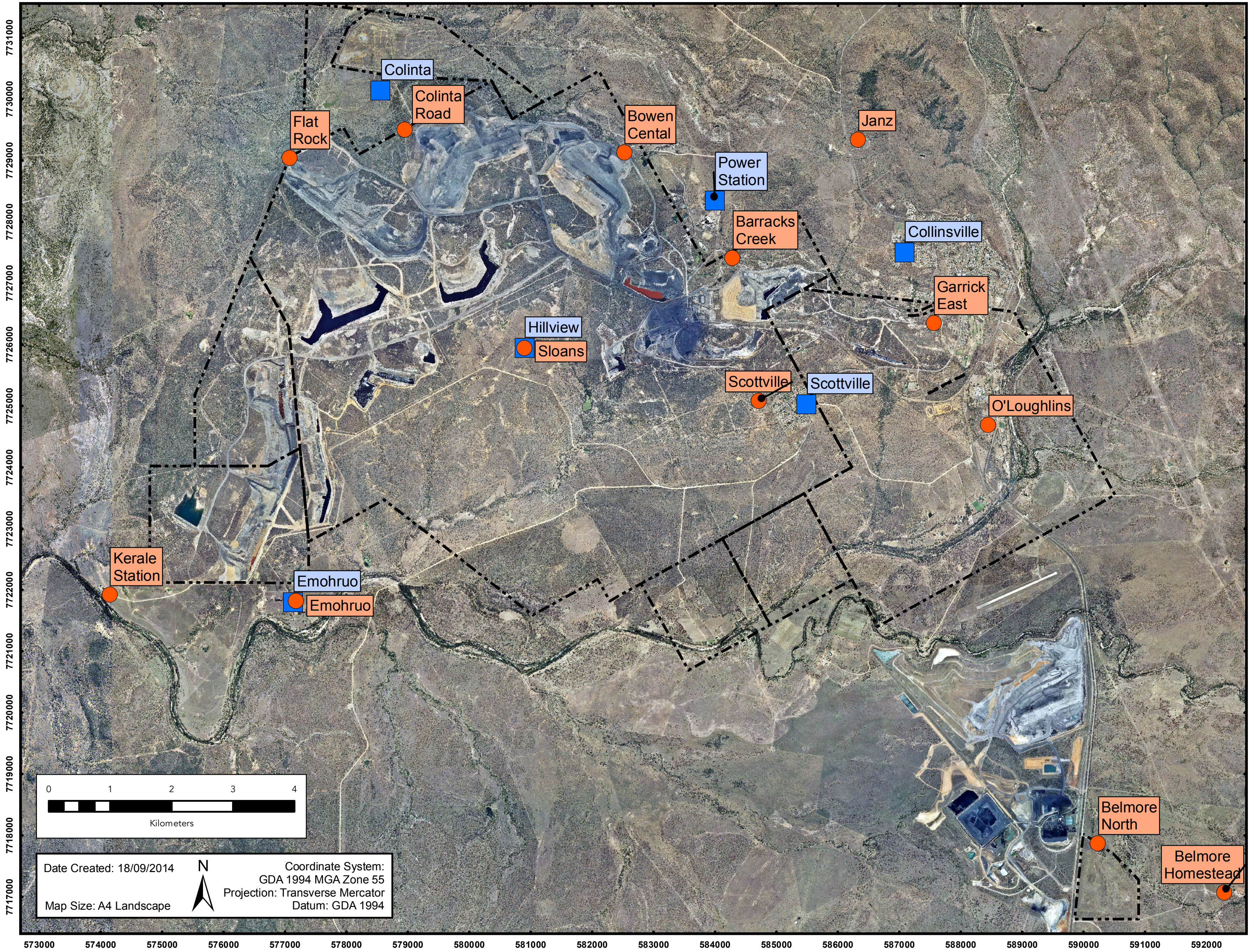


Collinsville Mine

Dust Monitoring Network as of September 2014

GLENCORE

Coal Assets Australia
www.glencore.com



Legend

- BAM Dust Monitor
- Depositional Dust Gauge
- Mining Lease Boundary

DISCLAIMER
Subject To Survey
Glencore makes every effort to ensure the quality of the information available on this map.Before relying on the information on this map, users should carefully evaluate its accuracy, currency, completeness and relevance for their purposes, and should obtain any appropriate professional advice relevant to their particular circumstances. Glencore cannot guarantee and assumes no responsibility for the accuracy, currency or completeness of the information and by using this map you accept that Glencore has no liability for any loss or damage in any form whatsoever caused directly or indirectly from the use of this map.

Ref: O:\SUSTAIN\ENV\MIData\03.MapDocuments\Monitoring\EnvMonNetworkGDA94.mxd

Coal Assets – Australia

Air Quality Management Plan

Number: COL-ENV-PLN-007 **Status:** Final
Owner: Environment & Community Manager **Version:** 1 (Oct 2014)

Table of contents

1 Purpose

1-1 The purpose of this *Air Quality Management Plan* (hereafter "AQMP") is to meet statutory requirements, relating to air quality management, from the Environmental Authority (EA) (EPML00332013).

1-2 The AQMP has also been prepared in accordance with ***CA-HSEC-PCL-0002 Glencore Air Quality Management Protocol***, and documents objectives, emission sources, management measures, monitoring, roles and responsibilities, and reviews required for the management of air quality impacts associated with activities at Collinsville Mine. Reference is made to supporting documentation where necessary, which include operational procedures, in which more detailed work instructions are provided.

2 Scope

2-1 The AQMP covers all mining operations undertaken at Collinsville Mine and incorporates all relevant legislative and other corporate requirements pertaining to air emissions or air quality. It is applicable to all Collinsville Mine employees and contractors in any capacity.

2-2 This AQMP addresses primary air emissions of interest in terms of air quality management, including particulate matter (dust) releases, blast fume and spontaneous combustion emissions, for off-site sensitive receptors. The plan provisions for effective management of actual and potential environmental impacts resulting from emissions to air associated with mining activities of Collinsville both current up to 5.9 million tonnes per annum (Mtpa) of run of mine (ROM) and those planned under 9.9 Mtpa under EA Amendment submission in 2014. The plan does not address occupational health and safety related monitoring and management.

2-3 Greenhouse gas emissions, such as coal seam methane releases from mining operations, are not covered by this plan.

2-4 The Plan forms part of the Collinsville Mine ***Community and Environmental Management System (CEMS)***.

3 Risk Management & Opportunities

3-1 Environment and Community (E&C) risks at Collinsville Mine have been identified in the Collinsville Mine ***COL-ENV-REG-001 E&C Risk Register***, which is a subset of the Collinsville Mine site risk database.

3-2 This plan has been developed to address the risk and control strategies associated with air quality identified in the Collinsville Coal ***E&C Risk Register.*** These issues can be summarised as:

a) Dust (that is, particulate matter in the form of TSP, PM_{10} or $PM_{2.5}$) from the general mining activities;

b) Fume (that is, NO_x emissions) from blasting; and

c) Odour and other substances due to potential spontaneous combustion of coal.

3-3 This risk register will be reviewed and updated annually or when changes to operational requirements amend or impact risks or the respective control strategies or when new risks are identified.

4 Legislative Requirements

4-1 Key legislative requirements of relevance to air quality management at Collinsville Mine are prescribed in Conditions G1 to G16, G18 and G19 in the EA (EPML00332013).

4-2 Conditions G1 to G19 are included in this Plan as ***Appendix A***.

5 Objectives

5-1 EA (EPML00332013) Condition G10 states, "*Dust and particulate matter must not cause an environmental nuisance at any sensitive or commercial place."* Compliance with EA (EPML00332013) Condition G10 will be demonstrated if activities at Collinsville Mine do not cause exceedances of the objectives outlined in Table 5-1, at sensitive places.

Table 5-1: Air quality objectives

Air quality parameter	Averaging time	Objective
Dust deposition (as insoluble solids)	Monthly	120 mg/m^2/day
Particulate matter (as PM_{10})	24-hour	50 µg/m^3

5-2 Section 9 identifies the monitoring to be carried out to assess compliance with the objectives in Table 5-1.

5-3 The objectives in Table 5-1 will be reviewed following completion of the *Air Quality Monitoring Program*, as required by EA (EPML00332013) Condition G13.

5-4 This AQMP also seeks to satisfy EA (EPML00332013) Condition G18, namely, *"The release of noxious of offensive odour or any other noxious of offensive airborne contaminant resulting from the mining activities must not cause an environmental nuisance at any sensitive or commercial place".* This objective is addressed via appropriate operational management (***Section 8***) and assessed by monitoring (***Section 9 and 10***).

6 Existing Environment

6-1 Local environmental conditions with direct implications for air quality management include the prevailing meteorology, existing air quality and location of sensitive receptors in relation to Collinsville Mine.

6-2 The locations of nearest sensitive receptors and existing monitoring sites are identified in Figure 6-1. The receptors are predominantly single dwellings, however Scottville and Collinsville represent larger populations. Non-sensitive location agreements (in accordance with condition A24 of the Environmental Authority) have been entered into with the owners of both "Hillview" and "Emohruo" Stations.

6-3 Air quality has been monitored in the vicinity of Collinsville Mine by up to 13 deposition dust gauges since 1998. Meteorological conditions are currently monitored by six weather stations. Beta Attenuated Mass (BAM) monitors were recently installed in May 2014 across the area as shown in Figure 6-1.

6-4 Meteorological conditions are important for determining the direction and rate at which emissions from a source, such as a mining activity, will disperse. The key meteorological parameters for air quality management are wind speed and wind direction.

6-5 The prevailing winds in the Collinsville area are from the east. This is demonstrated by the wind-roses shown in Figure 6-2 and Figure 6-3 which summarise the data collected in 2013 by the Garrick East and Ramp 11 weather stations respectively. Meteorological data from the 2013 calendar year have been found to the representative of the long-term conditions of the Collinsville area (***SKM 2014***). These wind-roses show the frequency of wind speeds and wind directions for each season. Easterly winds prevail in all seasons, to various degrees, with north-easterly winds also common in spring.

6-6 In general, the prevailing easterly winds are favourable for transporting emissions from Collinsville Mine away from most of the sensitive receptors. However, the Ramp 2 mining area, coal processing plant and coal and product stockpiles are upwind of Hillview Station when winds are from the east

.

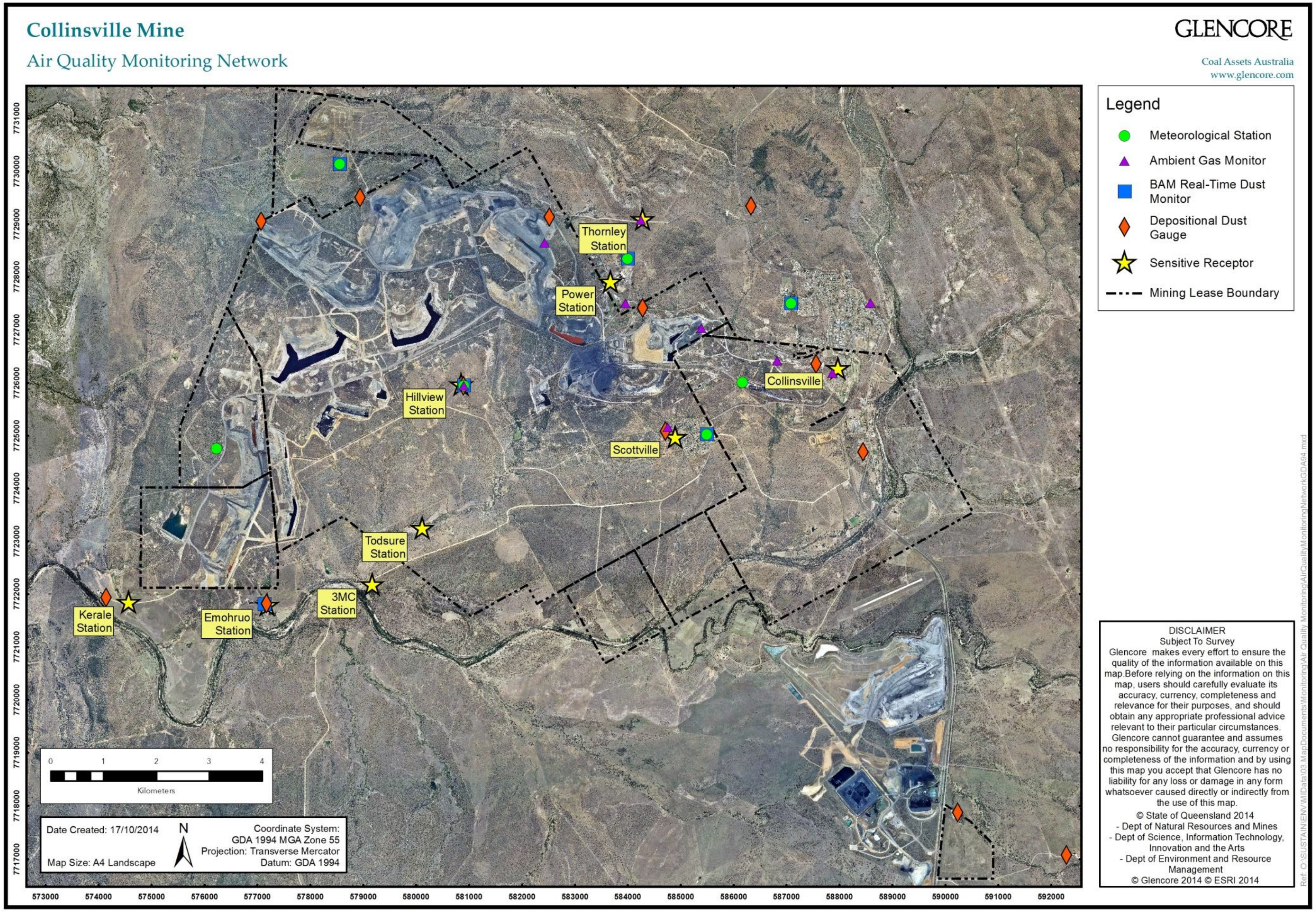


Figure 6-1 – Location of nearest sensitive receptors and air quality monitors

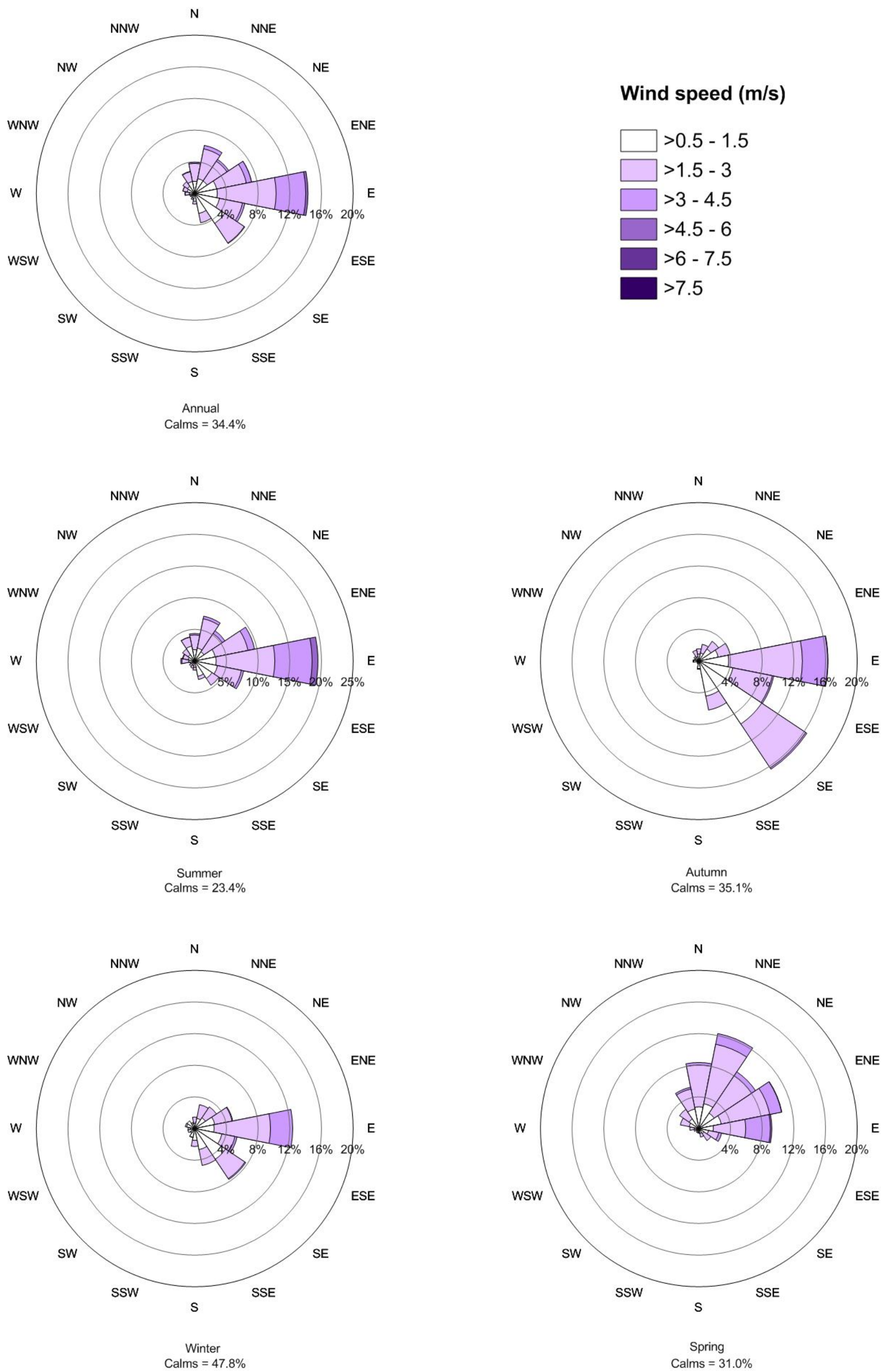


Figure 6-2 – Measured wind patterns from the Garrick East meteorological station (2013, representative year)

Figure 6-3 – Measured wind patterns from the Ramp 11 meteorological station (2013, representative year)

6-7 Figure 6-4 shows the mean rainfall for Collinsville over the 1939-2014 period. The warmer months of December, January and February are usually associated with higher rainfall. August, September and October are potentially the higher risk months in terms of dust generation, due to lower average rainfall.

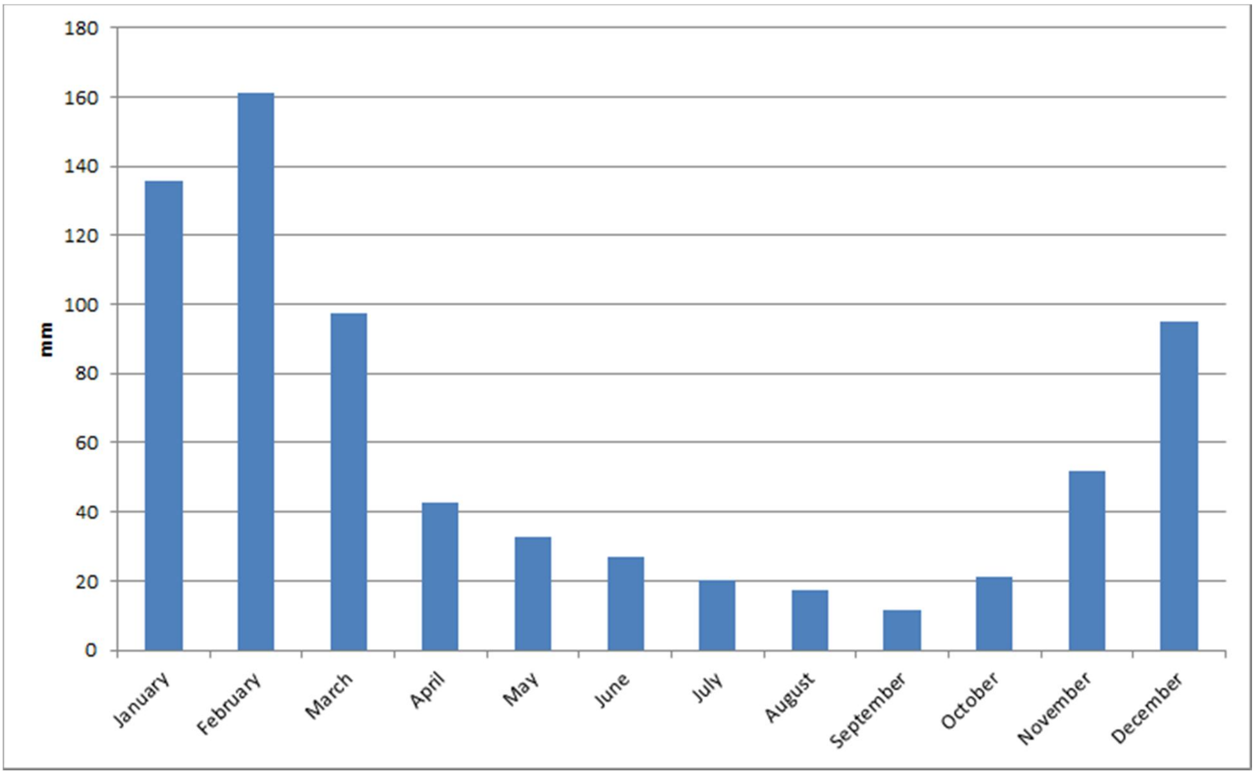


Figure 6-4 – Mean rainfall for Collinsville Post Office (1939 to 2014)

6-8 The meteorological conditions that most commonly lead to elevated dust concentrations include:

a) Warm weather and extended periods without rainfall, resulting in less moisture in the ground.

b) Wind speeds greater than 5 m/s. These winds are conducive to higher wind erosion rates.

c) Stable conditions, such as at night with light winds and when a temperature inversion is present. Under these conditions, plume dispersion is poor and elevated dust concentrations can occur due to mechanically generated emissions.

6-9 The conditions above can be identified by plotting measured or predicted PM_{10} concentrations (due to the mining activities) by hour of day. An example is shown by Figure 6-5. It can be seen from this figure that, at night, the highest concentrations are generally associated with light winds. During the day, the highest concentrations are generally associated with stronger winds (greater than 5.5 m/s). This analysis will be verified by continuous PM_{10} monitoring data, once available.

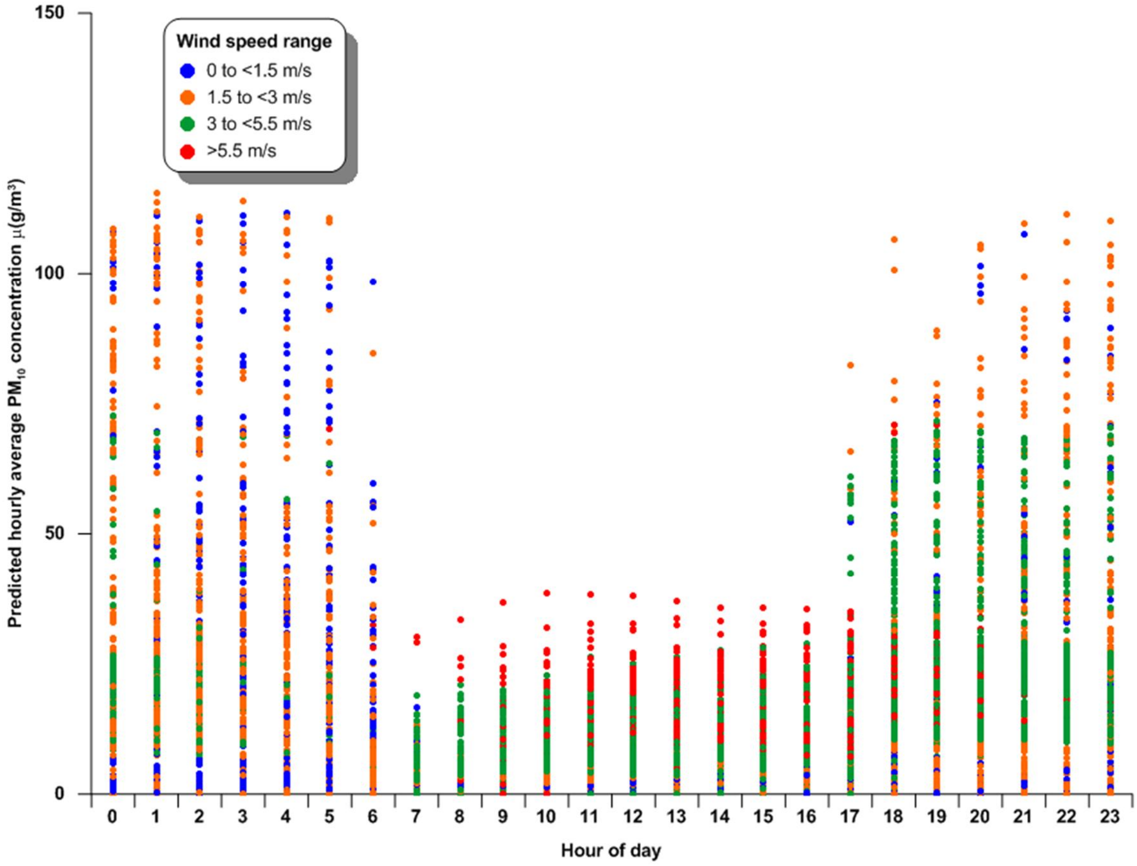


Figure 6-5 – Predicted hourly PM_{10} concentrations by hour of day at Hillview Station

6-10 The existing environment is characterised by wet summers and dry winters. Prevailing winds are from the east in all seasons and most of the sensitive receptors are upwind of the existing mining activities.

6-11 The most effective emission mitigation measures will focus on controlling emissions under unfavourable meteorological conditions, such as dry, windy conditions, stable night-time conditions and/or when winds are blowing from mining activities towards sensitive receptors. Hillview Station has been identified as the receptor with the highest potential to be affected by emissions from the mining activities. This is because Hillview Station is downwind of some of the mining areas in the prevailing easterly winds.

7 Sources

7-1 Based on the risk assessments performed for Collinsville Mine as referenced in Section 3, the key air quality issues to be managed at Collinsville Mine include:

a) Dust (that is, particulate matter in the form of TSP, PM_{10} or $PM_{2.5}$) from the general mining activities;

b) Fume (that is, NO_x emissions) from blasting; and

c) Odour and other substances due to potential spontaneous combustion most notably from legacy areas impacted by historic coal mining and stockpiling practices.

Dust

7-2 Dust emissions from the general mining activities are from a variety of sources including material handling, material transport, processing, wind erosion, and blasting. These emissions mainly comprise of particulate matter (TSP, PM_{10} and $PM_{2.5}$) although there are also minor emissions (relatively) from machinery exhausts such as carbon monoxide (CO) and oxides of nitrogen (NO_x).

7-3 Source prioritisation for dust emissions has been undertaken for mining activities at Collinsville Mine. In this undertaking, reference was made to the emissions inventory developed as part of Collinsville's proposed production increase to 9.9 Mtpa (***SKM 2014***). Annual PM_{10} emissions were estimated for 9.9 Mtpa operations (equivalent to around 2018). The top five sources of PM_{10} emissions were identified, including control measures. These sources are shown by Table 7-1. Figure 7-1 shows dust sources by fraction of the total site emissions. The emission sources have been prioritised in this way in order to develop the most effective management measures and target the most significant sources.

Table 7-1: Annual PM10 emissions for the top five emission sources at Collinsville Mine

Rank	Source	Annual PM_{10} emissions (9.9 Mtpa)
1	Wind erosion from dumps / pits / topsoil piles	1,783,923
2	Hauling on unsealed roads	437,279
3	Dragline	286,721
4	Unloading overburden to dumps	247,057
5	Dozer / loader pushing ROM / product coal	94,883

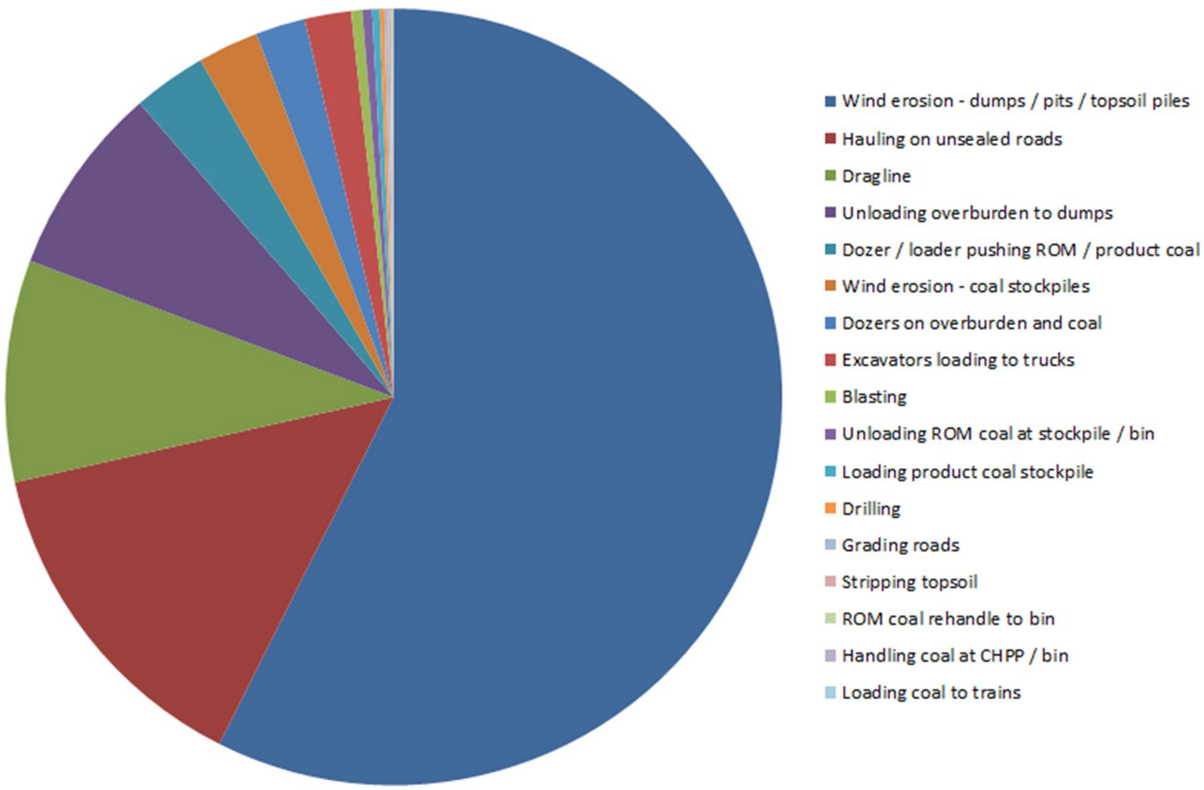


Figure 7-1 – Annual PM_{10} emissions as percentages by activity type

Fume

7-4 Post-blast fume can be produced in non-ideal explosive conditions of the ammonium nitrate/fuel oil (ANFO) and visible as an orange / brown plume.

7-5 Post-blast fumes comprise of oxides of nitrogen (NOx) including nitric oxide (NO) and nitrogen dioxide (NO_2). In general, at the point of emission, NO will comprise the greatest proportion of the total emission. Typically this is 90% by volume of the NOx. The remaining 10% will comprise mostly NO_2. It is the NO_2 which has been linked to adverse health effects.

Odour

7-6 Spontaneous combustion of coal and other carbonaceous materials is the main potential source of odour.

7-7 "Self-heating" occurs when coal and other carbonaceous materials undergo an exothermic reaction when exposed to oxygen in the air, to generate heat. This process causes the temperature of the material to rise which in turn accelerates the oxidation and, in turn, the heat generation process. As the material temperature rises above about 70°C the temperature acceleration is rapid enough to result in ignition of the material. This ignition is referred to as spontaneous combustion.

7-8 The propensity of coal (or carbonaceous material) to self-heat and potentially combust is governed by many factors but most commonly by the type of coal, the carbon content, the size of the particles, the material temperature, the presence of oxygen and quantity of coal. Spontaneous combustion results in the emission of noxious gases including carbon dioxide, carbon monoxide, sulphur dioxide, hydrogen sulphide, nitrogen oxides, acid mist and a range of volatile organic compounds.

7-9 The emissions to air have the potential to lead to the following hazards:

a) Adverse health effects due to inhalation;

b) Nuisance effects due to odour;

c) Fire and hot material;

d) Subsidence;

e) Smoke and effects on visibility.

8 Management

8-1 Air quality management at Collinsville Mine includes a combination of the following types of measures:

a) Engineering Controls (such as enclosure of conveyors);

b) Source specific control measures routinely implemented as shown below (for example, water spraying roads for dust suppression during hauling); and

c) Contingency measures implemented during periods of high particulate matter concentrations or adverse meteorological conditions. These measures include modification or ceasing of operations as required (Trigger Action Response Plan (TARP)).

Dust

8-2 Source-specific dust emission control measures to be considered and, if appropriate to the situation, implemented on a routine basis are listed in Table 8-1 by source type with reference made to procedural documents where applicable.

8-3 Dust control strategies (that is, those in addition to the routine air quality management measures listed in Table 8-1) will also be based on a combination of automated daily forecasting, visual monitoring, meteorological monitoring and ambient air quality monitoring to determine dust risk on a daily basis. These strategies, including the TARP which defines the actual trigger levels based on visual, meteorological, ambient air quality and forecast dust conditions and associated actions for controlling dust emissions, are documented in ***COL-ENV-PGM-017 Dust Management Program***.

Table 8-1: Dust emission management measures

Activity / source	Management measures
Wind erosion from dumps / pits / topsoil piles	Management measures may include: • Minimising the size of disturbed areas. • Undertaking timely rehabilitation of such areas in accordance with the operation's annual rehabilitation plan. • Planning the pre-strip areas to minimise the time of exposure following clearing in advance of mine development. • Watering exposed areas/active areas if dust generation is observed. • Applying temporary rehabilitation to overburden emplacement areas that are to be in place for one to three years. • Preventing unauthorised clearing of non-mining areas. • Checking actual rehabilitation rates against annual targets.
Hauling on unsealed roads	Management measures may include:

Activity / source	Management measures
	• Ripping and re-vegetating obsolete roads. • Managing and maintaining temporary haul roads and other unsealed roads on a risk-based approach to reduce dust generation by applying measures such as reducing vehicle speed, water spraying, chemical suppression or gravel surfacing. • Providing timely clean up and removal of material deposited on roads and hardstand areas. • Restricting vehicle speed on unsealed haul roads. • Requiring operational personnel and support staff to call for additional dust suppression if considerable dust is visible for a sustained period above wheel height. • Conducting regular haul road maintenance to provide for compact surfaces with low silt contents.
Dragline	Management measures may include: • Avoiding over-dragging material when filling the bucket. • Lifting bucket cleanly away from the dig face. • Keeping the bucket clear of all walls and batters and hoist up with minimum spillage where applicable. • Maintaining drop heights to a practical minimum when emptying the bucket. • Exercising particular care when material being moved is dry and contains excessive fines. • Modifying, and if necessary ceasing operations during dry, windy conditions when its activities are significantly affecting sensitive receptors.
Material extraction and handling	Management measures may include: • Modifying operations during adverse weather conditions (for example, dry windy conditions). • Minimising double handling of material. • Identifying material types that contain fine and/or friable material, and implement a risk-based approach for effective dust mitigation. • Preparing work areas prior to commencement of mining, e.g. watering of extraction areas. • Conducting sheltered dumping during high winds (e.g. dumping within the pit). • Minimising the drop distance of overburden materials during loading and tipping. • Watering overburden loading operations, including soaking of the bench and wetting dry materials prior to extraction
Dozers on coal stockpiles	Management measures may include: • Avoiding dozer operations at wind-exposed areas during dry, windy conditions. • Designating and maintaining dozer routes between work areas. • Ceasing or modifying dozer operations (e.g. by reducing dozer tramming speeds) when elevated dust levels are detected by trained personnel or under adverse meteorological conditions.
Coal handling	Management measures may include: • Applying automated sprays on hoppers. • Applying conveyor belt cleaning to remove debris.
Drilling	Management measures may include: • Fitting drill rigs with dust suppression systems. • Ceasing drill operations when dust suppression systems are not operating and have the potential to significantly affect sensitive receptors. • Wetting down drill cuttings, including dust cones, to prevent dust generation. • Watering drill patterns during hot, dry or windy conditions if feasible to do so (eg. not on reactive ground).
Blasting	Management measures may include: • Identifying site-specific adverse meteorological conditions for blasts and establish procedures to avoid blasts during such conditions. • Implementing automated, real-time meteorological assessment procedures linked to on-site meteorological monitoring to inform blast personnel of blasting opportunities. • Watering blast areas prior to shot loading to suppress fine, dry material and form crusting on drill hole cuttings.

Activity / source	Management measures
	• Using coarse material (gravel) or material with a lower dust generation potential as stemming material in overburden blasts. • Adequate stemming. • Implementing Collinsville Mine's Explosives & Shotfiring Blast ***Fume Management Plan COL-TECH-PLN-003*** and ***COL-ENV-PGRM-019 Blast Management Program***.
Machinery exhausts and plant and equipment	The protocols for regular maintenance of plant and equipment are detailed in the ***Xstrata Coal Asset Management Framework Version 1***. Emissions management measures for machinery exhausts and plant and equipment include servicing all machinery in accordance with maintenance contracts and the ***Xstrata Coal Asset Management Framework Version 1***. The framework describes the equipment maintenance strategy and program which covers: • Adopting original equipment manufacturer recommendations for maintenance. • Targeting the maintenance to ensure equipment remains fit for purpose over its whole life cycle. • Defining failure modes, effects and criticality. • Constructing timelines for downtimes required by the maintenance strategy.

Fume

8-4 Collinsville Mine's ***COL-TECH-PLN-003 Explosives & Shotfiring Blast Fume Management Plan*** and ***COL-ENV-PGM-019 Blast Management Program*** outline the measures to be implemented to minimise emissions from blasting, including for the control of fume generation. The fume management actions include:

a) Inhibiting product;

b) Assessment of sleep time;

c) Risk assessment prior to firing;

d) Implementation of blasting contractor QA systems; and

e) Defining risk zone based upon weather patterns and permission to fire.

Odour

8-5 Source-specific odour emission control measures to be implemented on a routine basis are listed in Table 8-2.

Table 8-2: Odour emission management measures

Activity / source	Management measures
Spontaneous combustion	Covering of exposed material and strategic handling of reactive material, to prevent spontaneous combustion events are the key controls used to minimise odour and potentially noxious emissions to air. Management measures for the prevention and reducing the incidence and impacts of spontaneous combustion are documented in the Collinsville Mine's ***COL-TECH-PLN-002 Spontaneous Combustion Management Plan***. The Spontaneous Combustion Management Plan outlines standards to be maintained, and the monitoring system and procedures to be followed in the management of spontaneous combustion. Hence it addresses the requirements required under condition E18 of the EA. The measures of the plan, procedure and supporting documents relevant to managing potential impacts to sensitive and/or commercial places include: • Elimination – processing and shipping of coal for its end use before the oxidation reaction that leads to spontaneous combustion occurs. • Separation – Where material has or is showing signs of spontaneous combustion it is stockpiled separate from other inert coals to avoid spreading the heating. • Engineering – Controls that minimise the impact of hot material such as establishing sprinklers/bench flooding to cool material prior to mining and selective digging and/or burying. • Procedures – Including early identification of spontaneous combustion; dealing with heated materials; provision of protective or first response capacity; and preparing for / cleaning up after spontaneous combustion. • Personnel skills and training – Personnel training and education on the effects of spontaneous combustion and how to prevent incident to all people who work in affected areas. • PPE – Including gas monitors, masks, respirators and eye protection are required when potentially exposed to spontaneous combustion.

8-6 A dust and ambient gas Trigger Action Response Plan (TARP) has been developed to manage potential off site impacts, such as those associated with emissions or odour from spontaneous combustion. Details of the TARP are included in the ***COL-ENV-PGM-016 Air Quality Monitoring Program***.

9 Monitoring

9-1 Monitoring for compliance purposes is undertaken in accordance with relevant Australian Standards. Relevant methods implemented are as follows:

a) Dust deposition gauges are sampled monthly for insoluble solids in accordance with ***AS 3580.10.1 (2003) Methods for sampling and analysis of ambient air – determination of particulate matter – deposited matter – gravimetric method***.

b) Beta Attenuation Mass (BAM) monitors measure and analyse PM_{10} in accordance with ***AS3580.9.11:2008 Method 9.11: Determination of suspended particulate matter – PM10 Beta Attenuation Monitor***.

9-2 Siting and operation of air monitoring equipment reflects the guidance in ***AS3580.1.1:2007 Guide to siting air monitoring equipment and AS3580.14.1:2011 Methods for sampling and analysis of ambient air***.

9-3 Meteorological monitoring is undertaken in accordance, where possible, with ***AS3580.14.1-2011 Methods for sampling and analysis of ambient air Part 14: Meteorological monitoring for ambient air quality monitoring applications***.

9-4 The locations of air quality and meteorological monitoring equipment in the vicinity of Collinsville Mine are shown in Figure 6-1.

9-5 The monitoring equipment, frequency of monitoring and relevant monitoring standards are summarised in Table 9-1.

Table 9-1: Air quality and meteorological monitoring

Instrument	Indicator (s)	Frequency	Location Figure 6-1	Standard
Dust deposition gauge	Insoluble solids	Monthly	Bowen Central	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Colinta	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Emohruo	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Flat Rock	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Garrick East	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Kerale Station	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	O'Loughlin	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Scottville	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Hillview	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Barracks Creek	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Belmore Homestead	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Belmore North	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Janz	AS/NZS 3580.10.1:2003
BAM + AWS	PM_{10} / weather	10-minute	Colinta	AS 3580.9.11:2009
BAM	PM_{10}	10-minute	Emohruo	AS 3580.9.11:2009
BAM + AWS	PM_{10} / weather	10-minute	Hillview	AS 3580.9.11:2009
BAM + AWS	PM_{10} / weather	10-minute	Scottville	AS 3580.9.11:2009
BAM + AWS	PM_{10} / weather	10-minute	Collinsville	AS 3580.9.11:2009
BAM + AWS	PM_{10} / weather	10-minute	Powerhouse	AS 3580.9.11:2009
BAM + AWS	PM_{10} / weather	10-minute	Roving	AS 3580.9.11:2009
Meteorological station	Wind speed, wind direction, temperature, humidity, precipitation	15-minute	Garrick East	AS 3580.14:2011
Meteorological station	Wind speed, wind direction, temperature, humidity, precipitation	15-minute	Ramp 11	AS 3580.14:2011
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Hillview	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Power Station	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Garrick East	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Ramp 14	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Scottville	No standard. Calibration by a NATA accredited laboratory every 6

Instrument	Indicator (s)	Frequency	Location Figure 6-1	Standard
				months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Collinsville North East	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Collinsville South West	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Thornley Station	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations

9-6 Collinsville Mine's ***COL-ENV-PGM-016 Air Quality Monitoring Program*** provides additional information on how the data collected by the monitoring equipment listed in Table 9-1 are used for operations management and for development of air quality objectives (as required by EA (EPML00332013) Conditions G6 to G9).

10 Compliance Evaluation

10-1 Collinsville Mine's ***COL-SAF-PRO-009 Incident Management Procedure*** and ***COL-ENV-PLN-013 Stakeholder and Community Engagement Plan*** will be followed in the event of monitored levels which exceed the air quality objectives identified in ***Table 5-1***.

10-2 Compliance will be demonstrated where the measured level is below the air quality objectives identified in Table 5-1. Measured levels above the objectives will not necessarily demonstrate non-compliance. In this case indirect methods are needed to demonstrate compliance.

10-3 Further assessment (indirect) of individual exceedances may be required to determine compliance or non-compliance where a measured result exceeds an objective and the contribution of Collinsville Mine's emissions is unclear. In these circumstances, further assessment will be undertaken by a suitably qualified person. This assessment will take account of background particulate concentrations, prevailing meteorology, and operational factors that influence particulate dispersion.

11 Complaint Management

11-1 Collinsville Mine's ***COL-SAF-PRO-009 Incident Management Procedure*** and ***COL-ENV-PLN-013 Stakeholder and Community Engagement Plan*** will be followed in the event of a complaint relating to air quality and emissions from Collinsville Mine, as per Conditions G12 and A9 to A11 from the Environmental Authority (EA) (EPML00332013).

11-2 Actions taken by Collinsville Mine's Environment and Community Department in relation to air quality (e.g. dust) concerns will include reviewing meteorological data, ambient air quality data, and mine operations.

12 Consultation and Communication

12-1 Consultation with applicable stakeholders is important in developing and maintaining effective and successful air quality management processes.

12-2 Stakeholders have been identified in accordance with the ***COL-ENV-PLN-013 Stakeholder and Community Engagement Plan*** and include :

a) Employees

b) Landholders and neighbours

c) Regulators

d) Local, State and Federal government

e) Local media

f) Neighbouring mines

g) Unions

h) Traditional owners

i) Industry and business

j) Non-government organisations

k) Townships (Collinsville and Scottville)

l) Local community members

m) Education, health and social service organisations

n) Emergency services

o) Community groups and associations

p) Suppliers and consultants

q) Chambers of Commerce and enterprise groups

r) Shareholders and JV partners

12-3 Communication and consultation with applicable stakeholders will be undertaken in accordance with the ***COL-ENV-PLN-013 Stakeholder and Community Engagement Plan.***

12-4 The Stakeholder Reference Group (SRG) and Community Reference Group (CRG) will provide opportunities to consult with external stakeholders on air quality management matters. Any consultation during these meetings will be recorded in the SRG and/or CRG Meeting Minutes.

13 Roles and Responsibilities

13-1 Air quality management related roles and responsibilities at Collinsville Mine are listed below.

Role	Responsibilities
Site Senior Executive / Operations Manager	• Provide sufficient resources to manage air quality related risks and progress opportunities for improvement.
Mining manager	• Coordinate mining operations to minimise dust generation. • Report excessive dust emissions to the relevant mining shift supervisor / open-cut examiner.
Mining shift supervisor / open-cut examiner	• Suspend or modify operations when dust suppression systems are not operational or effective. • Implement appropriate contingency measures in the event of triggers activated due to potential air quality impacts. • Notify the Environment and Community Manager about operations that are creating excessive dust or if the measures listed in this AQMP are not being implemented, or if they are not effective in mitigating air emissions.
Environment and Community Manager	• Have a sound understanding of mine-related air emission sources and controls. • Oversee the implementation, monitoring and review of this AQMP in accordance with applicable legal and other requirements pertaining to air quality. • Record, investigate and respond to air quality related incidents and complaints in accordance with the ***COL-SAF-PRO-009 Incident Management Procedure*** and ***COL-ENV-PLN-013 Stakeholder and Community Engagement Plan***. • Periodically assess dust management performance and review the AQMP to

	reduce the overall risk profile. • Provide training to employees and contractors for the implementation of dust management related controls, systems and procedures. • Provide induction programs for employees, contractors and visitors addressing relevant air quality management objectives, hazards, risks, controls, behaviours and consequences of inappropriate behaviour. • Consult with potentially affected stakeholders regarding air quality issues, and maintain records of consultation, personnel participating in the consultation and the issues discussed. • Report on air quality performance in accordance with site specific reporting legislative requirements. • Communicate potential air quality risks from operations to the mining shift supervisor / open-cut examiner on a daily basis.
All persons	• Demonstrate an awareness of air quality contaminant emission sources and related risks, both generally and specifically in relation to their own site activities. • Identify and report incidents involving excessive dust emissions. • Consistently implement dust management measures integrated within site operating procedures.
Air quality monitoring contractor(s)	• Collect, analyse and report air quality related data to Collinsville Mine Environment and Community personnel in accordance with legislative requirements, Australian Standards and recognised Air Quality Control Procedures.

14 Auditing and Review Provisions

14-1 In accordance with EA (EPML00332013) Condition G3, the ***COL-ENV-PLN-007 Air Quality Management Plan*** will be reviewed at least every two (2) calendar years, and a report prepared by an appropriate person to:

a) Assess the plan against the requirements of the EA;

b) Include recommended actions to ensure actual and potential environmental impacts are effectively managed for the coming year; and

c) Identify any amendments made to this plan following the review.

14-2 In accordance with EA (EPML00332013) Condition G4, Collinsville Mine will attach to the review report required a written response to the report and recommended actions, detailing the actions taken or to be taken by Collinsville Mine on stated dates:

a) To ensure compliance with the EA (EPML00332013); and

b) To prevent reoccurrence of any non-compliance issues identified.

14-3 The review report and Collinsville Mine's written response to the review report will be submitted to the administering authority by 30 June in the relevant year.

15 Document information

Reference information

15-1 Reference information, listed below, is information that is directly related to the development of this document or referenced from within this document.

Reference
AS 3580.10.1 (2003) Methods for sampling and analysis of ambient air – determination of particulate matter – deposited matter – gravimetric method
AS3580.9.11:2008 Method 9.11: Determination of suspended particulate matter – PM_{10} Beta Attenuation Monitor
AS3580.1.1:2007 Guide to siting air monitoring equipment
AS3580.14.1:2011 Methods for sampling and analysis of ambient air
AS3580.14.1- 2011 Methods for sampling and analysis of ambient air Part 14: Meteorological monitoring for

Reference	
ambient air quality monitoring applications	
CA-HSEC-PCL-0002	*Glencore Air Quality Management Protocol*
COL-ENV-PGM-016	*Air Quality Monitoring Program*
COL-ENV-PLN-015	*Communications Management Plan*
COL-ENV-PGM-017	*Dust Management Program*
COL-ENV-REG-001	*Environment & Community Risk Register*
Collinsville Mine: Environmental Management System (EMS)	
COL-TECH-PLN-003	*Explosives & Shotfiring Blast Fume Management Plan*
COL-SAF-PRO-009	*Collinsville Mine: Incident Management Procedure*
COL-ENV-PLN-013	*Social Involvement Plan*
COL-TECH-PLN-002	*Collinsville Mine: Spontaneous Combustion Management Plan*
SKM (2014) Air Quality Impact Assessment, Collinsville Mine Production Increase. July 2014.	
Xstrata Coal Version 1.	*Asset Management Framework: Elements, Drivers, Outcomes and Key Requirements.*

Table 15-1 – referenced information

Document change information

15-2 Full details of the document history are stored electronically in the document library, by version, on the intranet. A summary of the current and previous change is provided in the table below.

Version	Date	Nature of the change
1	17 October 2014	Document prepared by SKM. S Lakmaker with input from Glencore personnel at Collinsville.

Table 15-2 – document change information

Appendix A - Relevant Environmental Authority Conditions

Schedule G Air

Air quality management plan

G1 An Air Quality Management Plan must be developed and submitted to the administering authority within twelve (12) months from the date of issue of this environmental authority. The holder of this environmental authority must start implementation of the Air Quality Management Plan within a timeframe agreed with the administering authority but no more than six (6) months after the date of its submission to the administering authority.

G2 The Air Quality Management Plan must provide for effective management of actual and potential environmental impacts resulting from air management associated with the mining activities carried out under this environmental authority and include the following as a minimum:

a) be developed by an appropriately qualified person;
b) identification of all potential sensitive and commercial locations which may be affected by air quality impacts from mining activities;
c) identification of all major sources of dust emissions that may occur as a result of mining activities;
d) description of the procedures to manage the dust emissions from the sources identified;
e) collection of air quality and meteorological data using the methods described in the Air Quality Monitoring Program;
f) identifying adverse meteorological conditions likely to produce elevated levels of PM_{10} at a sensitive or commercial place due to mining activities;
g) integration of dust control strategies as described in the Dust Management Program;
h) protocols for regular maintenance of plant and equipment, to minimise the potential for fugitive dust emissions; and
i) description of procedures to be undertaken if any non-compliance is detected.

G3 The Air Quality Management Plan must be reviewed every two (2) calendar years and a report prepared by an appropriately qualified person. The report must:

a) assess the plan against the requirements under condition G2;
b) include recommended actions to ensure actual and potential environmental impacts are effectively managed for the coming period; and
c) identify any amendments made to the Air Quality Management Plan following the review.

G4 The holder of this environmental authority must attach to the review report required under condition G3, a written response to the report and recommended actions, detailing the actions taken or to be taken by the environmental authority holder on stated dates:

a) to ensure compliance with this environmental authority; and
b) to prevent a recurrence of any non-compliance issues identified.

Air quality monitoring program

G6 An Air Quality Monitoring Program: Baseline Investigations to Determine Air Quality Objectives must be developed within twelve (12) months from the date of issue of this environmental authority.

G7 The Air Quality Monitoring Program must include the following as a minimum:

a) be developed by an appropriately qualified person;
b) provision for the collection of a minimum of 2 years of representative data;
c) collect air quality and meteorological data using industry recognised monitoring methods;
d) determine trigger values for the concentration of particulate matter generated by the mining activities; and
e) a program for monitoring and review of the effectiveness of the Air Quality Monitoring Program.

G8 The holder of this environmental authority must start implementation of the Air Quality Monitoring Program within a timeframe agreed with the administering authority but no more than six (6) months following completion of the development of the Air Quality Monitoring Program required under condition G6.

G9 Within six (6) months after completing the monitoring described in the Air Quality Monitoring Program required under condition G6, the environmental authority holder must submit a report to the administering authority that includes:

a) proposed air quality monitoring locations;
b) proposed final air quality objectives for the concentration of particulate matter generated by mining activities; and
c) a review of the reliability and validity of air quality data and the suitability of the monitoring program.

The report must include sufficient information to allow the administering authority to develop suitable air quality monitoring conditions.

Air quality objectives

G10 Dust and particulate matter generated by mining activities must not cause an environmental nuisance at any sensitive or commercial place.

G11 Monitoring required pursuant to condition A21 must be carried out at a place(s) relevant to the potentially affected sensitive place. The holder of this environmental authority will not be in breach of condition G10 if dust and particulate matter does not exceed the following levels when measured at any sensitive place:

a) dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the current edition of *AS 3580.10.1 Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method*; or
b) a concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (μm) (PM_{10}) suspended in the atmosphere of 50 micrograms per cubic metre over a 24 hour averaging time, at a sensitive place downwind of the operational land, when monitored in accordance with:
   i. *AS 3580.9.6 Methods for sampling and analysis of ambient air - Particulate matter - Determination of suspended particulate PM_{10} high-volume sampler with size-selective inlet - Gravimetric method*;
   ii. *AS/NZS 3580.9.11:2008 Method 9.11: Determination of suspended particulate matter – PM_{10} Beta Attenuation Monitor*;
   iii. any alternative method of monitoring PM_{10} which may be permitted by the Air Quality Sampling Manual as published from time to time by the administering authority; or
   iv. any other method of monitoring PM_{10} which may be agreed to by the administering authority.

G12 If monitoring indicates exceedence of the relevant limits in condition G11, the environmental authority holder must:

a) if a complaint is raised due to the exceedence, address the complaint including the use of appropriate dispute resolution if required; and
b) immediately implement dust abatement measures so that emissions of dust from the activity do not result in further exceedence.

G13 Following completion of the Air Quality Monitoring Program required under condition G9, Schedule G – Table 2 must be populated with the final air quality objectives, and air quality impacts generated by mining activities must not exceed the final air quality objectives in Schedule G – Table 2 at the monitoring locations and frequency defined in Schedule G – Table 2 in accordance with condition G9.

Schedule G – Table 2 – Final air quality objectives

Air quality parameter	Air quality objectives	Monitoring method	Monitoring frequency	Monitoring location(s)
Deposited dust	TBA	*AS 3580.10.1 Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method*	TBA	TBA
Total suspended particulate matter	TBA	*AS 3580.9.3 Methods for sampling and analysis of ambient air – Determination of suspended particulate matter - Total suspended particulate matter (TSP) - High volume sampler gravimetric method*; or any alternative monitoring method which may be permitted by the Air Quality Sampling Manual as published from time to time by the administering authority; or any other monitoring method which may be agreed to by the administering authority.	TBA	
Particulate matter with an aerodynamic diameter of less than 10 micrometres (PM_{10})	TBA	Real-time monitoring of the 24 hour average in accordance with *AS 3580.9.8 Determination of suspended PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser*, or *AS/NZS 3580.9.11:2008 Method 9.11: Determination of suspended particulate matter – PM_{10} Beta Attenuation Monitor, or* any alternative method of monitoring PM_{10} that may be permitted by the Air Quality Sampling Manual as published from time to time by the administering authority.	TBA	

Dust management program

G14 A Dust Management Program must be developed within twelve (12) months from the date of issue of this environmental authority.

G15 The Dust Management Program must include the following as a minimum:

a) be developed by an appropriately qualified person;
b) integration of dust control strategies with the meteorological monitoring system that would activate the timely management of dust control actions;
c) consideration of best practice environmental management dust control measures; and
d) a program for monitoring and review of the effectiveness of the Dust Management Program.

G16 The holder of this environmental authority must start implementation of the Dust Management Program within a timeframe agreed with the administering authority but no more than six (6) months following completion of the development of the Dust Monitoring Program required under condition G14.

Meteorological monitoring

G17 The environmental authority holder must establish and maintain a meteorological monitoring system to measure and record wind speed, wind direction, temperature, relative humidity and precipitation.

Note: It is possible for environmental authority holders to utilise relevant and available weather monitoring information collected by other parties as reference data for the purposes of this condition.

Odour nuisance

G18 The release of noxious or offensive odour or any other noxious or offensive airborne contaminant resulting from the mining activities must not cause an environmental nuisance at any sensitive or commercial place.

G19 If the administering authority determines the odour released to constitute an environmental nuisance, then the environmental authority holder must:

a) address the complaint including the use of appropriate dispute resolution if required; and
b) immediately implement odour abatement measures so that emissions of odour from the activity do not result in further environmental nuisance.

COLLINSVILLE OPEN CUT
GLENCORE

Coal Assets – Australia

Air Quality Monitoring Program

Number:	COL-ENV-PGM-016	**Status:**	Final
Owner:	Environment & Community Manager	**Version:**	1 (Oct 2014)

Table of contents

1 Purpose

1-1 The purpose of this *Air Quality Monitoring Program* is to meet statutory requirements, relating to air quality management, from the Environmental Authority (EA) (EPML00332013). Specifically this document describes the *Air Quality Monitoring Program* that will be used to assist with determining Final Air Quality Objectives and monitoring locations for Collinsville Mine.

1-2 The main purpose of this program is to determine appropriate Air Quality Objectives as per Condition G9, Schedule G – Table 2 from the Environmental Authority (EA) (EPML00332013). A copy of this table is shown below in Table 1-1, to which interim air quality objective have also been added. Population of this table will occur during and following the collection of two years of representative monitoring data. This iterative development of Air Quality Objectives is also an outcome of the "collaborative amendment process" (CAP) undertaken between DEHP and Collinsville Mine.

Table 1-1: Air quality objectives to be determined by the monitoring program

Air quality parameter	Air quality objectives	Interim Air Quality Objectives	Monitoring method	Monitoring frequency	Monitoring location(s)
Deposited dust	TBD	120 mg/m^2/day	AS 3580.10.1	TBD	TBD
Total suspended particulate matter	TBD	90 µg/m^3 annual average	AS 3580.9.3	TBD	TBD
Particulate matter (as PM_{10})	TBD	50 µg/m^3 annual average	AS 3580.9.8 or AS/NZS 3580.9.11:2008	TBD	TBD

1-3 The *Air Quality Monitoring Program* has been developed to outline the collection of air quality data to assess emissions from Collinsville Mine for reporting of operational and regulatory compliance.

1-4 This Program forms part of Collinsville Mine's Community Environmental Management System (CEMS) and should be read in conjunction with the ***COL-ENV-ENV-007 Air Quality Management Plan***. Reference is also made to supporting documentation where necessary, which include operational procedures, in which more detailed work instructions are provided.

2 Scope

2-1 This Program incorporates all relevant legislative and other corporate requirements pertaining to the monitoring of particulate matter (i.e. dust) and gases (due to spontaneous combustion of coal) in the vicinity of Collinsville Mine.

2-2 The Program forms part of the Collinsville Mine ***Community Environmental Management System (CEMS)***.

3 Legislative Requirements

3-1 Key legislative requirements of relevance to this Program are prescribed in Conditions G6 to G13 and Conditions G17 to G19 in the EA (EPML00332013). Conditions G1 to G19 are included in this Plan as ***Appendix A***.

4 Monitoring

4-1 The *Air Quality Monitoring Program* will consist of dust deposition gauges, Beta Attenuation Mass (BAM) monitors, meteorological stations and gas detection units.

4-2 The monitoring will be undertaken in accordance with relevant Australian Standards, as follows:

a) Dust deposition gauges, sampled monthly for insoluble solids in accordance with *AS 3580.10.1 (2003) Methods for sampling and analysis of ambient air – determination of particulate matter – deposited matter – gravimetric method*.

b) BAM monitors to measure and analyse PM_{10} in accordance with *AS3580.9.11:2008 Method 9.11: Determination of suspended particulate matter – PM_{10} Beta Attenuation Monitor*.

c) Meteorological monitoring in accordance with *AS3580.14.1- 2011 Methods for sampling and analysis of ambient air Part 14: Meteorological monitoring for ambient air quality monitoring applications.*

4-3 Siting and operation of air monitoring equipment reflects the guidance in *AS3580.1.1:2007 Guide to siting air monitoring equipment* and *AS3580.14.1:2011 Methods for sampling and analysis of ambient air*.

4-4 The locations of air quality and meteorological monitoring equipment in the vicinity of Collinsville Mine are shown in Figure 4-1.

4-5 The monitoring equipment, frequency of monitoring and relevant monitoring standards are summarised in Table 4-1.

Table 4-1: Air quality and meteorological monitoring

Instrument	Indicator (s)	Frequency	Location (Figure 4-1)	Standard
Dust deposition gauge	Insoluble solids	Monthly	Bowen Central	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Colinta	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Emohruo	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Flat Rock	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Garrick East	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Kerale Station	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	O'Loughlin	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Scottville	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Hillview	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Barracks Creek	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Belmore Homestead	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Belmore North	AS/NZS 3580.10.1:2003
Dust deposition gauge	Insoluble solids	Monthly	Janz	AS/NZS 3580.10.1:2003
BAM + AWS	PM_{10} / weather	10-minute	Colinta	AS 3580.9.11:2009
BAM	PM_{10}	10-minute	Emohruo	AS 3580.9.11:2009
BAM + AWS	PM_{10} / weather	10-minute	Hillview	AS 3580.9.11:2009
BAM + AWS	PM_{10} / weather	10-minute	Scottville	AS 3580.9.11:2009
BAM + AWS	PM_{10} / weather	10-minute	Collinsville	AS 3580.9.11:2009
BAM + AWS	PM_{10} / weather	10-minute	Powerhouse	AS 3580.9.11:2009
BAM + AWS	PM_{10} / weather	10-minute	Roving	AS 3580.9.11:2009
Meteorological station	Wind speed, wind direction, temperature, humidity, precipitation	15-minute	Garrick East	AS 3580.14:2011
Meteorological station	Wind speed, wind direction, temperature, humidity, precipitation	15-minute	Ramp 11	AS 3580.14:2011
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Hillview	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Power Station	No standard. Calibration by a NATA accredited

Instrument	Indicator (s)	Frequency	Location (Figure 4-1)	Standard
				laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Garrick East	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Ramp 14	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Scottville	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Collinsville North East	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Collinsville South West	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations
Multirae gas	Oxygen, CO, SO_2, LEL, H_2S, VOC (isobutylene)	1-minute	Thornley Station	No standard. Calibration by a NATA accredited laboratory every 6 months, as per manufacturer's recommendations

4-6 Data from the monitoring equipment listed in Table 4-1 will be collected for a minimum of two representative years from the date at which all monitors are operational.

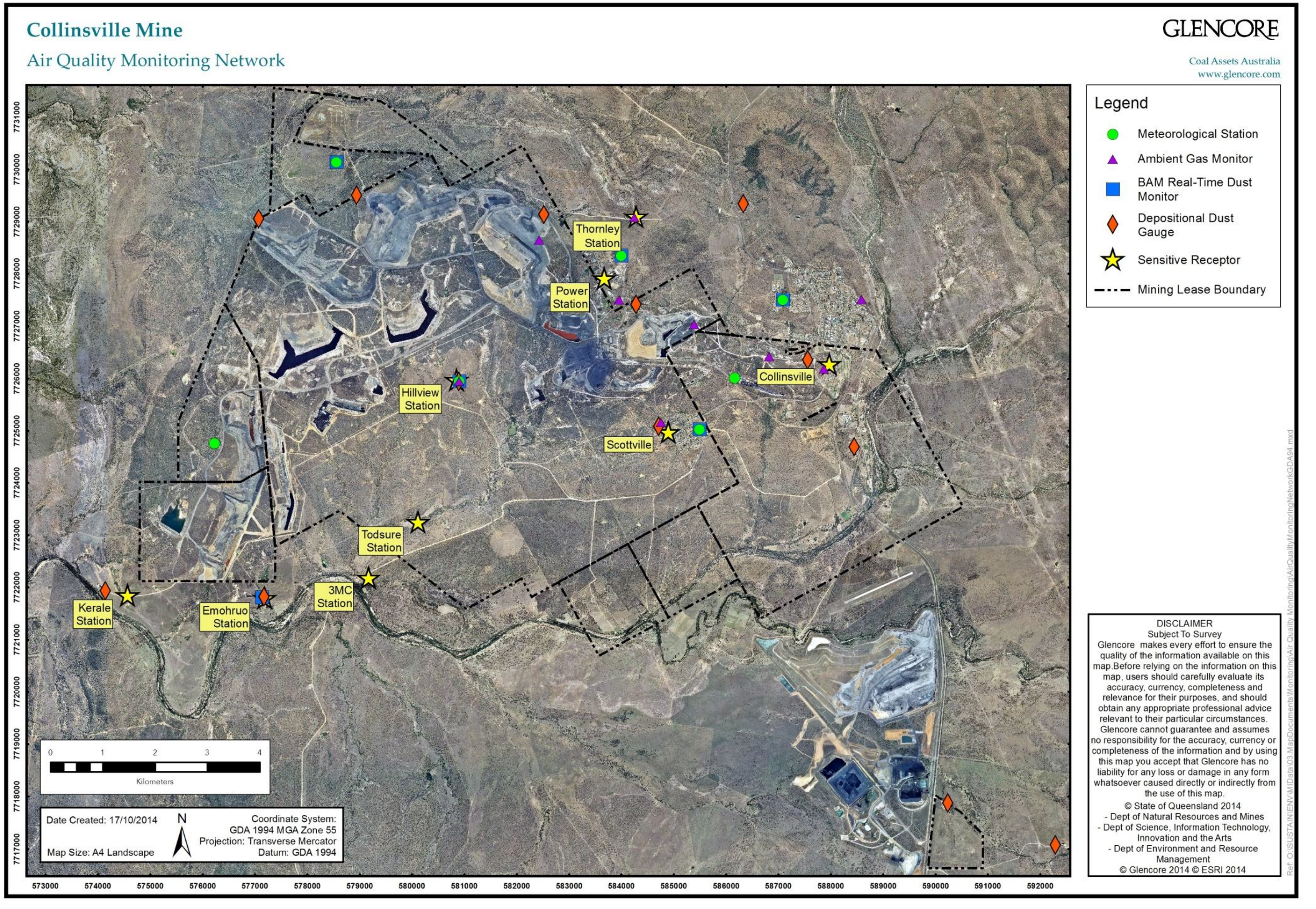


Figure 4-1 – Location of air quality and meteorological monitoring sites

5 Determination of Trigger Levels

Overview

5-1 Routine air quality management measures for specific activities at Collinsville Mine are documented in the ***COL-ENV-PLN-007 Air Quality Management Plan***.

5-2 Dust (and air quality) control strategies (that is, those in addition to the routine air quality management measures) will be based on a combination of automated daily forecasting, visual monitoring, meteorological monitoring and ambient air quality monitoring to determine dust risk on a daily basis. These strategies, which will be used to inform necessary control actions, are shown by Figure 5-1 below:

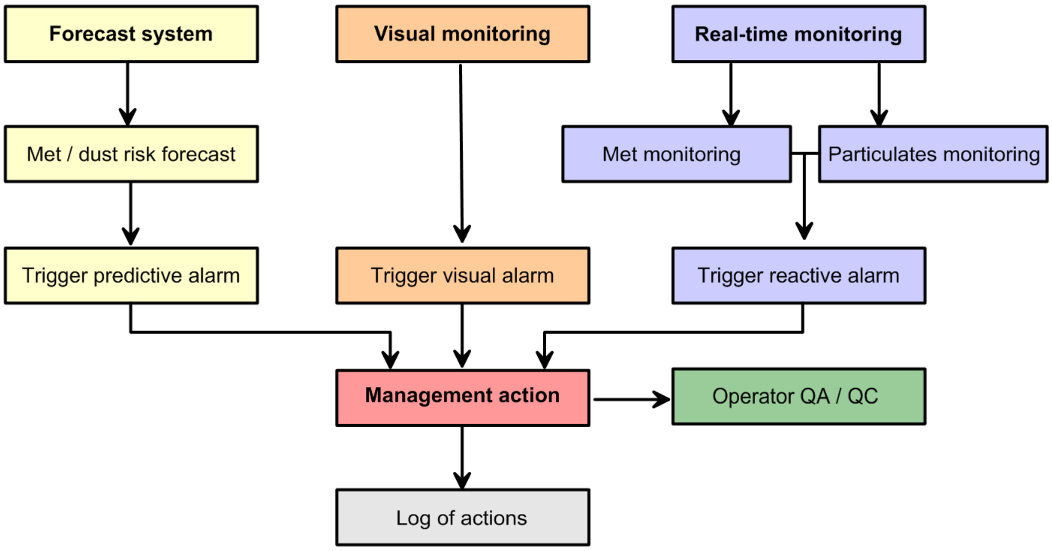


Figure** 5-1**: Integration of dust and air quality control strategies

Dust and Odour Management

5-3 Management of dust and odour emissions in the ambient air is via a Dust and Ambient Gas Trigger Action Response Plan (TARP). The TARP is fully described in ***COL-ENV-PGM-017 Dust Management Program*** has been developed to manage potential off site impacts, such as those associated with mining activities and atmospheric conditions.

5-4 The TARP is informed by visual monitoring, ambient air quality monitoring, and forecasts of emission transport from Collinsville Mine.

5-5 Dust management trigger levels will be designed to provide pre-emptive alerts for the purposes of modifying mining operations, if required, to minimise the impact of airborne dust on the environment and local community, and thereby ensuring acceptable standards are maintained.

5-6 As air quality (dust and odour) objectives are aggregate values of dust/gas concentration or deposition over nominal time periods (for example, 1-hour rolling average SO_2, 24 hours for PM_{10} and 1 month for dust deposition). Real time management of dust/odour impacts is required, so as to ensure objectives can be achieved.

5-7 As shown in Figure 5-1, provision is made for:

a) **visual conditions** – identification of significant windblown dust being generated by mining activities;

b) **meteorological conditions** – identification of dry and / or windy conditions with sensitive receivers downwind of mining activities; and

c) **ambient air quality conditions** (that is, PM_{10} and SO_2 concentrations) – measurement of short-term (hourly average) PM_{10} and SO_2 concentration at sensitive receptors, the latter as a surrogate for odour emissions.

5-8 Actual trigger levels will be determined following the commencement of real-time PM_{10} monitoring and when sufficient data are available for analysis together with contemporaneous meteorological data to determine short term PM_{10} trigger levels required to ensure longer term (ie 24 hour average) objectives can be achieved.

5-9 Typically there will be multiple trigger levels that can be progressively implemented to mitigate or slow increases in PM_{10} concentrations, where initial triggers are not effectively reducing concentrations, so as to ensure compliance with objectives can be achieved.

5-10 The definitions of the alert states, based on trigger levels, are as follows:

Normal state	Reasonably expected (normal) conditions in day to day operations No cause for review or action, but routine dust management to be continued
Level 1 Triggers	Change from normal indicating a potential risk Not of a serious nature, but acts as an alert and requires monitoring to detect further trends
Level 2 Triggers	Moderate risk of dust related impacts occurring Remedial action needs to be planned and executed
Level 3 Triggers	High risk of dust related impacts occurring A situation has occurred that poses an immediate risk and remedial action must be undertaken

Ambient Air Quality Triggers

5-11 This section refers to interim ambient air quality trigger levels. Final air quality trigger levels will be determined as per the procedures outlined in section 6, during and following the collection of 2 years of representative data.

5-12 The final TARP will define the trigger levels based on visual, meteorological, ambient air quality and forecast air quality conditions as per Figure 5-1. Each trigger will be associated with a specific action (or actions) for controlling emissions to air.

5-13 The interim PM_{10} trigger levels are shown in ***Appendix B***. These are applied when the wind direction is from mining areas towards sensitive receptors. Ambient concentrations of SO_2 are also measured and included in ***Appendix B***.

Meteorological Triggers

5-14 Meteorological conditions are measured in real-time and are built into the interim ambient air quality triggers shown in ***Appendix B***. The ambient air quality triggers apply when the wind direction is from mining areas towards sensitive receptors. An example of wind direction ranges as they apply to gas concentration triggers at select monitoring stations is shown in Table 5-1

Table 5-1: Wind direction ranges for application of gas concentration triggers

Monitoring station	Wind direction ranges
Hillview (Multirae)	SW to SE (clockwise)
Power Station (Multirae)	SE to NW (clockwise)
Garrick East (Multirae)	SW to NW (clockwise)
Ramp 14 (Multirae)	SE to NW (clockwise)
Scottville (Multirae)	W to N (clockwise)

Risk Forecast System

5-15 The Glencore Air Quality Control System includes daily forecasts of meteorological conditions and air emission transport from Collinsville Mine. This system provides early warning of adverse risks, thus facilitating proactive management of mining activities.

5-16 Risks of emissions (dust and odour) being transported from Collinsville Mine to sensitive receptors are to be reviewed by mining supervisors prior to each shift. Air quality risks are to be identified from these forecasts with actions as appropriate.

5-17 In the event that high dust risks are forecast the Mining Supervisor and/or Mining Superintendent will plan for contingency measures, as outlined in the *Dust and Ambient Gas Management TARP*, to ensure that dust generation potentials are reduced. The Environment and Community Department is responsible for providing additional environmental information as may be required to inform the production personnel's actions.

6 Determination of Objectives

6-1 The Department of Environment and Heritage Protection (DEHP) regulates air quality under the Environmental Protection Act 1994 and, specifically, as outlined in ***Environmental Protection (Air) Policy 2008 (EPP (Air))*** – Schedule 1. Air quality objectives are specified for health and wellbeing related to dust (that is, PM_{10} or fine particles of less than 10 microns in diameter) and for long-term nuisance total suspended particulates (TSP).

6-2 The DEHP objectives are:

a) dust deposition not exceeding 133 mg/m^2/day, revised upwards from 120 mg/m^2/day based on a change in DEHP policy advice (August, 2013);

b) TSP not exceeding 90 µg/m^3 on an annual basis; and

c) PM_{10} not exceeding 50 µg/m^3 over a 24 hour averaging time more than 5 times per year.

6-3 The DEHP objective for TSP will be adopted as Interim Air Quality Objectives, and reviewed for applicability at the completion of 12 months of monitoring (as outlined in ***Section 4***).

6-4 From an operational perspective, mine-related dust emissions and impacts of 24-hour average PM_{10} and depositional dust are mostly independent from background dust levels. As such setting mine related air quality objectives with consideration of background levels is problematic, particularly over short time periods (for example, 24-hours as relevant to PM_{10}).

6-5 Collinsville Mine will operate in accordance with Condition G11 of the EA for a period of 12 months following the commencement of the monitoring outlined in ***Section 4***.

6-6 After 12 months of monitoring (outlined in ***Section 4***) the Collinsville Mine contribution to measured levels will be determined by analysis of upwind and downwind PM_{10} concentrations for each day where a PM_{10} concentration above 50 µg/m^3 is recorded.

6-7 At the completion of 12 months of monitoring the Interim Air Quality Objectives will be reviewed to determine their adequacy for ensuring that project specific impacts do not exceed the EPP(Air) objectives.

6-8 At the completion of the 2 year monitoring period the Final Air Quality Objectives will be determined as per Condition G9, Schedule G – Table 2.

7 Roles and Responsibilities

7-1 Roles and responsibilities relating to execution of this Program are listed below.

Role	Responsibilities
Environment and Community Manager	• Have a sound understanding of mine-related air emission sources. • Oversee the implementation of monitoring equipment and arrange for review of monitoring data in accordance with applicable legal and other requirements.
Air quality monitoring contractor(s)	• Collect, analyse and report air quality related data to Collinsville Mine Environment and Community personnel in accordance with legislative requirements, Australian Standards and recognised Air Quality Control Procedures.

8 Review Provisions

8-1 In accordance with EA (EPML00332013) Condition G9, a report will be prepared and submitted to the administering authority within six (6) months after completing the monitoring. The report will include:

a) Proposed air quality monitoring locations;

b) Proposed final air quality objectives for the concentration of particulate matter generated by mining activities; and

c) A review of the reliability and validity of air quality data and the suitability of the monitoring program.

8-2 In accordance with EA (EPML00332013) Condition G7(c), the effectiveness of the *Air Quality Program* will be monitored and reviewed. The program for monitoring and review will be as follows:

a) Monitoring and review of the monitoring locations on an annual basis.

b) Formalisation of any amendments to the monitoring locations in accordance with the review provisions outlined in the ***COL-ENV-PLN-007 Air Quality Management Plan***.

9 Document information

Reference information

9-1 Reference information, listed below, is information that is directly related to the development of this document or referenced from within this document.

Reference	
AS 3580.10.1 (2003)	*Methods for sampling and analysis of ambient air – determination of particulate matter – deposited matter – gravimetric method*
AS3580.9.11:2008	*Method 9.11: Determination of suspended particulate matter – PM_{10} Beta Attenuation Monitor*
AS3580.1.1:2007	*Guide to siting air monitoring equipment*
AS3580.14.1:2011	*Methods for sampling and analysis of ambient air*
AS3580.14.1- 2011	*Methods for sampling and analysis of ambient air Part 14: Meteorological monitoring for ambient air quality monitoring applications*
CA HSEC PCL 0002	*Glencore Air Quality Management Protocol*
COL-ENV-ENV-007	*Air Quality Management Plan*
COL-ENV-PGM-017	*Dust Management Program*
	Collinsville Mine: Environmental Management System (EMS)
	Environmental Protection (Air) Policy 2008 (EPP (Air))

Table 9-1 – referenced information

Document change information

9-2 Full details of the document history are stored electronically in the document library, by version, on the intranet. A summary of the current and previous change is provided in the table below.

Version	Date	Nature of the change
1	17 October 2014	Document prepared by SKM. S Lakmaker with input from Glencore personnel at Collinsville.

Table 9-2 – document change information

Appendix A - Environmental Authority Conditions

Schedule G Air

Air quality management plan

G1 An Air Quality Management Plan must be developed and submitted to the administering authority within twelve (12) months from the date of issue of this environmental authority. The holder of this environmental authority must start implementation of the Air Quality Management Plan within a timeframe agreed with the administering authority but no more than six (6) months after the date of its submission to the administering authority.

G2 The Air Quality Management Plan must provide for effective management of actual and potential environmental impacts resulting from air management associated with the mining activities carried out under this environmental authority and include the following as a minimum:

a) be developed by an appropriately qualified person;
b) identification of all potential sensitive and commercial locations which may be affected by air quality impacts from mining activities;
c) identification of all major sources of dust emissions that may occur as a result of mining activities;
d) description of the procedures to manage the dust emissions from the sources identified;
e) collection of air quality and meteorological data using the methods described in the Air Quality Monitoring Program;
f) identifying adverse meteorological conditions likely to produce elevated levels of PM_{10} at a sensitive or commercial place due to mining activities;
g) integration of dust control strategies as described in the Dust Management Program;
h) protocols for regular maintenance of plant and equipment, to minimise the potential for fugitive dust emissions; and
i) description of procedures to be undertaken if any non-compliance is detected.

G3 The Air Quality Management Plan must be reviewed every two (2) calendar years and a report prepared by an appropriately qualified person. The report must:

a) assess the plan against the requirements under condition G2;
b) include recommended actions to ensure actual and potential environmental impacts are effectively managed for the coming period; and
c) identify any amendments made to the Air Quality Management Plan following the review.

G4 The holder of this environmental authority must attach to the review report required under condition G3, a written response to the report and recommended actions, detailing the actions taken or to be taken by the environmental authority holder on stated dates:

a) to ensure compliance with this environmental authority; and
b) to prevent a recurrence of any non-compliance issues identified.

Air quality monitoring program

G6 An Air Quality Monitoring Program: Baseline Investigations to Determine Air Quality Objectives must be developed within twelve (12) months from the date of issue of this environmental authority.

G7 The Air Quality Monitoring Program must include the following as a minimum:

a) be developed by an appropriately qualified person;
b) provision for the collection of a minimum of 2 years of representative data;
c) collect air quality and meteorological data using industry recognised monitoring methods;
d) determine trigger values for the concentration of particulate matter generated by the mining activities; and
e) a program for monitoring and review of the effectiveness of the Air Quality Monitoring Program.

G8 The holder of this environmental authority must start implementation of the Air Quality Monitoring Program within a timeframe agreed with the administering authority but no more than six (6) months following completion of the development of the Air Quality Monitoring Program required under condition G6.

G9 Within six (6) months after completing the monitoring described in the Air Quality Monitoring Program required under condition G6, the environmental authority holder must submit a report to the administering authority that includes:

a) proposed air quality monitoring locations;
b) proposed final air quality objectives for the concentration of particulate matter generated by mining activities; and
c) a review of the reliability and validity of air quality data and the suitability of the monitoring program.

The report must include sufficient information to allow the administering authority to develop suitable air quality monitoring conditions.

Air quality objectives

G10 Dust and particulate matter generated by mining activities must not cause an environmental nuisance at any sensitive or commercial place.

G11 Monitoring required pursuant to condition A21 must be carried out at a place(s) relevant to the potentially affected sensitive place. The holder of this environmental authority will not be in breach of condition G10 if dust and particulate matter does not exceed the following levels when measured at any sensitive place:

a) dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with the current edition of *AS 3580.10.1 Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method*; or
b) a concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (µm) (PM_{10}) suspended in the atmosphere of 50 micrograms per cubic metre over a 24 hour averaging time, at a sensitive place downwind of the operational land, when monitored in accordance with:
    i. *AS 3580.9.6 Methods for sampling and analysis of ambient air - Particulate matter - Determination of suspended particulate PM_{10} high-volume sampler with size-selective inlet - Gravimetric method*;
    ii. *AS/NZS 3580.9.11:2008 Method 9.11: Determination of suspended particulate matter – PM_{10} Beta Attenuation Monitor*;
    iii. any alternative method of monitoring PM_{10} which may be permitted by the Air Quality Sampling Manual as published from time to time by the administering authority; or
    iv. any other method of monitoring PM_{10} which may be agreed to by the administering authority.

G12 If monitoring indicates exceedence of the relevant limits in condition G11, the environmental authority holder must:

a) if a complaint is raised due to the exceedence, address the complaint including the use of appropriate dispute resolution if required; and
b) immediately implement dust abatement measures so that emissions of dust from the activity do not result in further exceedence.

G13 Following completion of the Air Quality Monitoring Program required under condition G9, Schedule G – Table 2 must be populated with the final air quality objectives, and air quality impacts generated by mining activities must not exceed the final air quality objectives in Schedule G – Table 2 at the monitoring locations and frequency defined in Schedule G – Table 2 in accordance with condition G9.

Schedule G – Table 2 – Final air quality objectives

Air quality parameter	Air quality objectives	Monitoring method	Monitoring frequency	Monitoring location(s)
Deposited dust	TBA	*AS 3580.10.1 Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method*	TBA	TBA
Total suspended particulate matter	TBA	*AS 3580.9.3 Methods for sampling and analysis of ambient air – Determination of suspended particulate matter - Total suspended particulate matter (TSP) - High volume sampler gravimetric method*; or any alternative monitoring method which may be permitted by the Air Quality Sampling Manual as published from time to time by the administering authority; or any other monitoring method which may be agreed to by the administering authority.	TBA	
Particulate matter with an aerodynamic diameter of less than 10 micrometres (PM_{10})	TBA	Real-time monitoring of the 24 hour average in accordance with *AS 3580.9.8 Determination of suspended PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser*, or *AS/NZS 3580.9.11:2008 Method 9.11: Determination of suspended particulate matter – PM_{10} Beta Attenuation Monitor, or* any alternative method of monitoring PM_{10} that may be permitted by the Air Quality Sampling Manual as published from time to time by the administering authority.	TBA	

Dust management program

G14 A Dust Management Program must be developed within twelve (12) months from the date of issue of this environmental authority.

G15 The Dust Management Program must include the following as a minimum:

a) be developed by an appropriately qualified person;

b) integration of dust control strategies with the meteorological monitoring system that would activate the timely management of dust control actions;

c) consideration of best practice environmental management dust control measures; and

d) a program for monitoring and review of the effectiveness of the Dust Management Program.

G16 The holder of this environmental authority must start implementation of the Dust Management Program within a timeframe agreed with the administering authority but no more than six (6) months following completion of the development of the Dust Monitoring Program required under condition G14.

Meteorological monitoring

G17 The environmental authority holder must establish and maintain a meteorological monitoring system to measure and record wind speed, wind direction, temperature, relative humidity and precipitation.

Note: It is possible for environmental authority holders to utilise relevant and available weather monitoring information collected by other parties as reference data for the purposes of this condition.

Odour nuisance

G18 The release of noxious or offensive odour or any other noxious or offensive airborne contaminant resulting from the mining activities must not cause an environmental nuisance at any sensitive or commercial place.

G19 If the administering authority determines the odour released to constitute an environmental nuisance, then the environmental authority holder must:

a) address the complaint including the use of appropriate dispute resolution if required; and

b) immediately implement odour abatement measures so that emissions of odour from the activity do not result in further environmental nuisance.

Appendix B - COL-ENV-TARP-003 Dust and Ambient Gas Management TARP

TARP Level	Normal	Level 1 - Alert	Level 2 – High Alert	Level 3 – Withdraw/Evacuate Area
Trigger Action Response Levels:	1-h rolling average PM_{10} <80 µg/m³	1-h rolling average PM_{10} >80 µg/m³ For 1 to 2 consecutive 10-min periods Winds from mining areas to sensitive receptors	1-h rolling average PM_{10} >80 µg/m³ For 3 or more consecutive 10-min periods Winds from mining areas to sensitive receptors	1-h rolling average PM_{10} >200 µg/m³ For 3 or more consecutive 10-min periods Winds from mining areas to sensitive receptors
	1-hour rolling average SO_2 concentration less than 0.2 ppm	1-hour rolling average SO_2 concentration greater than 0.2 ppm for 1 to 14 consecutive 1 minute periods	1-hour rolling average SO_2 concentration greater than 0.2 ppm for 15 or more consecutive 1 minute periods	1-hour rolling average SO_2 concentration greater than 0.4 ppm for 15 or more consecutive 1 minute periods.
Operational Activities	Normal operations	Continue operations with extra vigilance	Continue with extra precautions and vigilance	Operations modified or suspended
Trigger Actions Responses for above Trigger Levels (Responsibilities)				
OCE / Supervisor	• Continue work / tasks as normal. • Maintain dust suppression activities. • Continue to monitor operation.	• Visual inspection to identify potential dust (and air emission) generating activities. • Maintain dust (and air emission) suppression activities. • Continue to monitor operation.	• Visual inspection to identify potential dust (and air emission) generating activities. • Maintain dust (and air emission) suppression activities. • Continue to monitor operation. • Plan and execute (as required) remedial actions with consideration of: - Additional watering - Re-locating activities - Reduced activity	• Visual inspection to identify potential dust (and air emission) generating activities. • Maintain dust (and air emission) suppression activities. • Continue to monitor operation. • Execute remedial actions with consideration of: - Additional watering - Re-locating activities - Stopping activities
Environment	• Continue work / tasks as normal.	• Continue monitoring to detect further trends.	• Continue monitoring to detect further trends. Advise OCE / Supervisor of alert level and likely emission sources.	• Continue monitoring to detect further trends. • Advise OCE / Supervisor of alert level and likely emission sources. • Log remedial actions in consultation with OCE / Supervisor. • Advise potentially affected neighbours, Whitsunday Regional Council, Mines Inspectorate, and Department of Environment and Heritage Protection

PM_{10} exceedences 2000 to 2016 (Air NEPM compliance reporting sites)

Site	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
South East Queensland																	
Mountain Creek			8	1	1	2	0	0	1	8	0	0	1	1	1	0	0
Rocklea	0	1	7	2	2	2	0	1	1	9	0	0	0	0	0	0	0
Springwood			7	1	0	2	0	0	1	10	0	2	0	0	0	1	0
Helensvale			1														
Arundel											0	1	0				
Flinders View	1	0	7	1	3	3	0	0	2	8	0	2	2	0	0	0	0
North Toowoomba				1	1	3	1	1	4	11	0						
Gladstone																	
South Gladstone		4	5	0	0	4	1	0	2	7	0	3	1	0	0	0	0
Mackay																	
West Mackay			6	7	0	7	1	2	8	18	0	1	1	0	0	0	0
Townsville																	
Pimlico					0	5	2	0	1	9	0	1	0	0	0	0	0
Mount Isa																	
The Gap										21	0	13	16	13	12	6	1
	Bushfire smoke (Flinders View)	Bushfire smoke (Rocklea)	Dust storms, bushfire smoke	Wind blown dust (SEQ), local dust source (Mackay)	Wind blown dust (Mountain Creek), bushfire smoke (Rocklea, Flinders View) Wood heaters (T'ba))	Dust storms	Wind blown dust (T'ba, G'stone, Mackay), grassfire smoke (T'ville)	Wind blown dust (SEQ) local dust source (Mackay)	Wind blown dust (SEQ, G'stone, T'ville) local dust source (Mackay)	Dust storms		Wind blown dust, bushfire smoke	Wind blown dust, bushfire smoke	Recycling facility fire (S'wood) Wind blown dust (Mt Isa)	Bushfire smoke (Mountain Creek) Wind blown dust (Mt Isa)	Local dust source (S'wood) Wind blown dust (Mt Isa)	Wind blown dust (Mt Isa)

$PM_{2.5}$ exceedences 2005 to 2016 (Air NEPM compliance reporting sites)

Site	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
South East Queensland																	
Rocklea						0	0	0	0	7	0	0	0	0	0	0	0
Springwood						0	2	1	0	3	0	3	0	0	0	0	0
Arundel											0	2	0				
North Toowoomba						0	0	0									
Gladstone																	
South Gladstone									0	7	0	9	1	0	1	0	0
							Bushfire smoke (S'wood)	Bushfire smoke (S'wood)		Dust storms, bushfire smoke		Bushfire smoke	Bushfire smoke (G'stone)		Bushfire smoke (G'stone)		

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Dr David Wainwright
Director Air Quality Sciences
Department of Environment and Resource Management
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Dear Dr Wainwright

Thank you for the opportunity to comment on the respirable crystalline silica results from the monitoring conducted in the vicinity of the Airport Link / Northern Busway construction activities at Lutwyche. A preliminary health risk assessment of the crystalline silica results has been undertaken and is attached to this letter.

The health risk assessment was based on samples obtained from mid April to early August 2011 and subsequently analysed by Simtars. Based on the information provided by the Department of Environment and Resource Management, Queensland Health is of the view that the community in the vicinity of the Airport Link / Northern Busway construction activities at Lutwyche is unlikely to have suffered any adverse health effects from respirable crystalline silica emanating from the Airport Link / Northern Busway construction activities.

Queensland Health does not have any objections to the report being placed on the Department of Environment and Resource Management internet site.

Yours sincerely

Sophie Dwyer
Executive Director
Health Protection Directorate
22/2/2012

Health Risk Assessment of Community Exposure to Silica from Airport Link / Northern Busway Construction Activities
Prepared by Environmental Health Science and Regulation Unit
Environmental Health Branch, Queensland Health

Background Information

The Air Quality Sciences Unit of the Department of Environment and Resource Management (DERM) has requested advice from Queensland Health in relation to potential health effects from the inhalation of silica dust from the Airport Link / Northern Busway construction works at Lutwyche. In response to community concerns regarding health effects from silica in dust emanating from the Lutwyche construction works, DERM conducted a dust monitoring program in the Lutwyche area from April to August 2011.

'Dust' is a generic term describing airborne particulate matter which has a range of different physical and chemical properties. The potential health effects of dust are closely related to particle size. The size range of airborne particles varies from less than 0.1 micrometre (µm) up to about 500 µm or half a millimetre. Human health effects of airborne dust are mainly associated with particles less than 10 µm in size (commonly termed PM_{10}), which are small enough to be inhaled into the lower respiratory tract. Particulate matter can also cause considerable nuisance problems through soiling of property. Nuisance effects can be caused by particles of any size, but are most commonly associated with those larger than 20 µm.

In Brisbane, PM_{10} is largely composed of crustal matter from roadside dust and soil, sea salt, organic compounds, elemental carbon from industrial and vehicle emissions and ammonium sulphate (Chan et al, 1997).

DERM Monitoring program design

The DERM dust monitoring program at Lutwyche focused on acquiring data on:

- PM_{10} (particles less than 10 µm in diameter) levels – for assessment against Queensland Environmental Protection (Air) Policy 2008 (EPP Air) 24-hour average air quality objective of 50 µg/m^3
- $PM_{2.5}$ (particles less than 2.5 µm in diameter) levels – for assessment against EPP Air annual objective of 8 µg/m^3 and the 24-hour average air quality objective of 25 µg/m^3
- Crystalline silica levels – for assessment against health based criteria. Crystalline silica was measured in both the $PM_{2.5}$ and PM_{10} particle fractions.

The $PM_{2.5}$ and PM_{10} samples used for the crystalline silica measurements were collected over sequential seven-day periods to ensure the volume of air sampled was sufficient to detect any exceedence of the health based criteria for crystalline silica. This sampling strategy was appropriate as the hazard posed by crystalline silica is related to chronic long term exposure (typically years).

Two monitoring sites in the Lutwyche area were chosen by DERM for the investigation. The two sites were:

- Lamington Avenue – located at a private residence adjacent to the southern end of the construction works
- Lutwyche Road – located within the grounds of St Andrew's Church and east of the central construction works area

Both sites were situated as close as possible to the construction works to obtain a measure of the particles leaving the Airport Link / Northern Busway construction area. The monitoring sites are shown on Figure 1.

All samples were collected by DERM and the crystalline silica analysis of the dust samples was conducted by Simtars (the Safety in Mine Testing and Research Station, Department of Employment, Economic Development and Innovation).

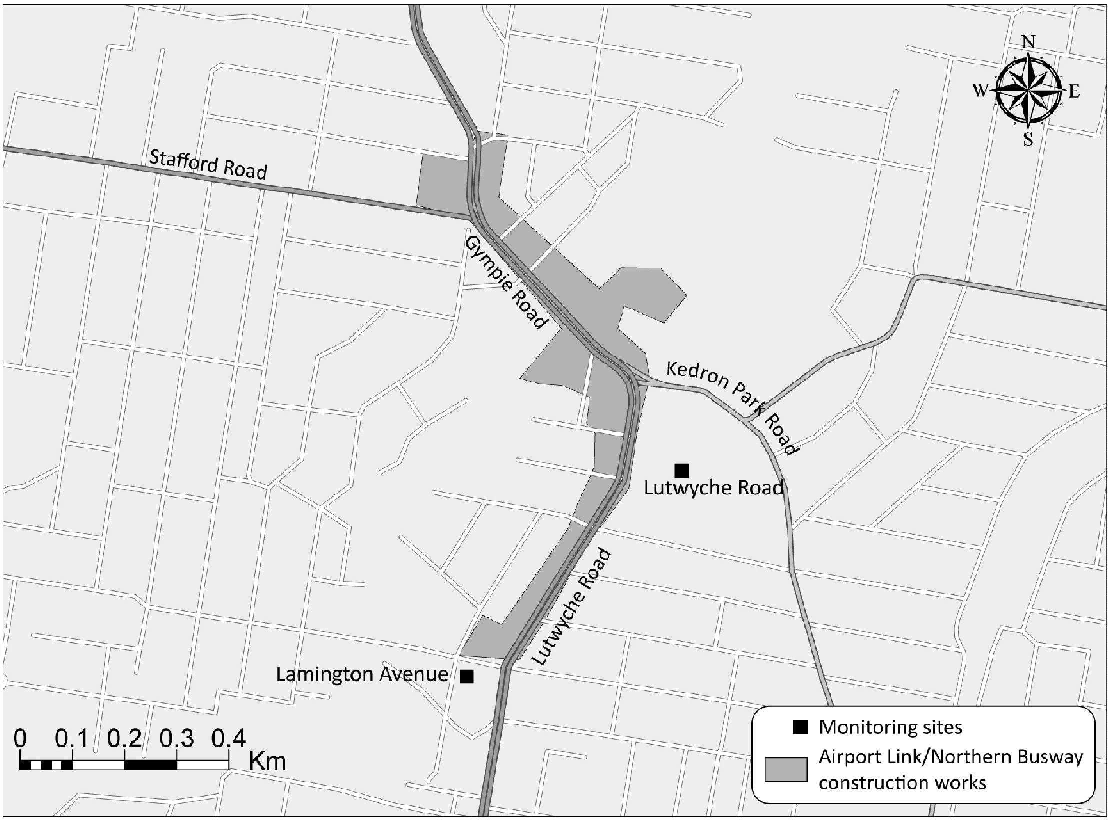

Figure 1: Monitoring sites in Lamington Avenue and Lutwyche Road in relation to the Airport Link / Northern Busway construction works.

Results

PM_{10} and $PM_{2.5}$ crystalline silica monitoring results, provided by DERM, are shown in Table 1.

The average PM_{10} crystalline silica concentration over the monitoring period from April to August 2011 was 0.57 µg/m^3 at the Lamington Avenue monitoring site and 1.43 µg/m^3 at the Lutwyche Road monitoring site. The corresponding average $PM_{2.5}$ crystalline silica concentrations were 0.57 µg/m^3 at the Lamington Avenue site and 1.21 µg/m^3 at the Lutwyche Road site.

Table 1: 7-day average PM_{10} and $PM_{2.5}$ crystalline silica monitoring results at the Lamington Avenue and Lutwyche Road monitoring sites, April to July 2011

Sampling period	Lamington Avenue monitoring site			Lutwyche Road monitoring site			Rainfall during monitoring period (mm)
	7-day average PM_{10} crystalline silica concentration (µg/m^3)	7-day average $PM_{2.5}$ crystalline silica concentration (µg/m^3)	Proportion of winds from direction of construction works (%)	7-day average PM_{10} crystalline silica concentration (µg/m^3)	7-day average $PM_{2.5}$ crystalline silica concentration (µg/m^3)	Proportion of winds from direction of construction works (%)	
16 - 22 April 2011	0.74	0.77	7.4	Monitoring site not operational			28.0
23 – 29 April 2011	0.29	0.28	0.0	Monitoring site not operational			31.5
30 April – 6 May 2011	0.41	0.42	6.5	1.21	1.21	55.7	16.0
7 – 13 May 2011	0.51	0.49	8.3	2.22	1.97	75.3	6.0
14 – 20 May 2011	0.63	0.63	0.9	1.32	1.33	38.1	2.0
21 – 27 May 2011	0.35	0.35	9.5	2.09	1.97	67.0	31.0
28 May – 3 June 2011	0.54	0.56	3.0	1.45	1.47	54.5	8.5
4 – 10 June 2011	0.69	0.70	3.9	2.33	2.17	76.5	0.0
11 – 17 June 2011	0.28	0.28	1.8	3.72	1.61	81.0	3.0
18 – 24 June 2011	1.00	0.97	4.8	0.50	0.21	75.3	0.0
25 June – 1 July 2011	0.63	0.63	1.2	0.53	0.56	34.5	3.0
2 – 8 July 2011	0.38	0.35	6.5	Sampler did not run due to power failure			0.0
9 – 15 July 2011	0.75	0.76	8.3	1.25	1.25	63.4	10.0
16 – 22 July 2011	0.22	0.21	1.2	0.63	0.63	72.9	0.0
23 – 29 July 2011	0.94	0.90	8.9	0.81	0.83	53.0	0.0
30 July – 5 August 2011*	0.75	0.79	2.1	0.56	0.56	45.5	0.0
Average	0.57	0.57		1.43	1.21		
Range	0.22 – 1.00	0.21 – 0.97		0.50 – 3.72	0.21 – 2.17		
*Sampling at the Lamington Avenue monitoring site concluded at 10:00 am on 4 August 2011							

Discussion

DERM has advised that for dust generated by the Airport Link / Northern Busway construction works to impact the Laminington Road monitoring site, the wind direction had to be between north and north-east and for the Lutwyche Road monitoring site, the wind direction had to be between south-west and north.

There was a low incidence of winds favourable for measurement of dust impacts from the construction works at the Lamington Avenue monitoring site between April and August 2011. Winds from the direction of construction works only accounted for between zero and ten percent of all winds during weekly sampling periods at this site. Particle measurements obtained during the monitoring period were therefore unlikely to be representative of worst case meteorological conditions.

There was a high incidence of winds favourable for measurement of dust impacts from construction works at the Lutwyche Road monitoring site between April and August 2011. Winds from the direction of construction works made up 35 to 81 percent of all winds during weekly sampling periods at this site. Particle measurements obtained during the monitoring period were therefore likely to be representative of worst case meteorological conditions.

Rainfall was another factor that may have influenced the outcome of the investigation through possible dust suppression. DERM provided daily rainfall information from the Bureau of Meteorology rainfall recording site at Eagle Farm (approximately four kilometres east of the monitoring site) and the rainfall data has been summarised in Table 1. Rainfall of up to 30 millimetres occurred during weekly sampling periods in April and May, however there was very little rain recorded during June and July. DERM considered that measured particle concentrations, particularly in the latter half of the monitoring period, would not have been suppressed to a significant degree by rainfall events during the monitoring period.

How dust affects the health of those exposed depends on the chemical composition of the dust, the airborne concentration and the particle size. The particle size influences where in the respiratory system the dust will be deposited. Particle with a size less than 10 µm (PM_{10}) are defined as respirable as they are able to penetrate to the alveolar region of the lungs.

Respirable crystalline silica is a potential component of airborne particulate matter in the vicinity of the Airport Link / Northern Busway construction works due to the presence of granite, quartz and sandstone in the ground through which the roadways and tunnels are being constructed. Specific health effects of respirable crystalline silica are related to repeated and prolonged workplace exposure (typically over many years) to concentrations of respirable crystalline silica, in excess of the current occupational exposure standard of 100 µg/m^3. These exposures may cause a lung disease called silicosis (fibrotic scarring of the lungs) and may also be associated with lung cancer. (However, in Australia, such occupational exposures are unlikely to occur today given modern work practices and enforcement of the occupational exposure standard.)

Queensland does not have a non-occupational health criterion for crystalline silica. Health criteria for crystalline silica developed by other national and international agencies are based on occupational respirable crystalline silica studies, as few studies of environmental exposure to silica have been conducted. In these studies, occupational respirable dust samplers which are designed to collect particles with a mass median aerodynamic diameter (MMAD) of 4.25 µm or less were used (Standards Australia, 2009). This occupational definition of respirable differs from the environmental definition of respirable, which is PM_{10} (or particles with a MMAD of 10 µm or less).

The Californian Office of Environmental Health Assessment (OEHHA) (an agency of the Californian EPA) used the occupational studies to derive a chronic inhalation Reference Exposure Level (REL) for community exposure to respirable crystalline silica of 3 µg/m^3 (measured using occupational respirable dust samplers) (OEHHA 2005). The chronic inhalation REL has been defined by the OEHHA as "an airborne level that would pose no significant health risk to individuals indefinitely exposed to that level" (OEHHA, 2007).

Victoria has adopted the OEHHA REL, but measures the crystalline silica concentration in the $PM_{2.5}$ fraction of the dust (Environmental Protection Authority Victoria, 2007).

Due to the non-availability of occupational respirable dust sampling equipment capable of measuring respirable crystalline silica concentrations of 3 $\mu g/m^3$ or less, PM_{10} and $PM_{2.5}$ samplers were used to estimate the respirable (occupational) crystalline silica concentration and determine if the respirable crystalline silica concentration was likely to pose a significant health risk to the community. Depending on the particle size distribution in the dust, the $PM_{2.5}$ samplers would, theoretically, underestimate the respirable (occupational) crystalline silica concentration and the PM_{10} would overestimate the respirable (occupational) crystalline silica concentration, that is the respirable (occupational) crystalline silica concentration would be somewhere between the $PM_{2.5}$ and PM_{10} crystalline silica concentrations.

The similarity of average levels at each site for $PM_{2.5}$ and PM_{10} samplers is consistent with the expectation that most crystalline silica generated by the construction works would be in the $PM_{2.5}$ fraction.

The average respirable silica concentrations over the monitoring period at the two Lutwyche monitoring sites were less than the derived annual exposure standard of 3 $\mu g/m^3$. This exposure standard was developed to prevent silicosis in people exposed to this concentration over a lifetime.

If it is assumed that the worst case meteorological conditions for the Lutwyche Road monitoring site existed all year, the annual average respirable crystalline silica concentration would be about 1.43 $\mu g/m^3$ or less than fifty percent of the derived annual exposure standard of 3 $\mu g/m^3$.

Conclusion

Based on the data provided by DERM, Queensland Health has formed the view that the Lutwyche community is unlikely to suffer any adverse health effects from respirable crystalline silica emanating from the Airport Link / Northern Busway construction works at Lutwyche.

Further confidence is provided by the fact that the period of exposure is limited to approximately four years rather than being a continuous lifetime exposure.

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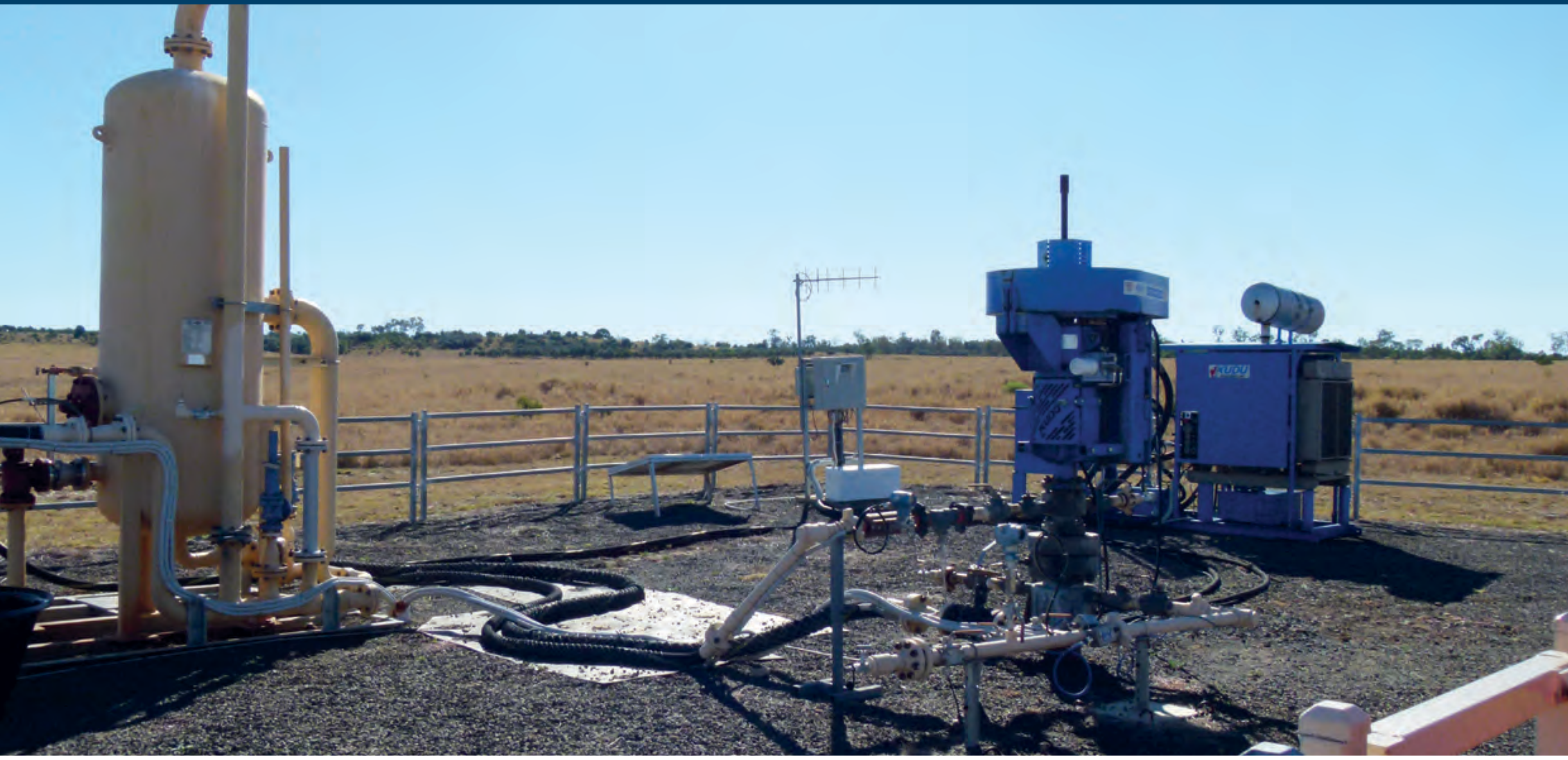
Department of Health



Coal seam gas in the Tara region:

Summary risk assessment of health complaints and environmental monitoring data

March 2013

Queensland Government

Coal seam gas in the Tara region: Summary risk assessment of health complaints and environmental monitoring data

Published by the State of Queensland (Queensland Health), March, 2013

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An electronic version of this document is available at
www.health.qld.gov.au/publications/csg/

Photo: Queensland Health image bank

Contents

1. Introduction

The coal seam gas (CSG) industry has developed significantly in the Tara region over recent years. Its development has coincided with complaints from some residents alleging impacts on the health of themselves and family members. Various government and industry stakeholders have undertaken a range of initiatives that are relevant to assessing the potential for public health risks from the industry. This report provides a summary risk assessment based on the data obtained from these reports.

This summary risk assessment is framed on the following questions:-

1. What is known about the health complaints among residents in the Tara region?
2. What is known about the impacts of CSG activities on environmental factors that may affect the health of the community (environmental health determinants) in the Tara region?
3. What is the most likely relationship between the residents' health complaints and any documented impacts of CSG activities on environmental health determinants?

This risk assessment primarily takes a community-wide focus rather than focussing on potential health impacts that may be attributable to highly site specific factors e.g. a single property's dam contains poor quality water. Site specific issues should be assessed on a site-by-site basis. This assessment also does not address occupational health and safety impacts for CSG workers.

A range of information available to the Department of Health up to February 2013 was used for the assessment. As further information becomes available over time, it will require specific evaluation. That may necessitate amendment to this assessment.

2. Information sources

The following information sources were used for this risk assessment:

1. *The Darling Downs Public Health Unit (DDPHU) investigation into the health complaints relating to Coal Seam Gas (CSG) activity from residents residing within the Wieambilla Estates, Tara, Queensland–July to November 2012* (Appendix 1). Report dated January 2013 by Dr Penny Hutchinson, Public Health Physician, Darling Downs Public Health Unit.
2. *Health effects of coal seam gas – Tara* (Appendix 2). Report for the Department of Health dated 19 February 2013 by Dr Keith Adam, Specialist in Occupational and Environmental Medicine, Medibank Health Solutions Pty Ltd and Adjunct Associate Professor, The University of Queensland.
3. *Environmental Health Assessment Report – Tara Complaint Investigation Report* (Appendix 3). Report by ERM (Environmental Resources Management Australia Pty Ltd) dated January 2013 of QGC's (Queensland Gas Company) environmental monitoring at nine residential sites in the Tara Estates during July 2012. The report was provided to the Department of Health by QGC and used with QGC's permission. (Note: The ERM report comprises 784 pages. Appendix 3 of this report does not include Annex C and Annex D of the ERM report. Annex C comprises maps of the nine residential sites. Annex D comprises 717 pages of the raw analytical results used for the body of the report and photos, sampling and other details collected at the nine properties involved in the QGC monitoring program.)
4. *Wieambilla Estates Odour Investigation Results: July-December 2012* (Appendix 4). Report dated January 2013 by Environmental Monitoring and Assessment Sciences, Science Delivery Division, Department of Science, Information Technology, Innovation and the Arts (DSITIA) for the Department of Environment and Heritage Protection (DEHP).
5. *Submission on National Greenhouse and Energy Reporting (Measurement) Determination 2012 – Fugitive Emissions from Coal Seam Gas.* A submission dated 19 October 2012 by Dr Isaac Santos and Dr Damien Maher, Centre for Coastal Biogeochemistry, Southern Cross University, to the Department of Climate Change and Energy Efficiency. Accessed 17 January 2013 from the Southern Cross University website at http://www.scu.edu.au/coastal-biogeochemistry/index.php/70/
6. *Enrichment of radon and carbon dioxide in the open atmosphere of an Australian coal seam gas field.* A journal article by researchers from the Centre for Coastal Biogeochemistry, School of Environment, Science and Engineering, Southern Cross University, Lismore. It was published (as a Just Accepted Manuscript) in Environ. Sci. Technol. on 27 February 2013, DOI: 10.1021/es304538g.
7. A report dated February 2013 on noise monitoring at one site in the Wieambilla Estates by the Department of Environment and Heritage Protection (DEHP).

3. Health complaint data

This section reviews the two sources of clinical information about the health complaints made by residents in the Tara region. The intent is to understand the key clinical features of the complaints e.g. nature, prevalence, severity and reversibility. This is the first step in identifying whether any particular factor/s, in particular CSG industry emissions, might have a role in their causation or exacerbation.

This section reviews the two sources of clinical information about the health complaints made by residents in the Tara region. The intent is to understand the key clinical features of the complaints e.g. nature, prevalence, severity and reversibility. This is the first step in identifying whether any particular factor/s, in particular CSG industry emissions, might have a role in their causation or exacerbation.

3.1. DDPHU report

The Darling Downs Public Health Unit (DDPHU) report on health complaints is based on two sources of clinical data. First, it uses reports from GPs and hospitals in the Tara region in regard to clinical presentations by residents claiming adverse health impacts from CSG activities. Secondly, it uses clinical data obtained during follow-up interviews of people who attended local general practitioners (GPs) and hospitals or registered health complaints related to CSG activities with 13HEALTH (13 43 25 84). Some residents' complaints are included in both data sources. The data covers the period 4 July to 12 November 2012.

The primary purposes of the DDPHU report were determining the nature, prevalence and severity of the health complaints. It also considers aspects of the exposure of the affected residents to CSG activities (type, proximity and duration), as well as other exposures unrelated to CSG activities that could be relevant to the health complaints.

The report is based on information for 56 people from 11 families resident in the region. Symptoms were reported for 46 of these people. Two other individuals who registered complaints with 13HEALTH were excluded from the analysis as they were not residents of the region. A broad range of symptoms was reported. The predominant symptoms reported were headaches (34 people), sore, itchy eyes (18), nosebleeds (14) and skin rashes (11). Other reported symptoms with frequencies less than 10 people are detailed in Table 1 of the DDPHU report.

Nine individuals presented to local healthcare providers (total of 16 presentations). Reported symptoms included headaches, nosebleeds, skin rashes and generally feeling unwell. Clinical examination of these cases did not reveal any significant identifying findings. There was no clinical evidence of nosebleeds in those who reported this symptom. No hospital admissions that were attributed to CSG exposure arose from these presentations to local healthcare providers.

The predominant symptoms of headaches, eye irritations, nosebleeds and skin rashes are discussed in the DDPHU report. For this summary, the following key observations are drawn:

- Headaches – varying types described (dull ache and pounding); often worse at night in association with sounds of compressors from CSG wells; variable duration up to months on end; medications used ranged from simple over-the-counter analgesics to narcotic analgesics; some reports of related symptoms such as pins and needles. It is not evident that any of the headaches have been associated with a specific medical condition (e.g. migraine) or a specific diagnosis related to a toxic substance.
- Eye irritations – sore, itchy eyes experienced mainly when outside the home with symptoms settling when indoors.
- Nosebleeds – predominantly reported in children; several presentations to the local GP in the study period, however GP did not report any findings on clinical examination.
- Skin rashes – more commonly reported in children; one skin rash was identified by the DDPHU public health physician as a common skin condition that would be unrelated to CSG activities.

In regard to the period prevalence of complaints, the DDPHU report estimates that complaints were registered for approximately 3.7 per cent of the resident population in the Wieambilla Estates during July to 12 November 2012. This includes complaints registered by parents/carers for their children. Approximately 0.7 per cent of the resident population is reported to have attended the local GP clinic at Tara with symptoms described by the resident as being related to CSG activities. As an indicator of clinical severity, there were no hospital admissions attributed to exposure to CSG activities.

Following evaluation of the information obtained about the clinical complaints, the DDPHU report concluded that the investigation by itself was unable to determine whether any of the health effects reported by the community are linked to CSG activities. Reasons for this are explained in the DDPHU report.

In summary, the most that can be drawn from the DDPHU report is that it provides some limited clinical evidence that might associate an unknown proportion of some of the residents' symptoms to transient exposures to airborne contaminants arising from CSG activities. The clinical evidence does not indicate any specific or unique medical conditions that can be attributed to such exposure. Rather, it points more to transient (reversible) effects at most. The test of whether any of the symptoms could be attributed to exposure to CSG emissions lies in the assessment of the data from environmental monitoring. This is discussed later in this report. Of note, the reported symptoms can have many potential causes unrelated to CSG activities and, indeed, unrelated to any other specific environmental health factor.

3.2. Dr Adam's report

Dr Keith Adam was commissioned by the Department of Health to provide an independent expert opinion on the health complaints of residents in the Tara area with particular regard to the potential for the complaints to be linked to CSG activities. Dr Adam conducted clinics at Tara Hospital on 11–12 October 2012. The clinics were advertised locally by various means, but the level of awareness achieved among residents is not known. Anecdotal comment has been received that awareness levels were low. Attendance at the clinics was voluntary and comprised individuals and family groups. Dr Adam undertook telephone consultations for people who were unable to attend in person.

Participants included adults and children. Information was obtained in regard to 23 people in total. Direct participation involved 15 people in person and two by telephone. Three of these participated as individuals and the remainder comprised separate family groups. Among the family groups, there were a further six people who were unable to attend the clinics due to school or work commitments. However, it is understood that any concerns relating to them were raised on their behalf by other family members who attended or telephoned the clinics. Dr Adam commented on the relatively small number of residents who participated in the clinics. He was unable to determine whether this was due to limited publicity of the clinics or a lack of widespread interest in the clinics among residents.

Reported symptoms are detailed in the full report. The complaints mainly related to headaches, nausea and vomiting, nosebleeds, nose, throat and eye irritation, and some skin rashes and sores. These are similar to the symptoms discussed in the DDPHU report. There were reports of odours associated with irritation of the nose and throat. There also were reports of low frequency vibration. A commonly reported pattern was improvement in symptoms when away from the area and recurrence on return.

On clinical examination, some limited nasal inflammation was observed in several cases. Dr Adam did not observe any bleeding or crusting of the nasal mucosa (inner lining of the nose) that might be expected in association with recent nosebleeds. One rash was observed, which Dr Adam was unable to identify. Apart from those limited observations, the key outcome from the physical examinations was that Dr Adam was not able to find any objective evidence of the clinical conditions which were reported. He noted the absence of clinical findings would not be unexpected for complaints of headache or nausea.

Dr Adam commented that the circumstances of potential exposure described to him by attendees would, for the most part, be expected to represent relatively low level exposure. This was based on the distance between the homes of affected individuals and CSG wells. For comparison, Dr Adam commented that his review of peer-reviewed literature in regard to occupational exposure to CSG did not identify evidence of unique or substantial harm to employees in the industry. This is highly relevant as potential exposure among workers in the industry itself could be expected to be significantly higher than in a community setting among residents located up to many kilometres from CSG sites.

The key clinical conclusion that is drawn from Dr Adam's report is that his clinical interview and assessment of residents who attended the clinics was not able to identify any specific clinical condition or pattern that would point to an obvious relationship between the reported health complaints and exposure to chemicals or emissions involved in the CSG industry. He comments that he would expect exposure to potential CSG emissions to be low, given the distances between the affected residents' homes and CSG wells. He particularly noted that review of any environmental monitoring would be important to test his presumption that resident' exposure is low.

Dr Adam reviewed the ERM and DSITIA reports (Appendices 3 and 4 of this report) in regard to environmental monitoring data. His overall finding was that the results in those reports 'do not indicate any significant exposure which could account for the ongoing symptoms'. However, Dr Adam identified one criticism of the ERM report in regard to the air monitoring results where 'in some cases, the standard against which the results were being compared was less than the limit of detection of the analytical method'. He explained that this meant that 'it cannot be stated with certainty that the standard was not exceeded'. Further detailed discussion of this aspect is found in the Department of Health's assessment of the ERM report (section 4.1.1 of this report). While noting this criticism, Dr Adam concluded, 'Despite this criticism, the testing provides comfort that despite testing for a wide range of substances, the vast majority were not able to be detected'.

The Department of Health's assessment of Dr Adam's report is that he was unable to identify a specific clinical disease or condition that clearly could be attributed to exposure to CSG emissions. The reported symptoms, if due in any way to CSG emissions, are more suggestive of intermittent exposure to low-level irritants and odours, rather than exposure leading to significant systemic toxicological effects. It appears clear the reported symptoms are rapidly reversible based on the reports that symptoms improved when residents were away from the area. As commented by Dr Adam, review of the environmental monitoring data is necessary to identify if there is any likely association. Apart from Dr Adam's review of available environmental data that is summarised in the preceding paragraph, further detailed review by the Department of Health follows in Section 4 of this assessment.

Apart from the clinical and environmental aspects, Dr Adam's report also contains observations that are pertinent to the general on-going assessment and management of CSG issues. These relate to the following:

- residents' reported concerns are not exclusively about health impacts
- the level of coordination between government agencies and the CSG industry in regard to environmental monitoring and feedback to residents
- the need for a comprehensive communication strategy to regain community confidence
- residents' reports of noise/vibration impacts.

As these aspects are not directly related to the clinical aspects of the health complaints, they will be considered further in the discussion section of this assessment.

4. Environmental monitoring data

This section reviews three information sources on environmental monitoring activities that have been undertaken in the Tara region. The intent is to identify if any particular environmental health determinants have been measured at levels that could explain the symptoms that have been reported by residents. This is the second step in determining whether any particular factor/s, in particular CSG industry emissions, might have a role in the causation or exacerbation of the residents' reported symptoms. It is based on the fundamental principle that adverse health effects can occur only if there is exposure to hazardous agents at levels and durations sufficient to induce the adverse effect.

4.1. QGC Environmental Monitoring – ERM report

QGC commissioned environmental monitoring of air, water and soil at nine residential blocks in the Wieambilla Estates near Tara. Sampling was undertaken by SGS Leeder Consulting at various times across the nine blocks during 11 to 19 July 2012. Analysis and reporting of the results was undertaken by ERM. For purposes of this assessment, the report of QGC's environmental monitoring program is referred to as the ERM report.

The Department of Health was not involved in the design and implementation of the monitoring program or the laboratory analysis of the samples. The results in the ERM report are used in this assessment on their face value as presented in the report. The key findings in regard to air, water and soil are discussed separately.

4.1.1. Air monitoring

The ERM report indicates that air monitoring was undertaken at the nine residential lots at various times during 11 to 19 July 2012. The properties were sampled on various dates with the outcome that air sampling occurred on seven different dates (11, 12, 13, 16, 17, 18 and 19 July 2012). No sampling was reported for 14 to 15 July 2012 which were weekend days. Thirteen air samples were collected. A single sample was collected at five properties with two samples at each of the remaining four properties. The sampling forms in the ERM report appear to indicate that the individual sampling periods ranged from just over seven hours to almost 22 hours. Four sampling periods were less than 12 hours. However, this level of detail is not summarised explicitly in the ERM report. At two properties there were both day time and night time samples.

Sampling was undertaken with vacuum canisters. This method provides the average air concentration of analytes over the duration of the sampling period. It does not identify short-term peaks and troughs in air concentrations that may occur during the full sampling period for a particular sample. Sampling and analysis was done in accordance with the relevant Australian Standard. The samples were submitted to SGS Leeder, a NATA (National Association of Testing Authorities) accredited laboratory, for analysis of:

- vacuum/pressure
- volatile organics
- total voc as n-hexane
- general gases (helium, hydrogen, methane, carbon dioxide, carbon monoxide and ethylene)
- sulphur gases.

ERM reviewed the laboratory quality assurance (QA) and quality control (QC) data and concluded the data were suitable for its intended use. Summary results are provided in Table 3 of the ERM report.

Section 7.1.3 of the report describes the screening criteria used by ERM to evaluate the results. The Australian National Environment Protection (Air Toxics) Measure (2004) (NEPM) was used as the primary criteria. However, as most of the 95 individual analytes reported by SGS Leeder are not included in the NEPM, the US EPA Regional Screening Levels (RSLs) for residential air were used as the secondary criteria. The NEPM and the RSL criteria represent air concentrations that are considered to be protective of human health over a lifetime of exposure at that concentration.

Table 7, Section 7.2.3 of the ERM report summarises the identified exceedances of the air criteria adopted for the report. The table indicates that the only exceedance related to the concentration of benzene in an overnight sample from one site. The specific concentration is not provided in the body of the report. However, review of the raw data indicates the reported result was 25 µg/m^3. The NEPM value is 10.3 µg/m^3 as an annual average. A second sample from the same property during day time was reported as <4.3 µg/m^3. The ERM report states the average of the two samples was below the NEPM value. As the two samples combined appear to have covered a 23.5 hour period without overlap, the 24-hour average would have been very close to the NEPM annual average value. However, it is not apparent to the Department of Health nor explained in the ERM report how an average less than 10.3 µg/m^3 was calculated given the individual values were 25 and <4.3 µg/m^3 respectively.

Apart from this single benzene result at one property, the ERM report indicates there were no other exceedances of the air quality screening criteria. The Department of Health considers this aspect of the ERM report needs significant qualification.

The air sample analyses comprised 95 discrete analytes which are listed in Table 3 of the ERM report. Of these 95 analytes, 49 do not have criteria listed in either the NEPM or the RSLs. Three, hydrogen, helium and carbon dioxide, are normal constituents of air and would not be expected to have NEPM or RSL criteria. Excluding carbon dioxide which was detected in all samples at typical concentrations in air (0.04 per cent except one sample at an unexpectedly low 0.02 per cent), the only positive detections (i.e. concentrations above the limits of reporting) for this group of analytes were:

- 31 µg/m^3 of cis-1,2-Dichloroethene at one site. The remaining 12 samples were reported as below the limit of reporting (<9.5 µg/m^3 or lower). This concentration is equivalent to approximately 8 ppb (parts per billion). In contrast, its odour becomes noticeable at approximately 17 ppm (parts per million) which is 2,000 times higher. Its occupational exposure standard is 200 ppm. The reported concentration would not be expected to be associated with any adverse effects.
- 0.44, 0.23 and 0.18 µg/m^3 of total VOC as n-hexane from sampling at two sites. The remaining 10 samples were reported as below the limit of reporting for the specific sample (<0.22 µg/m^3 or lower). This result relates to the mass of the total VOC (volatile organic compounds) in the sample expressed as its equivalence as just n-hexane, rather than as discrete substances. No specific comment can be made other than to state that these concentrations, if due to n-hexane alone, would not be expected to be associated with any adverse effects.

There were another 20 analytes where all concentrations reported for the 13 air samples were below the NEPM or RSL criteria. Two of these analytes, toluene and o-xylene, have criteria in both reference lists. For both, the reported concentrations in all samples were substantially below both criteria values. None of the results for these 20 analytes suggest exposure at levels that would be expected to be associated with adverse health effects.

Of the remaining 26 analytes, the ERM report shows the limit of reporting for each analyte in the 13 air samples was higher than the relevant NEPM or RSL criteria value (Table 3 of the ERM report). For many of these analytes, the relevant criteria value was two or more orders of magnitude (i.e. at least 100 times) lower than the limit of reporting of the respective analyte in the samples. In this situation, while the analysis report might indicate the analyte is below the limit of reporting (i.e. a measureable concentration was not detected), it can not be categorically stated that the concentration in the sample was also below the relevant criteria value. For these 26 analytes, it is possible that the air concentrations in some samples may have exceeded the reference criteria value i.e. above the criteria value but below the limit of reporting. It is impossible to identify which analytes or samples to which this important qualification might apply. It is equally possible that some, or even all, of these analytes were not present in the air at concentrations above the reference criteria or that they were even present at any measureable concentration if a more sensitive sampling and analysis methodology had been used for the program. It may also be the case that none of these 26 analytes are even related to CSG activities in the area, so their presence, if any, could be unrelated to CSG activities. It would have been helpful for more detailed analysis to have been included in the ERM report given this dilemma brought on by reference criteria that are significantly below the limits of reporting of the sampling and analytical techniques used for the air sampling.

Despite these qualifications, it remains the case there was only one analyte in any of the 13 samples that demonstrably exceeded its reference criteria. This was the benzene concentration of 25 µg/m^3 in one of the two samples collected at one site. This result appears to relate to a 12-hour sample (approximately), whereas the NEPM reference value is an annual average of 10.3 µg/m^3. The 12 remaining benzene results were reported as <5.9 µg/m^3 or lower. Benzene is a confirmed human carcinogen and the NEPM reference value is based on limiting the risk of cancer to acceptable levels following lifetime exposure (nominally 70 years) to benzene. The second air sample (also approximately a 12-hour sample) at the same property was reported as <4.3 µg/m^3, meaning the 24-hour average for the property would have been approximately 13.5 µg/m^3. This average assumes the value of the second result (reported as <4.3 µg/m^3) is assumed to be half the limit of reporting (i.e. 2.2 µg/m^3). Using half the limit of reporting is a common method used to derive statistics for results which are below the level of reporting.

Neither the measured level of 25 µg/m^3, nor the estimated 24-hour average of 13.5 µg/m^3, is sufficiently high to be associated with acute impacts on health. The NEPM reference value (10.3 µg/m^3) is an annual average calculated to reduce the risk of cancer from a lifetime of exposure at that level. While that site can be calculated to have experienced a 24-hour average approximating the NEPM reference value on the day that testing occurred there, all other lots experienced results that were clearly below the NEPM reference value. The explanation of this single result is unknown, but the ERM report advises ‘Benzene is not a compound that is found in CSG and this cannot be attributed to CSG activities but rather from a local source such as smoking, etc.’

In the context of a further 12 samples, including one at the same property, that are all reported as <5.9 µg/m^3 or lower, it is considered that this result is an outlier which is not reflective of the general ambient air quality in the area. It is likely there is a local explanation for the result, rather than it being explained by CSG or any other industrial activities impacting on the region’s air shed. For example, it may relate to benzene emissions from sources such as petrol or smoking on the property in question near to where the sample was collected. These are given simply as examples of common alternative source of benzene which may explain this single outlier result.

Despite the qualifications the Department of Health places on the evaluation in the ERM report about the air monitoring results, it remains that the air monitoring did not identify any analytes at detectable concentrations that would be expected to be associated with adverse health effects of the type reported by residents. The air monitoring results outlined in the ERM report do not provide an explanation of the symptoms reported by residents of the area. However, the air monitoring program had important limitations. The total monitoring period was nine days, the methodology resulted in limits of reporting for some analytes that were substantially higher than reference air quality criteria and the monitoring was not designed to identify short-term peaks or troughs in air concentrations. It is considered a more strategic air quality monitoring program could be implemented to provide more useful information on the impacts of the CSG industry, if any, on ambient air quality in the region.

4.1.2. Water monitoring

Aspects of the ERM report concerning water relate to the same nine residential lots in the Wieambilla Estate. Samples were collected from potable drinking water sources (all nine lots) and ponds and surface water sites (five lots). The samples were analysed by SGS Leeder and compiled into the report by ERM. Over 90 chemical, physical and microbial parameters are included in the report (Table 1 of the ERM report). The water quality data were assessed against the health and aesthetic parameters of Australian Drinking Water Guidelines (ADWG) (National Health and Medical Research Council (NHMRC) and National Resource Management Ministerial Council (NRMMC) 2011).

Table 1: Physical, chemical and microbial properties of water included in the ERM report

Property	Specific parameters
Physical Properties	pH, conductivity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), Biological Oxygen Demand(BOD)
Cations/Anions	Sodium, potassium, calcium, magnesium, chloride, fluoride, carbonate (as $CaCO_3$), bicarbonate (as $CaCO_3$), hydroxide (as $CaCO_3$), sulphate (as SO_4^{2-}), total phosphorous, nitrate, nitrite, total nitrogen, cyanide Total anions, total cations, total alkalinity, Sodium Adsorption Ratio (SAR)
Metals (Total and dissolved)	Aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silica (SiO_2), silver, strontium, vanadium, zinc
Total Petroleum Hydrocarbons	C_6-C_9, C_{10}-C_{14}, C_{15}-C_{28}, C_{29}-C_{36} and Total C_6-C_{36}
PAHs (Polycyclic aromatic hydrocarbons)	3-Methylcholanthrene, 7,12-Dimethylbenz(a)anthracene, Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(ghi)perylene, Benzo(k)fluoranthene, Benzo(a)anthracene, Chrysene, Dibenz(ah)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Naphthalene, Phenanthrene, Pyrene
Phenols	2,3,4,6-Tetrachlorophenol, 2,4,5-Trichlorophenol, 2,4,6-Trichlorophenol, 2,4-Dichlorophenol, 2,4-Dimethylphenol, 2,4-Dinitrophenol, 2,6-Dichlorophenol, 2-Chlorophenol, 4-Chloro-3-methylphenol, 2-Methyl-4,6-dinitrophenol, 2-Nitrophenol, 4-Nitrophenol, Dinoseb, Hexachlorophene, *m* & *p*-Cresol, o-Cresol, Pentachlorophenol, Phenol
BTEX	Benzene, ethylbenzene, toluene, *m* & *p*-xylenes, o-xylene
Microbial	Coliforms, thermotolerant coliforms, faecal coliforms, *E. coli*, standard plate count

Assessing the suitability of water for use at the properties where samples were obtained requires the comparison of test results with the appropriate standard. According to the ERM report, all properties reported use of roof-harvested water for drinking and most household purposes. Two properties reported use of on-site ponds or surface water created by a dam for washing and bathing. The Department of Health recommends that the quality of water used for domestic purposes, other than toilet flushing and laundry, should be assessed against the ADWG. For all other uses, water is more appropriately assessed against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Chapter 5, Guidelines for Recreational Water Quality And Aesthetics (ANZGFMWQ) (NWQMS, 2000). However, the ERM report has assessed all water against ADWG guidelines, distinguishing health from aesthetic criteria, without regard to the source or use of the water. The ADWG are generally a more conservative standard, and therefore exceedances for non-potable water use may not necessarily represent a health risk.

In addition, the ERM report in Section 7.2 summarises the results for dissolved metals, rather than total metals, the latter being more relevant to human health and generally more conservative. The following discussion refers to the data in Table 1 of the ERM report (*Summary of Water Analytical Results Environmental Health Assessment Report – 0181432*) using the analytical results for total metals.

Potable drinking water

The ERM report identified four physical or chemical parameters where the drinking water quality exceeded the ADWG: pH, aluminium, cadmium, and zinc. It is noted that the report identified an exceedance for lead at one site. In that case, the reported result was equal to the guideline value and is therefore not considered an exceedance for this review. Four rainwater tanks were not within the ADWG guideline range (6.5–8.5) for pH (three were low at 4.5, 6.0 and 6.4, and one was elevated at 8.9). One rainwater tank exceeded the aesthetic guideline concentration for aluminium (reported as 0.022 mg/L; ADWG aesthetic guideline 0.02 mg/L). Two rainwater tanks exceeded the cadmium health guideline value (reported as 0.0023 mg/L and 0.0025 mg/L; ADWG 0.002 mg/L) and the zinc aesthetic guideline value (4.8 mg/L and 5.4 mg/L, aesthetic guideline 3 mg/L).

With the exception of cadmium, all reported exceedances were for aesthetic parameters. The ADWG suggests that untreated water, with no obvious sources of contamination, that does not meet aesthetic parameters should be assessed on historical data. Further investigation and corrective action would be recommended only if test results were outside normal operating limits. The exceedances reported for these aesthetic parameters were all slightly outside the guideline values and would not be expected to represent an immediate or long-term health risk. Therefore, based on the aesthetic chemical parameters, the drinking water supplies are fit for purpose, although some would benefit from pH adjustment.

In the case of the two samples where cadmium exceeded the guideline value, the results were marginal elevations of the ADWG health guideline value. The ADWG notes that the World Health Organisation (WHO) guideline value for cadmium in drinking water is slightly different (higher) at 0.003 mg/L due to rounding in the calculation. The reported results do not exceed the WHO guideline value. As the ADWG concludes that the difference between the ADWG and WHO guideline values is not significant, the drinking water supplies would also be considered fit for purpose based on the health chemical parameters. The ADWG notes that cadmium may be found in drinking water due to impurities in the zinc of galvanised pipes or in solders used in plumbing fittings. The occurrence of elevated zinc in the same locations as the two elevated cadmium results suggests that further investigation into the storage or plumbing of drinking water supplies at those locations may be worthwhile.

Although the ERM report included the results of five types of microbial testing, the ADWG includes a health guideline value for one, E.coli. Two rainwater tanks were reported to contain E.coli, but all tanks had some type of microbial contamination as demonstrated by the other testing. The presence of microbes is expected in both roof-harvested water and untreated surface water. Further microbial analysis would be needed to identify potential health hazards. In situations where infants, the elderly and immune-compromised (e.g. dialysis, HIV, cancer patients) may consume the water, it is recommended that roof-harvested water be boiled before drinking and for personal hygiene uses such as teeth cleaning. In addition, appropriate control measures should be used to manage the quality of this water, as provided in Guidance on the use of rainwater tanks (enHealth, 2010).

Non-potable water

The analysis of water from ponds and surface water identified four physical or chemical parameters that were above the guidelines: total dissolved solids, aluminium, iron and total silica. The ERM report incorrectly identifies an exceedance of silver for one site in Table 6 (page 22 of report), whereas the summary data table (Table 1) and the laboratory reports in Annex D of the ERM report indicate that silver was not detected in any samples for this property. Two ponds had an elevated total dissolved solids result (reported as 640 and 1300 mg/L; both above the ADWG value of 600 mg/L, but only one was above the ANZGFMWQ value of 1000 mg/L). Three ponds had elevated concentrations of both aluminium (reported as 1.4, 0.94 and 2.7 mg/L; ANZGFMWQ guideline value 0.2 mg/L) and iron (reported as 1.3, 2.1, and 1.7 ; ANZGFMWQ guideline value 0.3 mg/L). One pond had an elevated concentration of aluminium (reported as 9.3 mg/L) and another had an elevated concentration of iron (reported as 0.57 mg/L). There is no ANZGFMWQ guideline value for silica in recreational water. However, three dams had silica concentrations (250, 380 and 640 mg/L) above the ADWG value of 80 mg/L. These values for aluminium, iron and silica are within the range expected for surface waters based on the soil composition in the area (and typical of western Queensland and New South Wales). Based on the physical and chemical properties, the pond water sampled was generally fit for purpose.

As with the drinking water, the surface water testing found microbial activity in all samples. All ponds had a standard plate count greater than 300 cfu/100mL, with four of the five ponds also showing E. coli activity, which is an indication of faecal contamination. Two ponds grossly exceeded the ANZGFMWQ guideline value for faecal coliforms (reported as 3,600 and 15,000 cfu/100mL; ANZGFMWQ value 150 cfu/100mL). Further microbial analysis would be needed to identify potential health hazards. Primary contact, such as swimming, bathing or other direct water-contact sports would not be recommended for these two ponds with high faecal coliforms. It should also be avoided in the other two ponds because of some evidence of faecal contamination. A water management program for the ponds should be strongly considered. Although the high bacterial levels observed in most of the pond water samples are an indication of a potential health hazard, such contamination is due to human and/or animal faeces rather than contamination by CSG water or other CSG emissions.

Schoeller diagrams

At the request of the Department of Health, ERM prepared Schoeller diagrams for each water sample (Annex E of ERM report). Schoeller diagrams provide a visual reference of the common ion profile of the water sample. CSG water has a distinctive common ion profile, comprising low concentrations of sulphate, calcium and magnesium, and high bicarbonate (Van Voast, 2003). This profile is useful in determining if a water source, particularly a groundwater source, has been impacted by CSG water. Based on the Schoeller diagrams and the chemical analyses provided, the water quality profiles at these nine residential sites did not match the expected profile of water that has been impacted by CSG water.

In summary, the evidence from the ERM report does not indicate that residents' reported health symptoms are due to CSG impacts on their supplies of roof-harvested water or dam water.

4.1.3. Soil monitoring

The soil monitoring component of the ERM report relates to soil samples taken from the same nine residential properties in the Wieambilla Estates at Tara. Eight properties had four samples taken. The remaining property had five samples taken. Sampling at five properties included the property's vegetable patch. For another two properties the samples included the 'garden'. The remaining samples were representative of surface soil generally on the respective properties. The samples were analysed for:

- pH
- moisture
- conductivity
- texture
- metals
- exchangeable metals
- total nitrogen
- total phosphorus
- total carbon.

From a human health perspective, the metal and pH analyses are relevant. The other analyses relate to soil fertility and plant growth considerations (Hamza, 2008). Metal analyses for all samples comprised aluminium, boron, calcium, copper, iron, magnesium, manganese, molybdenum, potassium, sodium, sulphur and zinc. Public health guidance on soil contamination is provided in the National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM). In particular, health investigation levels (HILs) are outlined in Schedule B(7a) of the NEPM (EPHC, 1999). These were the criteria used in the ERM report to evaluate the soil results. The ERM report concluded that 'no constituents were reported in soil above health risk criteria'. The Department of Health considers this conclusion requires qualification.

Of the metals included in the analyses, HILs have been developed for only boron, copper, manganese and zinc. The other metals included in the analyses are not normally regarded as toxic soil contaminants and HILs have not been required for public health purposes. Of the metals included in the analyses that have an HIL, all reported concentrations were less than the relevant HIL for residential land.

However, the soil samples were not analysed for all metals that have HILs listed in the NEPM. Metals with HILs that were not analysed were arsenic, beryllium, cadmium, chromium (III), chromium (VI), cobalt, lead, inorganic mercury and nickel. These metals are of more relevance to public health considerations of soil contamination. It would have been preferable if analyses for these metals had been done for the soil monitoring program. However, there is no reason to expect that the background soil concentrations of these metals would increase significantly as they are not anticipated emissions of CSG activities.

In regard to pH, reported levels ranged from 4.8–6.7 (median 5.9). These levels would not be expected to pose a risk to health from direct skin contact with the soil.

In summary, the reported soil results are not remarkable from a public health perspective. They do not indicate any obvious impact from CSG activities in the area. It is considered that the reported soil results do not provide any evidence relevant to the symptoms reported by residents. The metals with Australian HILs which were not analysed are not considered likely explanations of the reported symptoms, nor is it expected that CSG activities in the region would be impacting on background soil concentrations of those metals.

4.2. Department of Environment and Heritage Protection environmental monitoring

4.2.1. Air monitoring – Department of Science, Information Technology, Innovation and the Arts Report

The Department of Environment and Heritage Protection (DEHP) initiated an odour sampling program in the Wieambilla Estate. It commissioned the Department of Science, Information Technology, Innovation and the Arts (DSITIA) to assist. The report (Appendix 4) outlines the methodology and results.

Two air monitoring methods were used. First, nine short-term (30–60 seconds) air samples were collected in evacuated summa canisters. The intent was to collect samples when odour was worst with the aim of determining peak levels of VOC volatile organic compounds. Four residents collected six samples, DEHP field staff collected two samples in the coal seam gas fields area and a control sample was collected by DEHP field staff in the Barakula State Forest some 38 kilometres north of Chinchilla. The samples were collected between 3 July to 6 December 2012. Secondly, monitoring to determine long-term average air concentrations of VOC was conducted at four locations in the Wieambilla Estate and a control location in Chinchilla. This sampling was undertaken for three weeks in the period 26 September to 16 October 2012. The results from this monitoring provide an indication of long-term average ambient air concentrations as opposed to the very short-term peaks from the summa canister sampling.

The results from the sampling were compared with relevant health-based ambient air quality criteria as outlined in the report. For four substances, occupational exposure guidelines were referenced as there were no available ambient air criteria.

The results of the summa canister sampling show that 3–7 VOC were detected in each of the nine samples. These detections represent very short-term peak levels (30–60 seconds) and none exceeded their short-term (1-hour) reference criteria. The majority of the results were substantially below the respective reference criteria. Acrolein was reported at 0.5–0.6 ppb in two residential samples and the Barakula State Forest control sample. Ontario and Texas have adopted 1-hour reference criteria of 2.0 and 1.6 ppb respectively. Neither was exceeded. The Ontario 24-hour criteria is 0.17 ppb and the Texas annual criteria is 0.066 ppb, but it would be incorrect to attribute concern to the 30–60 second results of 0.5–0.6 ppb given these raw values exceed those 24-hour and annual reference criteria respectively. Acrolein is an acute irritant, but as the exposure period decreases e.g. from 24 hours (or even annual) to just a few minutes, an acceptable exposure level increases. Thus, comparing the summa canister results for acrolein with 24-hour and annual average criteria is not appropriate. It also should be noted that the passive sampling over three weeks did not identify the presence of acrolein. In summary, the summa canister sampling did not identify any VOC contaminants at levels that would be expected to be associated with adverse health effects.

In the case of the passive sampling, all results, with the exception of a single benzene result reported for one residence were well within relevant reference criteria. That sample was reported as 0.6 ppb, whereas the other four samples were all reported as <0.17 ppb. The DSITIA report identifies three reference criteria for annual average exposure to benzene. These criteria are 3 ppb (the Queensland EPP Air), 1.4 ppb (Texas) and 0.13 ppb (Ontario). Thus, the reported result of 0.6 ppb meets the Queensland and Texas reference values, but exceeds the Ontario reference value. Previous comment was made in this summary assessment in regard to a single benzene result in the ERM report. In comparison to the other four passive sampling results, including three from within the Wieambilla Estate, this single result of 0.6 ppb at one residence appears to be an outlier. For further comparison, the Air Quality Bulletin for South-East Queensland dated October 2012 (the most recent monthly report available online) shows that monthly maximum 24-hour benzene levels at the Springwood site in Brisbane ranged from 0.9–1.3 ppb during November 2011 to October 2012 (DSITIA, 2012). The annual average level at Springwood for 2011 (the most recent year for which an annual average has been reported online) was 1.1 ppb (DERM, 2011). Thus, the result of 0.6 ppb reported for one residence, while higher than the other four results, is still lower than typical ambient air concentrations reported for benzene at the long-term monitoring site for South-East Queensland at Springwood. As discussed previously in regard to the ERM report, it is considered this pattern of results of a single higher result at one property is more likely to be explained by a very local source of benzene rather than a generalised impact on ambient levels within the Tara region. In any case, the reported concentration of 0.6 ppb is not sufficiently high to be associated with acute health effects such as those symptoms reported by some residents in the area.

The DSITIA report does not indicate unacceptable short-term or longer term air concentrations of VOC. The monitoring data do not show air contaminants at concentrations that would be expected to be associated with adverse health effects. It is feasible that some contaminants may have been detectable as transient odours, but the reported concentrations from both monitoring methods do no suggest that exposure would pose likely risks of adverse health effects.

4.2.2. Noise monitoring

DEHP undertook noise monitoring at a single residence in the Wieambilla Estate from 31 July 2012 to 6 December 2012 due to concerns by residents regarding low frequency noise. Low frequency noise is normally considered to be noise with a frequency range of 10 Hz to 200 Hz (Leventhall, 2003). Noise measurements were recorded approximately ten metres from a residential house using two logging sound level meters. Noise measurements were recorded as A-weighted, C-weighted and linear sound pressure levels. Linear 1/3 octave noise levels from 6.3 Hz to 20 kHz were also recorded. Assessment of the noise monitoring data by DEHP was limited to three time periods identified by the resident as causing noise impacts and two other randomly chosen time periods for comparison.

Environmental noise is normally composed of a complex mixture of many different frequencies which may include discrete frequencies and broad frequency ranges. To enable noise to be expressed in a simple manner which accounts for the importance of different frequency components, different frequency weighting networks have been defined. The A-weighting is the most commonly used and approximates the response of the human hearing system. It filters out the low frequency components which, at the same level, the hearing system does not respond to as well as the mid and high frequency components. C-weighting is also commonly used where filtering of only very high or very low frequencies is required. The difference between the A-weighted and the C-weighted levels gives an indication of the amount of low frequency noise present (Berglund, Lindvall and Schwela, 1999). If the difference exceeds 20 dB further investigation is generally required.

The measurements were taken by DEHP to check compliance with the low frequency noise requirements in the Environmental Authority PEN100020207 for the QGC Kenya Central Coal Seam Gas Processing Facility and not specifically for assessing health impacts. DEHP concluded that 'while low frequency noise was detected, the level was not high enough to result in a breach of the conditions in Environmental Authority PEN100020207'. However, it was acknowledged in the DEHP report that the level of the low frequency noise had the potential to result in annoyance, even though it did not breach the conditions in the environmental authority.

Annoyance is generally accepted as being one of the major effects of exposure to environmental noise. Berglund, Lindvall and Schwela (1999) defined annoyance as '*a feeling of displeasure associated with any agent or condition, known or believed by an individual or group to adversely affect them*'. The level of annoyance from low frequency noise depends on the level and duration of the noise and also on non-acoustical factors such as the individual's noise sensitivity, fear with respect to the source, attitude towards the source and perceived control over the situation (van Kempen, Staatsen and van Kamp, 2005). Other health related effects of low frequency noise include stress, irritation, unease, fatigue, headache, possible nausea and disturbed sleep (Casella Stanger, 2001). Sensitisation to low frequency noise often occurs over time, resulting in the person becoming more aware of the noise and not being able to shut it out or get used to it. Other people may not be able to hear the low frequency noise as it may be close to or below their threshold of hearing and/or its importance may be underestimated (Moorhouse, Waddington and Adams, 2005). Berglund, Lindvall and Schwela (1999) noted that 'a large proportion of low frequency components in noise may increase considerably the adverse effects on health'.

The noise monitoring undertaken by DEHP was at just one location in the Wieambilla Estate, but it identified periods where the difference between the C-weighted and A-weighted sound levels exceeded 20 dB. This indicates that low frequency noise may be a problem. DEHP was unable to identify the source of the low frequency noise, but assumed in its report it was coming from the QGC Kenya Central Coal Seam Gas Processing Facility due to its location relative to the monitoring site. It is feasible that some headaches reported by some residents may be due to low frequency noise. However, low frequency noise does not provide an explanation for other commonly reported symptoms of eye irritation, nosebleeds and skin rashes.

If concerns continue in the community about low frequency noise, additional assessment by DEHP and/or industry stakeholders may be required even though the conditions in the environmental authority are being complied with at the one site where noise monitoring was undertaken. This would be needed to determine if low frequency noise is a significant issue across the area and if noise mitigation measures are required.

4.2.3. Water monitoring

This assessment is based on roof-harvested and dam water supplies that are potentially used for drinking and other household purposes. These are the potential sources of residents' exposure to water that may be relevant to their health complaints. DEHP advised it had very little water monitoring data that would be relevant to this aspect of the assessment of the residents' health complaints. It is considered the data in the ERM report from the QGC monitoring program is sufficient to assess the impacts of CSG activities on residents' roof-harvested and dam water supplies, and any potential links to residents' health complaints.

4.3. Southern Cross University research on fugitive methane, carbon dioxide and radon

Two documents based on research from Southern Cross University, Lismore, were reviewed.

The first was a submission to the Department of Climate Change and Energy Efficiency in October 2012. It relates to a new mobile method for measuring fugitive methane and carbon dioxide emissions in a CSG setting. It is understood the method and results have not been published in a peer-reviewed publication to date. The data described in the document are taken on their face value for the purposes of this assessment.

Methane and carbon dioxide measurements were recorded serially over a wide land area in a CSG area, including the Tara region, for comparison with similarly collected measurements in non-CSG areas to the south of Tara, including northern New South Wales. Methane concentrations in the CSG area ranged from <2 ppm [~1.77 ppm] (parts per million in air) to a peak of 6.89 ppm. In the non-CSG areas, concentrations ranged from 1.78–1.94 ppm. Carbon dioxide concentrations ranged from 388–541 ppm in CSG areas, with non-CSG areas recording concentrations of 390–423 ppm.

Methane has two relevant properties in regard to human health from direct exposure:-

1. Methane is a simple asphyxiant if its concentration in air is high enough to cause a sufficient reduction in the inhaled oxygen concentration. In this circumstance, symptoms from lack of adequate inhaled oxygen can occur. The oxygen concentration of the atmosphere's dry air is normally reported as 20.95 per cent (~209 500 ppm). The peak reported methane level of 6.89 ppm would have a negligible impact on this normal oxygen concentration and no impact on human health from direct exposure.

2. Methane is an explosive gas at concentrations of 5-15 per cent (~50 000-150 000 ppm) in air. The peak level measured is over 7 000 times lower than methane's lower explosive limit.

Carbon dioxide is produced as a waste by the body during normal cellular respiration. It is excreted by exhalation during respiration. The concentration of carbon dioxide in exhaled air is approximately 4-5 per cent (40 000–50 000 ppm) compared to its typical concentration in inhaled air of approximately 0.04 per cent (~400 ppm). Inhalation of up to 541 ppm carbon dioxide, the peak level reported in the CSG area, is of no clinical significance.

The data reported by the Southern Cross University researchers in their submission to the Department of Climate Change and Energy Efficiency is relevant to considerations of total fugitive greenhouse gas emissions from CSG deposits and activities undertaken to collect CSG resources. However, the reported results have no bearing on the specific health complaints of residents in the Tara region.

The second document was an article published on 27 February 2013 (as a Just Accepted Manuscript) in Environmental Science and Technology. The aim of the study was to assess whether atmospheric radon-222 and carbon dioxide concentrations were elevated within a coal seam gas field. The study hypothesises that radon-222 may be used as a marker to indicate the presence of other gases released as fugitive emissions from coal seam gas extraction activities. The study involved measuring radon-222 and carbon dioxide concentrations at five locations inside (three sites) and outside (two sites) a coal seam gas field over a 24-hour period. The study reported a three-fold increase in maximum radon-222 concentration inside the gas field compared to outside of it.

The study was not conducted to collect data for the purposes of a health assessment and the authors do not express any health related concerns about their findings. As noted in the report, the radon-222 concentration varied throughout the 24-hour period. At the control location outside of the gas field, the average radon-222 concentration was 3.5 Bq/m^3 (approx), and the maximum was 8.5 Bq/m^3 (approx). At the location within the gas field where the highest radon levels were measured, the radon-222 concentration was an average of 7.7 Bq/m^3 (approx) and a maximum of 26 Bq/m^3 (approx).

For comparison:

- UNSCEAR (1993) reports an average radon concentration in outdoor air of 10 Bq/m^3
- ARPANSA (2012) reports that the average concentration of radon in Australian homes is about 11 Bq/m^3
- The recommended action level for radon-222 in indoor air is 200 Bq/m^3, and for workplaces it is 1 000 Bq/m^3 (ARPANSA, 2002). These action levels are set at levels where it may be useful in deciding whether any countermeasures need to be taken to reduce or avoid exposure. All of the radon-222 concentrations observed during the study are well below the levels at which action needs to be considered.

The average concentrations of radon-222 observed during the study are similar to natural background levels and do not raise concerns about adverse health effects. The results do not explain the symptoms reported by the residents.

Similarly, the carbon dioxide levels reported in the paper (average 24-hour levels of ~390 ppm at the control site up to ~467 ppm near the centre of the gas field) are of no clinical significance from direct exposure. These results do not explain the symptoms reported by the residents.

5. Discussion

The fundamental issue underlining this assessment is the concern among some residents in the Tara region that various symptoms they have experienced are related to CSG emissions. The intent of this assessment is to evaluate current information on the health complaints and environmental health determinants with a view to determining, as best as is possible, whether there is any likely association between CSG emissions and the complaints. If a likely association can be identified, measures to address any putative factors can be investigated and implemented. Alternatively, if a likely association can not be identified, greater assurance can be given to the community that emissions from the CSG industry are not considered to be having adverse health impacts.

Review of the two reports dealing with the clinical aspects of the complaints does not reveal clear evidence associating reported symptoms with CSG emissions. The most prevalent reported symptoms are headache, transient (reversible) eye irritation, nosebleeds and skin rashes. All of these are common medical complaints generally, as reflected by the following data.

- WHO (2012) reports an estimated 47 per cent of the adult population suffered a headache at least once within the last year and 1.7–4 per cent of the world's adult population have headache on 15 or more days every month.
- Various surveys of the prevalence of skin conditions in Australia have been reported (Marks, Plunkett, Merlin et al, 1999). These data show that the prevalence of self-reported skin disease, including eczema/dermatitis, is significant in the Australian community generally:
  - The national health survey by the Australian Bureau of Statistics in 1989–90 found 12.7 per cent of the population reported a disease of the skin and subcutaneous tissue within the previous two weeks.
  - In 1996-97, the School Skin Survey of 2491 children in urban and rural Victoria found 54 per cent of school children aged four to 18 years were reported by themselves or their parents as currently having at least one of the following common skin conditions, such as acne/pimples, eczema/dermatitis, tinea/ringworm, and warts/papilloma. In particular, in the context of the skin rashes reported by Tara residents, eczema/dermatitis was reported by the students or parents in 15.6 per cent of children in that survey.
  - The Maryborough Skin Health Survey in 1997–98 was a computer-assisted telephone interview survey in Maryborough, Victoria of 1457 adults aged 20 years and over. It found 27 per cent of people self-reported one or more skin conditions over the previous two weeks and 59 per cent self-reported at least one skin condition over the previous six months. In regard to self-reports of dermatitis/eczema in particular, the prevalence was 25.5 per cent in the previous two weeks and 12.6 per cent in the previous six months (excluding the previous two weeks).
  - The Tiny Tots Survey in 1998–99 of 1116 pre-school children aged from birth to five years found 49 per cent were reported by their parents to have skin disease. For eczema/dermatitis, the reported prevalence was 29.4 per cent.
- In regard to eye irritation:
  - A cross-sectional prevalence study compared residents near a chemical waste site at Kingston (south of Brisbane) and a control site at Beenleigh (Dunne, Burnett, Lawton et al, 1990). Chronic eye irritation in the previous six months was reported by 34 per cent of the Kingston respondents (n=257) and 11 per cent of the Beenleigh respondents (n=105).
  - A report by NSW Health (2003) states that the prevalence of eye, nose and throat irritation in the community is difficult to quantify. It cited a study of 2060 Danes in whom the prevalence of work-related irritation of the eyes, nose and throat was 16 per cent, whereas 7 per cent of subjects reported having irritation at home.
- In regard to nosebleeds, lifetime incidence in the general population is estimated at 60 per cent, though fewer than 10 per cent seek medical attention. Peaks in incidence occur in children under 10 years of age and adults older than 45 years of age (Medscape Reference, 2011; NICE, 2011).

The complaint data in the DDPHU report suggest the overall period prevalence of complaints of specific symptoms within the total resident community is low compared to these comparison prevalence data for headaches, skin rashes and eye irritation. As the reference data for nosebleeds relate to lifetime incidence, a direct comparison can not be made. The data in the DDPHU report also suggest that complaints are generally of low clinical severity as complaints relatively rarely (~17 per cent of complainants) have resulted in attendance at the local GP or hospital for assessment or treatment and there have not been any hospital admissions reported. It is recognised that the complaint data might be affected by under-reporting for various reasons. However, the overall impression from the health complaint data is that the reported symptoms do not reflect a distinct or unique clinical pattern within the Tara region of increased symptoms over what reasonably could be anticipated in any community setting.

There are many potential causes of each symptom. For a specific factor/s to be a common cause of these symptoms, whether CSG-related or not, there would need to be exposure at levels sufficiently high to induce effects. For example, various hydrocarbon chemicals in air can induce headache or irritate the eyes, but these effects are not seen until exposure levels exceed a threshold for each particular substance or mixture of substances. Different substances and mixtures have different threshold levels for different clinical effects. In regard to skin rashes, there are many substances that can cause skin irritation or damage to the extent of inducing an observable skin rash e.g. dermatitis, but this typically requires direct skin contact usually with the substance in liquid or solid form. The skin is an effective barrier with the capability to resist damage from potential hazards unless the exposure is sufficient to breach its normal defensive mechanisms. For the combination of headache, eye irritation, nosebleeds and skin rashes to be caused by associated agents, presuming an origin from CSG activities, it is considered there would need to be significant exposure to the agent/s and such exposure would be expected to be evident from environmental monitoring data that was comprehensive in scope. Nosebleeds could be a potential consequence of mucosal damage due to chronic nasal irritation. However, the evidence from the clinical assessments does not indicate that such damage has occurred in individual cases. No significant nasal mucosal damage has been reported and no recent bleeding sites were observed following clinical examination. Also, if clinically significant nasal irritation from airborne irritants was occurring to the extent of inducing mucosal damage and bleeding, it would be likely to be associated with irritant effects on other parts of the respiratory tract (both upper and lower), but this is not reflected in the complaints.

The DDPHU report discusses other factors that could be relevant to some symptoms. For example, exposure to smoke from domestic wood heaters and open fires, if sufficiently high, could cause symptoms such as headache and eye irritation. However, typical exposure to smoke from domestic wood heaters and open fires generally would not be expected to be associated with nosebleeds or skin rashes. Similarly, microbiological contamination of rainwater sources used for drinking purposes might be relevant to some symptoms such as nausea and vomiting. However, there is no obvious link between microbial water contamination and other symptoms such as long-term headaches, nosebleeds and transient eye irritation that is worse when outside the residence. It is important to note that most of the dam water samples reported in the ERM report indicate microbial contamination, including faecal contamination from human and/or animal sources. This could be relevant for some symptoms reported by some residents (e.g. nausea, skin rashes, eye problems) if residents at such sites use these water sources for direct recreational contact or other purposes.

Review of the reports dealing with environmental monitoring of air, water and soil did not identify evidence of exposure to potential emissions from CSG emissions that could be anticipated to be associated with adverse health effects within the residential community. In particular, there were no air monitoring data that indicated exposure to CSG emissions that would be likely to be associated with the most commonly reported symptoms of headaches, eye irritation, nosebleeds or skin rashes. The air monitoring data in the ERM report has limitations such as detection limits for some analytes exceeding reference criteria, sampling covered a limited time period and the sampling methodology related to average levels over the sampling period rather than potential short-term peaks. Given these limitations, it is feasible that short-term peaks in levels of some airborne contaminants might explain some complaints relating to reversible eye irritation, headache and odour. However, the short-term (summa canister) air monitoring outlined in the DSITIA report did not reveal any air concentrations of VOC that might be expected to be associated with adverse health effects. In the absence of any specific monitoring data showing exposure to unacceptable air concentrations of any contaminants, it is not possible to link reported symptoms to the CSG activities or any other source. Similarly, there were no results in the water or soil sampling that can associate the reported symptoms with emissions produced by CSG activities.

As mentioned in Section 3.2, Dr Adam made a number of observations that were unrelated to his clinical assessment of the residents who participated in his clinics. First, potential health effects were not the only concern of residents. Residents also reported environmental concerns and distress about the CSG companies being able to establish wells without necessarily securing the agreement of all stakeholders. This latter point, if correct, could be a significant cause of distress which could impact on the overall health and well-being of disaffected residents. The potential mental health effects of such impacts may need further evaluation and response within the affected community.

Secondly, Dr Adam commented about whether there has been adequate coordination between government agencies and

CSG companies that have undertaken environmental monitoring, and the feedback of such information to residents. The Department of Health recognises this concern. This assessment is one step to providing a consolidated point of feedback in regard to residents' health complaints and available environmental monitoring data. However, this observation needs to be considered into the future in regard to the overall governance of the CSG industry from a community perspective.

Thirdly, Dr Adam commented on the importance of a comprehensive communication strategy to ensure that the community is kept well informed with a view to regaining community confidence. He commented on the importance of a single organisation or agency being responsible for overall coordination.

Finally, Dr Adam commented on the complaints of noise and vibration, particularly at night. He is uncertain of the potential cause/s, but speculated about the possibility it may be related to high-pressure piston pumps. The Department of Health agrees with Dr Adam that this issue may warrant further investigation by relevant regulatory authorities and industry stakeholders to ensure that community noise and vibration from CSG activities is maintained within acceptable limits.

6. Conclusions

Based on the clinical and environmental monitoring data available for this summary risk assessment, a clear link can not be drawn between the health complaints by some residents in the Tara region and impacts of the local CSG industry on air, water or soil within the community. The available evidence does not support the concern among some residents that excessive exposure to emissions from the CSG activities is the cause of the symptoms they have reported.

The air monitoring provided to the Department of Health was sufficient to assess whether the reported symptoms were related to CSG activities. However, the available data were insufficient to properly characterise any cumulative impacts on air quality in the region, particularly given the anticipated growth of the industry. It is necessary to assess those impacts according to health-based standards which are relevant to long-term exposure.

Noise and vibration from CSG activities were common complaints. The DEHP report on its community noise investigation at one site showed that low frequency noise did not exceed the relevant environmental authority. However, there was acknowledgement that the levels could be a source of annoyance. A potential consequence in some people of noise annoyance can be headache, which was the most reported symptom. Conversely, noise annoyance would not explain other commonly reported symptoms such as eye, nose and throat irritation, nosebleeds or skin rashes. If concerns continue in the community about low frequency noise, additional assessment by DEHP and/or industry stakeholders may be required to determine if noise mitigation measures are required.

Whilst no emissions from the CSG activities are apparent that can explain the reported symptoms, the DDPHU report identified the issue of solastalgia. This term describes the distress that is produced in people by environmental change in their home environment. Negative effects can be exacerbated by a sense of lack of control over the unfolding change process in a person's normal environment (Albrecht, Sartore, Connor et al, 2007).

7. Recommendations

a. The CSG industry is predicted to expand significantly throughout Queensland. Given the level of community-wide concern with CSG expansion, it is recommended that relevant government agencies establish mechanisms to ensure a coordinated response to community and social aspects identified in this report. For example, a community reference group drawn from CSG areas may assist in the identification of health, community and social concerns at a community level and in the development of appropriate responses.

b. The Department of Communities, Child Safety and Disability Services take a lead role in advising on community support initiatives that can be implemented in areas where there are significant concerns about the impacts of CSG development.

c. Regular, timely and accurate information be provided to communities in CSG areas in relation to health, community and social concerns, including the feedback of information on environmental monitoring activities.

d. That a strategic ambient air monitoring program be established by DEHP to monitor overall CSG emissions and the exposure of local communities to those emissions. This could be based on consolidation of existing air monitoring undertaken by DEHP and industry, with supplementation where insufficient data exists. This would allow improved identification of any current and future impacts of CSG activities on ambient air quality. The Department of Health would provide health-based guidance on the design of the program and participate with other agencies in the review and reporting of results. Key elements to include are:

- identification of analytes that are known or reasonably likely to be associated with CSG activities
- identification of relevant health-based reference criteria for each analyte prior to determining sampling and analysis methods. these should include short-term and/or long-term criteria (i.e. criteria for short-term peaks and longer term averages) as appropriate for each specific analyte
- use of sampling and analysis methods that will achieve limits of reporting that do not exceed the health-based reference criteria for each analyte.

e. Noise and vibration have been identified as significant concerns among residents following assessment of their health complaints. If concerns continue in the community about low frequency noise, additional assessment by DEHP and/or industry stakeholders may need to determine if noise mitigation measures are required.

f. Future health clinics related to CSG concerns may be indicated for residents in the Tara region and elsewhere. Community input should be sought in regard to the nature, location, frequency and timing of such clinics. Given the identification of mental health concerns relating to the impacts of the CSG industry on some residents in the Tara region, future clinics should include specific expertise on mental health aspects. Relevant Hospital and Health Services in CSG areas should be involved in the planning and resourcing of such clinics within their areas.

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9. Appendices

Appendix 1:

The Darling Downs Public Health Unit (DDPHU) investigation into the health complaints relating to Coal Seam Gas (CSG) activity from residents residing within the Wieambilla Estates, Tara, Queensland—July to November 2012.

Report dated January 2013 by Dr Penny Hutchinson, Public Health Physician, Darling Downs Public Health Unit.

Appendix 2:

Health effects of coal seam gas – Tara.

Report for Queensland Department of Health dated 19 February 2013 by Dr Keith Adam, Specialist in Occupational and Environmental Medicine, Medibank Health Solutions Pty Ltd, and Adjunct Associate Professor, University of Queensland.

Appendix 3:

Environmental Health Assessment Report – Tara Complaint Investigation Report.

Report by ERM (Environmental Resources Management Australia Pty Ltd) dated January 2013 of QGC's (Queensland Gas company) environmental monitoring at 9 residential sites in the Tara region during July 2012.

Appendix 4:

Wieambilla Estates Odour Investigation Results: July–December 2012.

Report dated January 2013 by Environmental Monitoring and Assessment Sciences, Science Delivery Division, Department of Science, Information Technology, Innovation and the Arts (DSITIA) for the Department of Environment and Heritage Protection (DEHP).

10. Acronyms

ADWG	Australian Drinking Water Guidelines
ANZGFMWQ	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
CSG	Coal seam gas
DDPHU	Darling Downs Public Health Unit
DEHP	Department of Environment and Heritage Protection
DSITIA	Department of Science, Information Technology, Innovation and the Arts
ERM	Environmental Resources Management Australia Pty Ltd
EPHC	Environment Protection and Heritage Council
GP	General practitioner
HIL	Health investigation level
NATA	National Association of Testing Authorities
NEMP	National environment protection measure
RSL	Regional screening levels
US EPA	United Stated Environmental Protection Agency
VOC	Volatile organic compounds
WHO	World Health Organization

Wieambilla Estates Odour Investigation Results

July – December 2012

Environmental Monitoring and Assessment Sciences, Science Delivery Division
Department of Science, Information Technology, Innovation and the Arts

Queensland Government

Prepared by:
Environmental Monitoring and Assessment Sciences, Science Delivery Division

Department of Science, Information Technology, Innovation and the Arts

Published by the Queensland Government, January 2013

January 2013

Summary

The Queensland Government commenced a community sampling program for volatile organic compounds (VOCs) in the Wieambilla Estate in response to community concerns about the impacts of air emissions from the local coal seam gas fields on the health and well-being of the surrounding community. The results of the community sampling program conducted between July – December 2012 indicate that a number of volatile organic compounds (VOCs) were detected in the ambient air, at levels generally well below relevant guidelines and criteria used to assess VOC concentrations.

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Introduction

People living in the Wieambilla Estate have raised concerns about the impacts of air emissions from the local coal seam gas fields on the health and well-being of the surrounding community. These concerns have primarily focused on odours and the potential health implications from those odours. The Wieambilla Estate is located half-way between Chinchilla to the north and Tara to the south of the estate.

In response to residents' concerns raised about the health impact of odour emissions from the local coal seam gas fields on surrounding residential areas, the Department of Environment and Heritage Protection (DEHP) initiated a community sampling program for odours in July 2012. The Science Delivery Division of the Department of Science, Information Technology, Innovation and the Arts (DSITIA) was commissioned to assist in the study. This report details the results of this study.

Monitoring study design

The DEHP and DSITIA air monitoring investigation at the Wieambilla Estate focused on acquiring data on the concentration of volatile organic compound species in the air when odour was present in the community.

A very helpful tool used by DSITIA to aid in odour complaint investigations is the summa canister (see Figure 1) which can be supplied to complainants to sample the air when odours are detected. A summa canister is an evacuated canister that is used to collect an instantaneous air sample. This method of obtaining an air sample is simple and can be used by any individual concerned about odours or emissions from a nearby source of air pollution. Participants receive written instructions on how to take a sample of air using the summa canister. It is at the discretion of the participant as to when a sample is taken.

Figure 1: Example of Summa Canister

Samples of air for VOC analysis were collected by residents during times when odour was detected at its worst. Residents were supplied with an evacuated summa canister. Air samples were collected by opening the canister valve, allowing the canister to come to atmospheric pressure and closing the valve (typically takes 30 to 60 seconds). The canister was then sent for laboratory analysis using gas chromatography and mass spectrometry (GC/MS) in accordance with USEPA Compendium Method TO-15 *Determination of Volatile Organic Compounds (VOCs) in air collected in specially-prepared canisters and analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)*[1]. The analysis was carried out by the Queensland Government Forensic and Scientific Services Laboratory. The TO-15 analysis method can measure up to 102 VOC compounds.

Four Wieambilla Estate residents participated in the community sampling program using the summa canisters and collected six samples. Samples collected by these residents are identified as:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

DEHP staff collected two samples associated with the coal seam gas fields. These samples are identified as:

- TO1743;
- Rhyme Pond.

A control sample was also collected by DEHP staff at the Barakula State Forest some 38 km north of Chinchilla.

VOC monitoring was also conducted using passive diffusion samplers to collect airborne VOCs on adsorbent material, followed by extraction of the adsorbed compounds and characterisation using capillary gas chromatography. The passive sampler worked by diffusion of gaseous VOC molecules through a permeable membrane and subsequent capture by Tenax TA adsorbing material positioned inside the permeable membrane. The passive samplers were deployed at four locations in the Wieambilla Estate and a control location in the town of Chinchilla for three weeks to maximise the detection of any VOCs present. Following collection, the passive samplers were sealed and sent for laboratory analysis. The average VOC concentration over the sampling period was calculated from the VOC mass collected, the sampling time and the rate of diffusion of the VOC species through the permeable membrane. Deployment and retrieval of the passive samplers was carried out by DEHP staff and the analysis was carried out by Gradko Environmental in the United Kingdom.

Four passive samplers were located in the Wieambilla Estate and are identified as:

- [redacted]
- [redacted]
- [redacted]
- [redacted]

A fifth passive sampler was located in the township of Chinchilla as a control.

Results and Discussion

Volatile Organic Compounds

Substances that are included in the VOC category include aliphatic hydrocarbons (such as hexane), aromatic hydrocarbons (such as benzene, toluene and the xylenes), and oxygenated compounds (such as acetone and similar ketones).

To assess the measured VOC concentrations, a number of sources of environmental and human health guidelines/criteria were considered to cover the full range of VOCs detected in the samples. These included the Queensland Environmental Protection (Air) Policy 2008 (EPP Air) air quality objectives, Ontario's Ambient Air Quality Criteria and the Texas Commission on Environmental Quality Effects Screening Levels (ESLs). For four of the compounds, Pentane, 3-Methylpentane, Methylcyclohexane and 3-Methylhexane there are no environmental and human health guidelines/criteria. For the first three compounds the United States National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limits (RELs) are provided while Germany's occupational exposure limit is provided for 3-Methylhexane for assessment.

The number of compounds detected in the samples from the summa canister sampling ranged from 3 to 7. It should be noted that the results from the Summa canister are from a 1-minute sampling period and cannot be directly compared with guideline values that have longer averaging periods (10-minute, 1-hour, 24-hours or annual averages). Concentrations determined using short-term sampling techniques relates to times when air quality was considered by the community to be poor (odour present) and pollutant levels are expected to be at a maximum. This means that VOC concentrations in the short term samples are expected to be significantly higher than samples collected over a longer time frame, when air with little or no pollutants would also be sampled. For assessment purposes if the levels of individual VOCs measured in the Summa canister samples are less than the long term averages used to assess the exposure impacts as shown in the column 'Guideline/Criteria' in Table 1, then it can be assumed that the guideline/criteria would be met. However, if the levels of VOCs from the canister are higher than the longer term guideline/criteria it does not necessarily mean that the guideline/criteria was not met (ie. it cannot be demonstrated as meeting the guideline/criteria). It should be noted that none of the measured concentrations of VOCs in the summa canister samples collected over a 1-minute period were higher than the longer term guideline/criteria.

The number of compounds detected in the passive diffusion samples ranged from 4 to 18. The results of the passive diffusion sampling are shown in Table 2. The measurement of Phenylmaleic anhydride could possibly be derived from an ozone-adsorbing artefact of the Tenax TA adsorbing material used in the passive sampler to adsorb the VOCs[2]. Detection limits of <0.17ppb on the three week averaged results were achieved compared with the summa canister of 0.5 – 1.0 ppb on the 1-minute averaged results. This has resulted in more compounds being detected. If the levels of VOCs over the whole year were similar to the concentrations experienced over the three week sampling period then the relevant guidelines and criteria for annual average used to assess VOC concentrations in ambient air would not be exceeded.

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Table 1: Results from summa canister sampling for chemical compounds with concentrations greater than the Limit of Reporting.

Chemical Compound	TO-1743 (ppb)	[redacted] HPV 1 (ppb)	[redacted] HPV 1 (ppb)	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	Barakula State Forest (ppb)	Rhyme Pond (ppb)	Ambient Air Guideline/Criteria				
										Averaging Period	ppb	µg/m^3	Source	Effect
Sampling Date	***3/07/12***	***4/07/12***	***4/07/12***	***11/09/12***	***1/11/12***	***25/11/12***	***1/12/12***	***4/12/12***	***6/12/12***					
Compounds detected	3	3	3	4	6	5	7	6	5					
Alkanes														
Hexane	**3**	**19.2**	**8.4**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	24 Hour	2,027	7,500	Ontario	Health
										1 Hour	1,500	5,300	Texas	Odour
										Annual	57	200	Texas	Health
Alkenes														
Propene	n/a	n/a	n/a	n/a	n/a	<0.5	**7.7**	<0.5	<0.5	24 Hour	2,210	4,000	Ontario	Health
Haloalkanes/ alkenes														
Chloromethane	<1.0	<1.0	<1.0	**0.7**	**0.7**	**0.6**	**0.6**	**0.6**	**0.7**	24 Hour	147	320	Ontario	Health
										1 Hour	1,030	500	Texas	Health
										Annual	103	50	Texas	Health
Dichlorodifluro-methane	<1.0	<1.0	<1.0	**0.5**	**0.6**	<0.5	<0.5	<0.5	**0.6**	1 Hour	10,000	50,000	Texas	Health
										Annual	1,000	5,000	Texas	Health
Methylene chloride	<1.0	<1.0	<1.0	<0.5	<0.5	<0.5	**5.2**	**0.7**	**0.7**	24 Hour	60	220	Ontario	Health
										Annual	12	44	Ontario	Health
										1 Hour	1,100	3,600	Texas	Health
										Annual	100	350	Texas	Health
Alcohols														
Ethanol	<1.0	<1.0	<1.0	**0.8**	**1.5**	**1.6**	**5.5**	**1.5**	**1.2**	1Hour	10,096	19,000	Ontario	Odour
										1 Hour	10,000	18,800	Texas	Health
										Annual	1,000	1,880	Texas	Health

Chemical Compound	TO-1743 (ppb)	[redacted] HPV 1 (ppb)	[redacted] HPV 1 (ppb)	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	Barakula State Forest (ppb)	Rhyme Pond (ppb)	Ambient Air Guideline/Criteria				
										Averaging Period	ppb	µg/m^3	Source	Effect
Sampling Date	*3/07/12*	*4/07/12*	*4/07/12*	*11/09/12*	*1/11/12*	*25/11/12*	*1/12/12*	*4/12/12*	*6/12/12*					
Carbonyls														
Acetone	<1.0	<1.0	<1.0	**2.4**	**1.5**	**5.6**	**10**	**6.7**	**2.0**	24 Hour	5,007	11,880	Ontario	Health
										1 Hour	2,500	5,900	Texas	Health
										Annual	250	590	Texas	Health
Methyl ethyl ketone	**1.5**	**1.5**	**4.8**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	24 Hour	400	1,000	Ontario	Health
										1 Hour	440	1,300	Texas	Odour
										Annual	900	2,600	Texas	Health
Acrolein	<1.0	<1.0	<1.0	<0.5	<0.5	**0.5**	**0.6**	**0.5**	<0.5	1 Hour	2.0	4.5	Ontario	Health
										24 Hour	0.17	0.4	Ontario	Health
										1 Hour	1.6	3.2	Texas	Health
										Annual	0.066	0.14	Texas	Health
Vinyl acetate	**4.4**	**3.9**	**4.6**	<0.5	<0.5	**1.0**	**0.6**	**0.7**	<0.5	1 Hour	40	150	Texas	Health
										Annual	4	15	Texas	Health
Aromatics														
Tolulene	<1.0	<1.0	<1.0	<0.5	**1.5**	<0.5	<0.5	<0.5	<0.5	24 Hour	1,000	4,112	EPP Air	Health
										Annual	100	410	EPP Air	Health
										30 Minute	260	1,069	EPP Air	Odour
										24 Hour	504	2,000	Ontario	Odour
										1 Hour	170	640	Texas	Odour
1,2,4-Trimethylbenzene	<1.0	<1.0	<1.0	<0.5	**0.7**	<0.5	<0.5	<0.5	<0.5	24 Hour	43	220	Ontario	Health
										1 Hour	250	1,250	Texas	Health
										Annual	25	125	Texas	Health

Table 2: Results from passive diffusion sampling for chemical compounds with concentrations greater than the Limit of Reporting.

Chemical Compound	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	Chinchilla Control (ppb)	Ambient Air Guideline/Criteria				
						Averaging Period	ppb	µg/m^3	Source	Effect
Sampling Date	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***					
Compounds detected	5	4	5	18	5					
Alkanes										
Pentane	<0.17	<0.17	<0.09	**0.3**	<0.17	8 Hour	120,000	350,000	NIOSH	REL
Hexane	<0.17	<0.17	<0.17	**0.5**	<0.17	24 Hour	2,027	7,500	Ontario	Health
						1 Hour	1,500	5,300	Texas	Odour
						Annual	57	200	Texas	Health
Heptane	<0.17	<0.17	<0.17	**0.3**	<0.17	24 Hour	2,552	11,000	Ontario	Health
						1 Hour	850	3,500	Texas	Health
						Annual	85	350	Texas	Health
Tetradecane	<0.17	<0.17	<0.17	<0.17	**0.2**	1 Hour	432	3,500	Texas	Health
						Annual	43	350	Texas	Health
Hexadecane	**0.2**	<0.17	<0.17	<0.17	<0.17	1 Hour	108	1,000	Texas	Health
						Annual	11	100	Texas	Health
Heptadecane	<0.17	<0.17	<0.17	**0.4**	<0.17	1 Hour	10	100	Texas	Health
						Annual	1	10	Texas	Health
Cyclohexane	<0.17	**0.6**	<0.17	<0.17	<0.17	24 Hour	1,685	6,100	Ontario	Health
						1 Hour	1,000	3,400	Texas	Health
						Annual	100	340	Texas	Health
2-methylbutane (Isopentane)	<0.18	<0.18	<0.18	**0.4**	<0.18	1 Hour	1,300	3,800	Texas	Odour
						Annual	2,400	7,200	Texas	Health

Chemical Compound	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	Chinchilla Control (ppb)	Ambient Air Guideline/Criteria				
						Averaging Period	ppb	µg/m^3	Source	Effect
Sampling Date	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***					
3-Methylpentane	<0.17	<0.17	<0.17	**0.3**	<0.17	8 Hour	100,000	350,000	NIOSH	REL
3-Methylhexane	<0.17	<0.17	<0.17	**0.3**	<0.17	8 Hour	500,000	1,500,00	Germany Occ. Health	OEL
2,2,4,6,6-pentamethyl-heptane	**1.2**	<0.17	<0.17	**0.2**	<0.17	1 Hour	503	3,500	Texas	Health
						Annual	50	350	Texas	Health
Methylcyclohexane	<0.17	<0.17	<0.17	**0.2**	<0.17	8 Hour	400,000	1,600,000	NIOSH	REL
Haloalkanes/alkenes										
Tetrachloroethylene	<0.17	<0.17	<0.17	**0.4**	<0.17	24 Hour	50	360	Ontario	Health
						1 Hour	300	2,000	Texas	Health
						Annual	3.8	26	Texas	Health
Alcohols										
2-ethyl-1-Hexanol	**0.2**	<0.17	**0.3**	<0.17	<0.17	1 Hour	107	600	Ontario	Odour
						1 Hour	500	2,700	Texas	Health
						Annual	50	270	Texas	Health
Carbonyls										
Ethyl Acetate	<0.18	<0.18	<0.18	**0.2**	<0.18	1 Hour	5,013	19,000	Ontario	Odour
						1 Hour	4,000	14,400	Texas	Health
						Annual	400	1,440	Texas	Health
Aromatics										
Benzene	<0.17	<0.17	<0.17	**0.6**	<0.17	Annual	3	10	EPP Air	Health
						24 Hour	0.69	2.3	Ontario	Health
						Annual	0.13	0.45	Ontario	Health
						1 Hour	54	170	Texas	Health
						Annual	1.4	4.5	Texas	Health

Chemical Compound	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	Chinchilla Control (ppb)	Ambient Air Guideline/Criteria				
						Averaging Period	ppb	µg/m³	Source	Effect
Sampling Date	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***					
Toluene	<0.17	**6.6**	<0.17	**7.0**	**0.5**	24 Hour	1,000	4,112	EPP Air	Health
						Annual	100	410	EPP Air	Health
						30 Minute	260	1,069	EPP Air	Odour
						24 Hour	504	2,000	Ontario	Odour
						1 Hour	170	640	Texas	Odour
						Annual	330	1,200	Texas	Health
Xylene	<0.17	**1.8**	<0.17	**1.3**	**0.8**	24 Hour	250	1,184	EPP Air	Health
						Annual	200	950	EPP Air	Health
						24 Hour	160	730	Ontario	Health
						10 Minute	657	3,000	Ontario	Odour
						1 Hour	80	350	Texas	Odour
						Annual	42	180	Texas	Health
Ethylbenzene	<0.17	**0.8**	<0.17	**0.2**	**0.6**	24 Hour	231	1,000	Ontario	Health
						10 Minute	438	1,900	Ontario	Odour
						1 Hour	170	740	Texas	Odour
						Annual	135	570	Texas	Health
1,2,4-Trimethylbenzene	<0.17	<0.17	<0.17	**0.2**	<0.17	24 Hour	43	220	Ontario	Health
						1 Hour	250	1,250	Texas	Health
						Annual	25	125	Texas	Health
Phenol	<0.17	<0.17	**0.12**	**0.3**	<0.17	24 Hour	7.4	30	Ontario	Health
						1 Hour	40	150	Texas	Odour
						Annual	5	19	Texas	Health

Chemical Compound	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	[redacted] (ppb)	Chinchilla Control (ppb)	Ambient Air Guideline/Criteria				
						Averaging Period	ppb	$\mu g/m^3$	Source	Effect
Sampling Date	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***	***26/09/12 – 16/10/12***					
Benzothiazole	<0.18	<0.18	**0.12**	<0.18	<0.18	24 Hour	12	70	Ontario	Health
						1 Hour	9.1	50	Texas	Health
						Annual	0.9	5	Texas	Health
Naphthalene	**0.4**	<0.17	<0.17	<0.17	<0.17	24 Hour	4.3	22.5	Ontario	Health
						10 Minute	9.5	50	Ontario	Odour
						1 Hour	90	440	Texas	Odour
						Annual	10	50	Texas	Health
[1]Phenylmaleic anhydride	**0.6**	<0.17	**0.4**	**0.5**	**0.4**					
Terpenes										
Alpha-Pinene	<0.17	<0.17	**0.2**	<0.17	<0.17	1 Hour	10	60	Texas	Odour
						Annual	63	350	Texas	Health

[1] Suspected ozone-adsorbing artefact of the Tenax TA adsorbing material used in the passive sampler to adsorb the VOCs.

Conclusion

This investigation is based on limited air sampling conducted in the residential area in the Wieambilla Estate during July - December 2012. The results of the community sampling program indicate that a number of VOCs were detected in the ambient air, at levels generally well below relevant guidelines and criteria used to assess VOC concentrations in ambient air.

References

[1]U.S. Environmental Protection Agency. (1999) Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. Second Edition. Compendium Method TO-15 Determination of Volatile Organic Compounds (VOCs) in air collected in specially-prepared canisters and analyzed by Gas Chromatography/Mass Spectrometry (GC/MS).

[2] Lee, J. H.; Batterman, S. A.; Jia, C.; Chernyak, S. Ozone Artefacts and Carbonyl Measurements Using Tenax GR, Tenax TA, Carbopack B and Carbopack X Adsorbents; *J Air and Waste Management Association 2006, 56, 1503-151.*

Appendix

Appendix 1: List of all VOCs monitored

In addition to the key pollutants measured, a range of additional pollutants were analysed for with the TO15 method. The full range of VOCs analysed for include:

Propene	Trichloroethylene	**2-Methylbutane**
Dichlorodifluoromethane	1,4 Dioxane	1-Pentene
Chloromethane	Methyl methacrylate	**Pentane**
Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-	**Heptane**	Isoprene
Ethene, chloro-	1-Propene, 1,3-dichloro-, (Z)-	trans-2-Pentene
1,3-Butadiene	2-Hexanone	cis-2-Pentene
Methane, bromo-	1-Propene, 1,3-dichloro-, (E)-	2,2-Dimethylbutane
Ethyl Chloride	Ethane, 1,1,2-trichloro-	Cyclopentane
Ethanol	**Toluene**	2,3-Dimethylbutane
2-Propenal	Methane, dibromochloro-	2-Methylpentane
Acetone	Ethane, 1,2-dibromo-	**3-Methylpentane**
Trichloromonofluoromethane	**Tetrachloroethylene**	1-Hexene
Isopropyl Alcohol	**m- & p-Xylene**	Methylcyclopentane
Ethene, 1,1-dichloro-	Styrene	2,4-Dimethylpentane
Methylene chloride	Benzene, chloro-	2-Methylhexane
Carbon disulfide	**Ethylbenzene**	2,3-Dimethylpentane
Ethane, 1,1,2-trichloro-1,2,2-trifluoro-	Methane, tribromo	3-Methylhexane
Ethyl acetate	Ethane, 1,1,2,2-tetrachloro-	2,2,4-Trimethylpentane
Ethylene, 1,2-dichloro-, (E)-	**o-Xylene**	**Methylcyclohexane**
Ethane, 1,1-dichloro-	Toluene, 4-ethyl-	2,3,4-Trimethylpentane
Methy tert-butyl ether	Benzene, 1,3,5-trimethyl-	2-Methylheptane
Vinyl acetate	**Benzene, 1,2,4-trimethyl-**	3-Methylheptane
2-Butanone	Benzene, 1,3-dichloro-	Octane
Ethylene, 1,2-dichloro-, (Z)-	Benzene, 1,4-dichloro-	Nonane
n-Hexane	Benzene, 1,2-dichloro-	Cumene
Trichloromethane	Benzene, 1,2,4-trichloro-	Propylbenzene
Tetrahydrofuran	**Naphthalene**	3-Ethyltoluene
Ethane, 1,2-dichloro	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-	2-Ethyltoluene
Ethane 1,1,1-trichloro-	Propane	Decane
Benzene	Isobutane	1,2,3-Trimethylbenzene
Carbon Tetrachloride	1-Butene	1,3-Diethylbenzene

Cyclohexane	Butane	1,4-Diethylbenzene
Propane, 1,2-dichloro-	trans-2-Butene	Undecane
Methane, bromodichloro-	Cis-2-Butene	Dodecane
Methyl ethyl ketone		

Compounds in bold type were present at concentrations greater than the minimum measurable concentration.

Chinchilla Heavy Metals in Dust Monitoring Program

Objectives

- To undertake a Heavy Metals in Dust Monitoring Program in particular at Mr Jenkyn's property to ascertain whether any heavy metals are present and would pose a risk to human health.

Conduct of Dust Monitoring Program

- The Environmental Monitoring and Assessment Sciences Branch of the Department of Science, Information Technology and Innovation (DSITI) has been requested by Queensland Health to co-ordinate the dust monitoring program.
- Simtars will provide and install the dust sampling equipment and prepare filters. Simtars will also train EHP staff in the operation of the sampling equipment.
- EHP will arrange approval the sampling locations, operate the equipment, changing and replacing filters and changing dust deposition bottles.
- DSITI's Chemistry Centre will undertake the metal analysis.
- Department of Health's Health Protection Branch would assess whether the heavy metals present in the samples would pose a risk to human health.

Description of the Dust Monitoring Program

Monitoring of particles will be undertaken using sampling equipment and methodologies that are in accordance with this project brief. The sampling equipment will be operated in accordance with the relevant Australian Standard.

The ambient air quality monitoring program for heavy metals in particles will be conducted using two monitoring regimes sampling over a three month sampling period or until 10 samples/site have been collected:

1) **TSP particles** at three locations in the Chinchilla area:
    a. XXXXXX property
    b. XXXXXX property
    c. Chinchilla Hospital

    As the Jenkyn's property does not have mains power, MicroVols will be utilised to collect a 24hour TSP dust sample at all three locations. The MicroVol is a low volume sampler (3l/min) that can operate on a battery. The battery will be changed for each filter change.

    The sampler will be operated in accordance to the Australian/New Zealand Standard PM_{10} (AS/NZS 3580.9.9:2006) Methods for sampling and analysis of ambient air - Determination of suspended particulate matter – PM_{10} low volume sampler - Gravimetric method except that a TSP head will be fitted on the MicroVol instead of a PM_{10} head.

    Sampling should be carried out for a 24 hour period from midnight to midnight. While sampling should be carried out every sixth day shorter or longer duration between sampling could be allowed for operational convenience.

The particle samples collected by the TSP samplers will be analysed by DSITI's Chemistry Centre for metals in accordance to the Australian/New Zealand Standard AS/NZS 3580.9.15:2014 Methods for sampling and analysis of ambient air Method 9.15: Determination of suspended particulate matter—Particulate metals high or low volume sampler gravimetric collection-Inductively coupled plasma (ICP) spectrometric method. The metals to be determined include:

- Aluminium Antimony Arsenic Barium Beryllium Cadmium
- Cobalt Chromium Copper Iron Mercury Manganese
- Nickel Lead(including Isotopes) Selenium Titanium Thallium
- Vanadium Zinc

The lower limit of reporting for lead using a low volume sampler is 0.025µg/m^3. The National standard for lead in ambient air is 0.5µg/m^3

2) **Dust deposition** at the same 3 locations used for sampling TSP particles.

Monthly sampling is to be conducted. Dust deposition to be sampled, measured and metals determined in accordance to the Australian/New Zealand Standard AS/NZS 3580.10.1:2016 Methods for sampling and analysis of ambient air Method 10.1: Determination of particulate matter—Deposited matter—Gravimetric method. The metals to be determined include will be the same as for the TSP dust samples.

Cost of Heavy Metals in Dust Monitoring Program

The total GST-exclusive cost of the Dust Monitoring Programs is $9,660. The breakdown of costs is as follows:

MONITORING PROGRAM (3 month)	**Cost**
Simtars:	
Equipment preparation, commissioning, training	3,500
MicroVol hire - 3 samplers for 3 months	1,300
Dust deposition hire - 3 samplers for 3 months	400
Pre & post weighing of MicroVol Filters – 30 filters	800
Simtars Subtotal	**6,000**
DSITI Chemistry Centre :	
TSP Metal analysis inc lead isotopes - 30 samples @ $80	2,400
Dust Deposition - 9 samples @ $60	540
Dust Deposition Metal analysis inc lead isotopes - 9 samples @ $80	720
DSITI Subtotal	**3,660**

The earliest Simtars could deploy the sampling equipment is the 10 October 2016.

Department of Science, Information Technology and Innovation

Air quality bulletin

South East Queensland

March 2017

Queensland Government

Prepared by

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Environmental Monitoring and Assessment Sciences
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Disclaimer

Acknowledgements

This report has been prepared by the Department of Science, Information Technology and Innovation.
Acknowledgement is made of the following organisations that have supplied air quality monitoring data for this bulletin:
• Department of Transport and Main Roads
• Caltex Refineries (Qld) Ltd

June 2017

Introduction

Air quality monitoring gathers information on the quality of the air environment. The objectives of the monitoring are to check compliance with ambient air quality guidelines, identify long-term trends in air quality, investigate local air quality concerns and assess the effectiveness of air quality management strategies.

Air quality monitoring was carried out by the Queensland Government at 13 sites in South East Queensland during February 2017. Data from Caltex Refineries (Qld) Ltd's monitoring sites at Wynnum North, Wynnum West and Lytton along with the Department of Transport and Main Roads' South Brisbane monitoring site are also included.

Pollutants monitored include carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, benzene, toluene, xylenes, formaldehyde, visibility-reducing particles, PM_{10} (particles less than 10µm in diameter) and $PM_{2.5}$ (particles less than 2.5µm in diameter). Monitoring of total suspended particulate matter (TSP) and dustfall (particles large enough to settle from the air) to assess dust nuisance also took place at selected sites on the Western-Metropolitan rail corridor. The air pollutants monitored at South East Queensland sites are shown in Table 1. Site locations are shown in Figure 30 at the end of this bulletin.

Air quality summary graphs

Figures 1 to 27 summarise available air quality data for each day of March. Only the maximum recorded level for each day is used to show the day-to-day variation in air quality. Figures 28 and 29 show the averaged daily dust deposition rate for March.

Air quality summary tables

Tables 3 to 15 present summaries of air quality data for each month of the preceding 12 months. These tables show the month-to-month variation in air quality. A monthly entry is given when at least three-fifths of the maximum possible number of observations during the month are available. When data is not available for the entire month this is indicated by the abbreviation 'n.d.' (no data). A dash is inserted when less than three-fifths of the data are available. Where data is not recorded, the reason for the low data availability is summarised in Table 16 at the end of this bulletin.

Reporting protocol

Data presented in this bulletin are based on clock hours. Hourly or other averages are constrained to start and finish on a clock hour.

Guidelines

Air quality measurements are compared against air quality objectives contained the Queensland *Environmental Protection (Air) Policy 2008* (EPP (Air)) to assess whether pollutants levels could affect health and wellbeing. Twelve-month average PM_{10} concentrations are also compared against the *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) annual standard. The EPP (Air) visibility objective is used to assess the impact of visibility-reducing particles on visual air quality. Limit values for TSP and dustfall specified in the Department of Environment and Heritage Protection (DEHP) guideline document *Application requirements for activities with impacts to air* (Air Impacts Guideline) are used to assess dust nuisance effects. The relevant guidelines are shown in the air quality summary table for each pollutant.

Table 1. Air pollutants monitored at South East Queensland sites.

	Nitrogen dioxide	Sulfur dioxide	Carbon monoxide	Ozone	Benzene	Toluene	Total xylenes	Formaldehyde	PM_{10}	$PM_{2.5}$	Visibility-reducing particles	TSP	Dustfall
Mountain Creek	✓			✓					✓		✓		
Deception Bay	✓			✓									
Wynnum North (industry)	✓	✓							✓	✓			
Wynnum West (industry)		✓							✓	✓			
Lytton (industry)		✓							✓	✓			
Cannon Hill									✓	✓		✓	✓
Bisbane CBD									✓		✓		
South Brisbane	✓		✓						✓	✓			
Woolloongabba	✓		✓						✓	✓			
Fairfield													✓
Rocklea	✓			✓					✓	✓	✓		
Springwood	✓	✓		✓	✓	✓	✓	✓	✓	✓			
North Maclean	✓			✓									
Flinders View	✓	✓		✓					✓		✓		
Mutdapilly	✓			✓									
Toowoomba (Brooks St)													✓
Toowoomba (Mort St)													✓

Compliance with air quality guidelines

During March, measured pollutant levels, with the exception of $PM_{2.5}$, did not exceed the relevant EPP (Air) air quality objective, Air NEPM standard or DEHP dust nuisance limit values at Queensland Government and industry air monitoring sites in South East Queensland.

The EPP (Air) annual average $PM_{2.5}$ air quality objective was exceeded at the South Brisbane site for the 12-month period ending March 2017. Local $PM_{2.5}$ sources such as motor vehicle emissions, coupled with occasional regional $PM_{2.5}$ episodes (e.g. bushfire smoke) during this period, led to this exceedence.

Table 2. Number of occasions during March 2017 when measured levels exceeded EPP (Air) objectives or Air NEPM standards for carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, benzene, toluene, xylenes, formaldehyde, PM_{10}, $PM_{2.5}$, visibility-reducing particles and TSP, and DEHP nuisance dust limit values for TSP and dustfall at Queensland Government and industry air monitoring sites in South East Queensland.

Air pollutant	Averaging period	Exceedences
Carbon monoxide	8-hour	0
Ozone	4-hour	0
	1-hour	0
Nitrogen dioxide	Annual	0
	1-hour	0
Sulfur dioxide	Annual	0
	24-hour	0
	1-hour	0
Benzene	Annual	0
Toluene	Annual	0
	24-hour	0
Xylenes	Annual	0
	24-hour	0
Formaldehyde	24-hour	0
PM_{10}	*EPP (Air)* 24-hour	0
	Air NEPM Annual	0
$PM_{2.5}$	Annual	1
	24-hour	0
Visibility-reducing particles (objective refers to protecting aesthetic environment, not health and wellbeing)	1-hour	0
TSP	Annual	0
	24-hour	0
Dustfall (30-day period refers to dust nuisance, not health and wellbeing)	30-day	0

Measured ambient concentrations

Carbon monoxide

Figure 1. Ambient concentrations of carbon monoxide at South Brisbane and Woolloongabba sites. Daily maximum 8-hour average concentrations (ppm), March 2017.

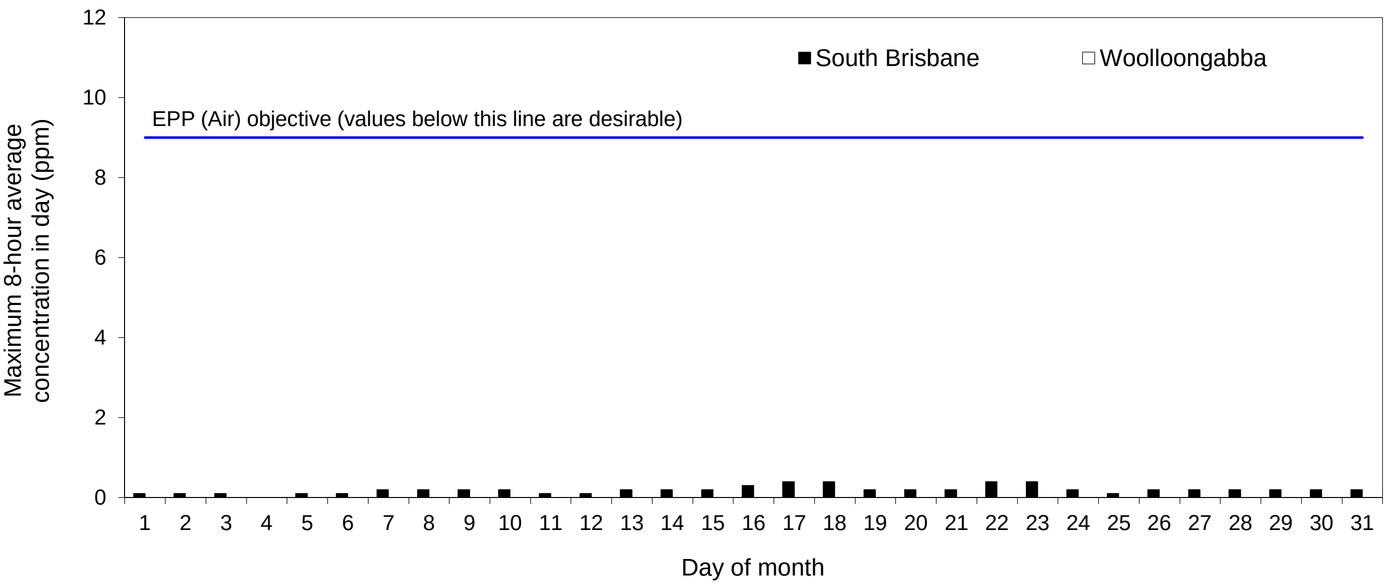

Table 3. Ambient concentrations of carbon monoxide. Monthly maximum 8-hour concentrations (ppm), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
South Brisbane												
Maximum 8-hour	0.3	0.4	0.7	0.7	0.3	0.1	0.1	<0.1	0.1	<0.1	0.2	0.4
% I.A.	98	98	98	98	98	98	98	98	98	98	98	98
Woolloongabba†												
Maximum 8-hour	0.7	1.2	-	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
% I.A.	98	98	50	0	0	0	0	0	0	0	0	0

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

†Construction works forced the closure of the Woolloongabba monitoring site on 17 June 2016. Another location for the station is being investigated.

The *Environmental Protection (Air) Policy 2008* air quality objective for carbon monoxide is an 8-hour average of 9 ppm (not to be exceeded on more than one day per year).

Ozone (photochemical oxidants)

Figure 2. Ambient concentrations of ozone at Mountain Creek, Deception Bay and Rocklea sites. Daily maximum 4-hour average concentrations (ppm), March 2017.

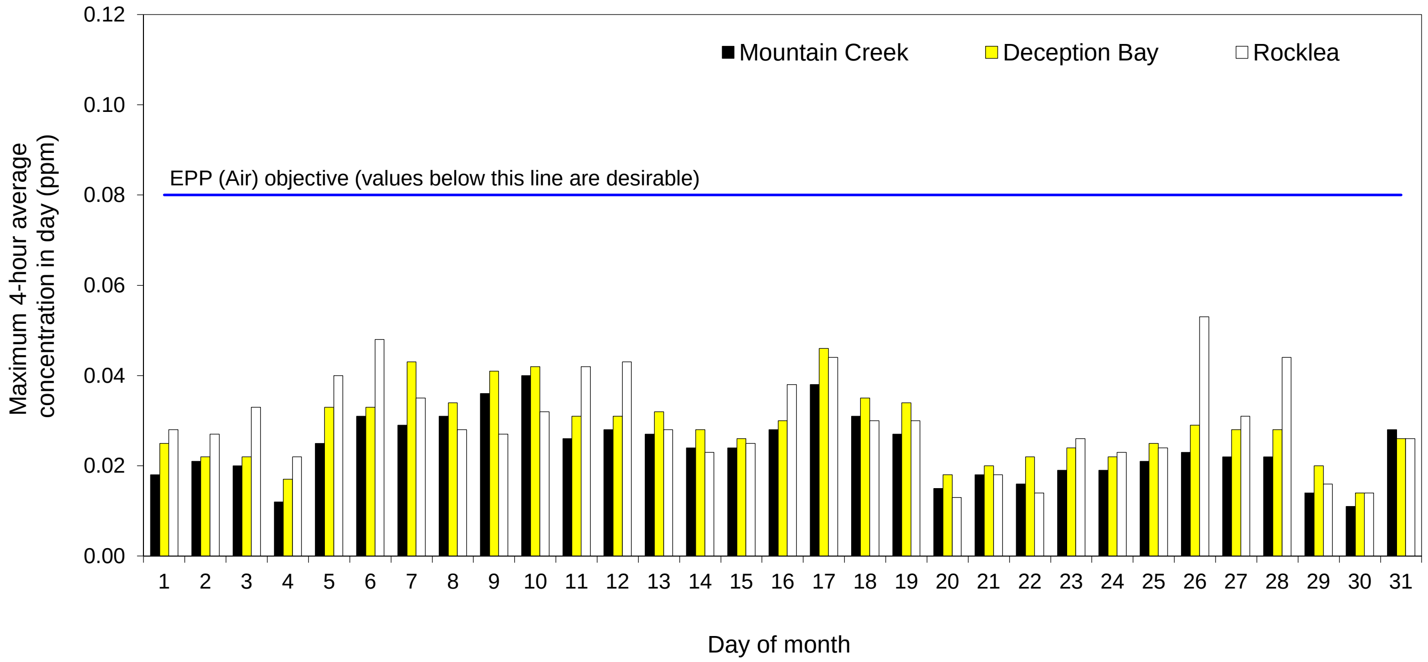

Figure 3. Ambient concentrations of ozone at Springwood, North Maclean, Flinders View and Mutdapilly sites. Daily maximum 4-hour average concentrations (ppm), March 2017.

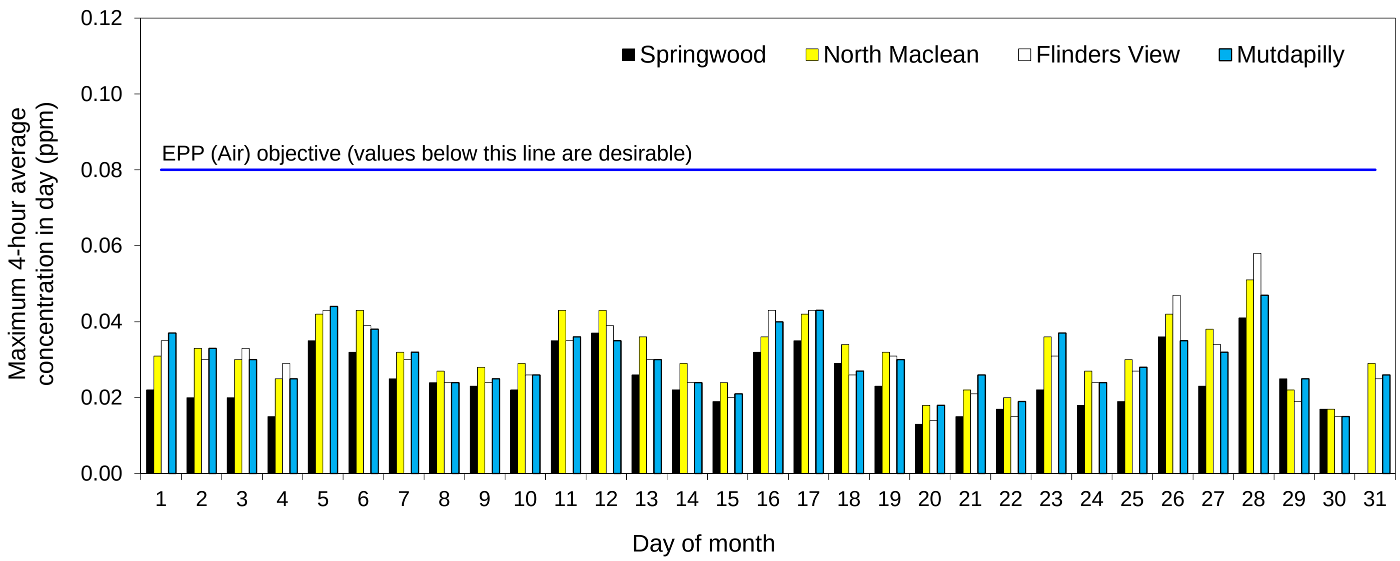

Figure 4. Ambient concentrations of ozone at Mountain Creek, Deception Bay and Rocklea sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

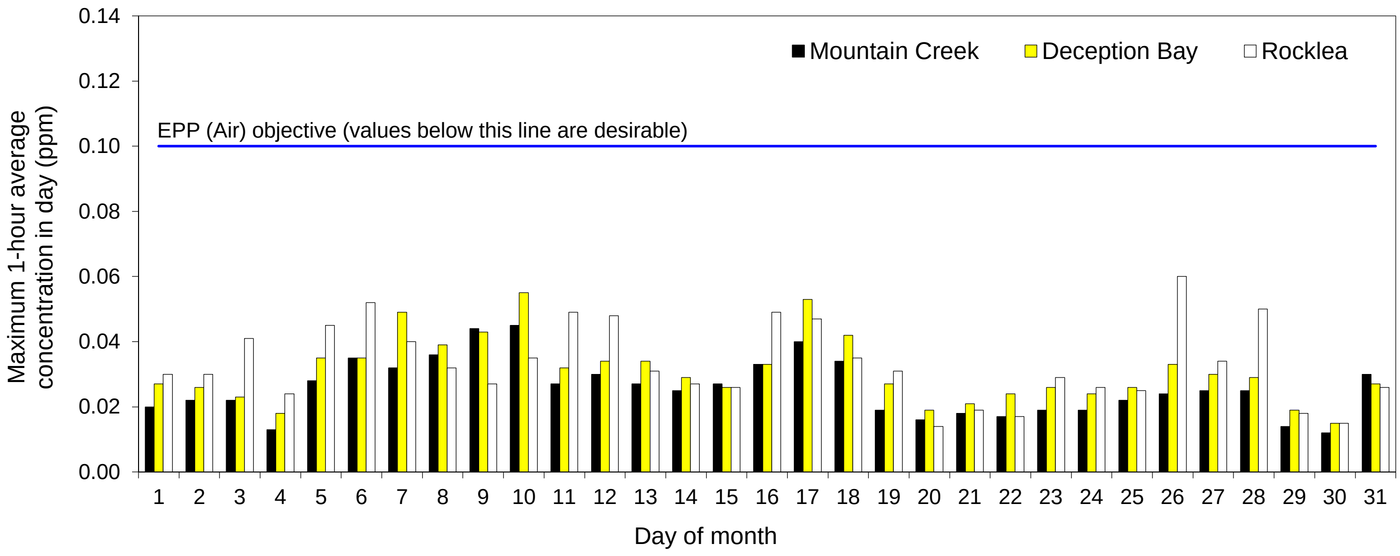

Figure 5. Ambient concentrations of ozone at Springwood, North Maclean, Flinders View and Mutdapilly sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

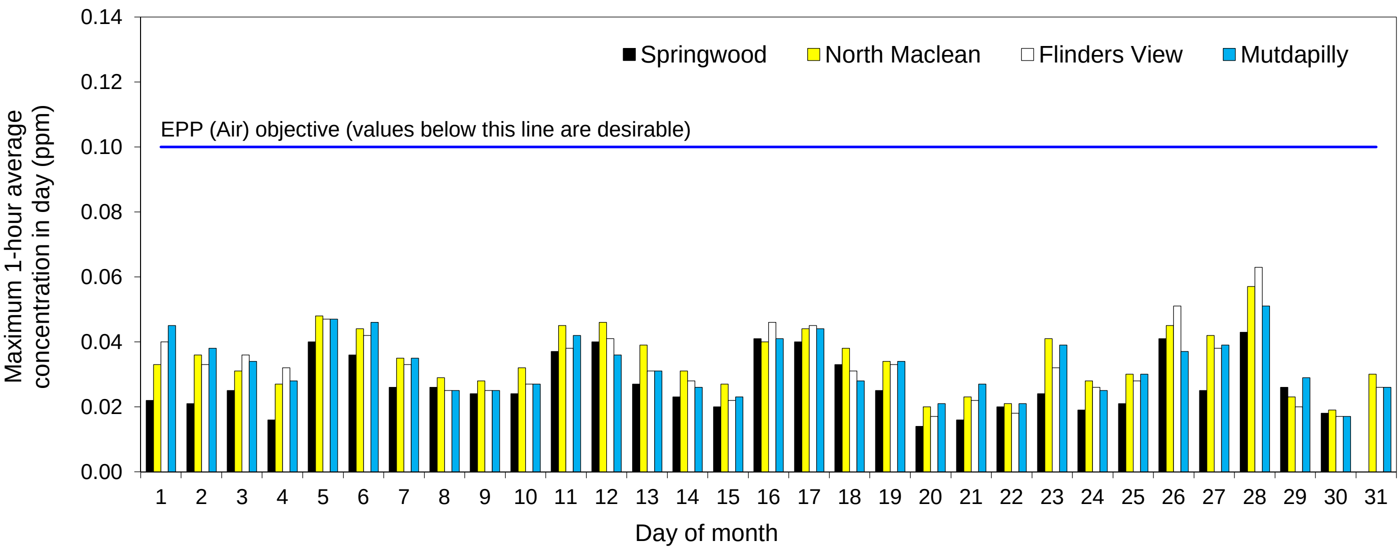

Table 4. Ambient concentrations of ozone. Monthly maximum 4-hour and 1-hour concentrations (ppm), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mountain Creek												
Maximum 4-hour	0.034	0.039	0.031	0.041	0.038	0.044	0.047	0.042	0.034	0.040	0.051	0.040
Maximum 1-hour	0.036	0.042	0.034	0.043	0.039	0.047	0.054	0.049	0.036	0.051	0.056	0.045
% I.A.	98	98	97	98	98	98	98	98	98	98	97	97
Deception Bay												
Maximum 4-hour	0.039	0.046	0.034	0.045	0.043	0.043	0.057	0.048	0.038	0.033	0.047	0.046
Maximum 1-hour	0.042	0.049	0.039	0.048	0.045	0.048	0.063	0.058	0.043	0.038	0.056	0.055
% I.A.	98	98	98	98	98	98	98	97	98	98	97	97
Rocklea												
Maximum 4-hour	0.048	0.041	0.029	0.038	0.043	0.042	0.051	0.058	0.049	0.069	0.068	0.053
Maximum 1-hour	0.055	0.046	0.034	0.042	0.047	0.047	0.059	0.073	0.061	0.085	0.081	0.060
% I.A.	98	97	98	98	98	78	98	97	98	98	97	97
Springwood												
Maximum 4-hour	0.041	0.036	0.027	0.033	0.030	0.034	0.038	-	0.054	0.044	0.055	0.041
Maximum 1-hour	0.045	0.039	0.030	0.035	0.033	0.036	0.042	-	0.058	0.048	0.063	0.043
% I.A.	100	99	99	89	95	100	90	45	99	100	100	94
North Maclean												
Maximum 4-hour	0.049	0.054	0.033	0.046	0.044	0.043	0.060	0.064	0.071	0.072	0.074	0.051
Maximum 1-hour	0.057	0.058	0.038	0.047	0.046	0.047	0.065	0.071	0.079	0.089	0.100	0.057
% I.A.	97	97	95	98	98	98	98	98	97	89	97	97
Flinders View												
Maximum 4-hour	0.053	0.048	0.034	0.043	0.041	0.045	0.062	0.059	0.053	0.059	0.065	0.058
Maximum 1-hour	0.058	0.055	0.036	0.045	0.043	0.049	0.074	0.063	0.060	0.071	0.071	0.063
% I.A.	98	97	97	95	98	98	97	98	97	97	98	98
Mutdapilly												
Maximum 4-hour	0.047	0.048	0.036	0.045	0.044	0.045	0.054	0.057	0.061	0.053	0.063	0.047
Maximum 1-hour	0.050	0.056	0.038	0.046	0.049	0.050	0.061	0.063	0.071	0.063	0.070	0.051
% I.A.	98	97	98	98	98	98	98	97	97	98	97	98

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for ozone are a 4-hour average of 0.08 ppm (not to be exceeeded on more than one day per year) and a 1-hour average of 0.10 ppm (not to be exceeeded on more than one day per year).

Nitrogen dioxide

Figure 6. Ambient concentrations of nitrogen dioxide at Mountain Creek, Deception Bay and Wynnum North sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

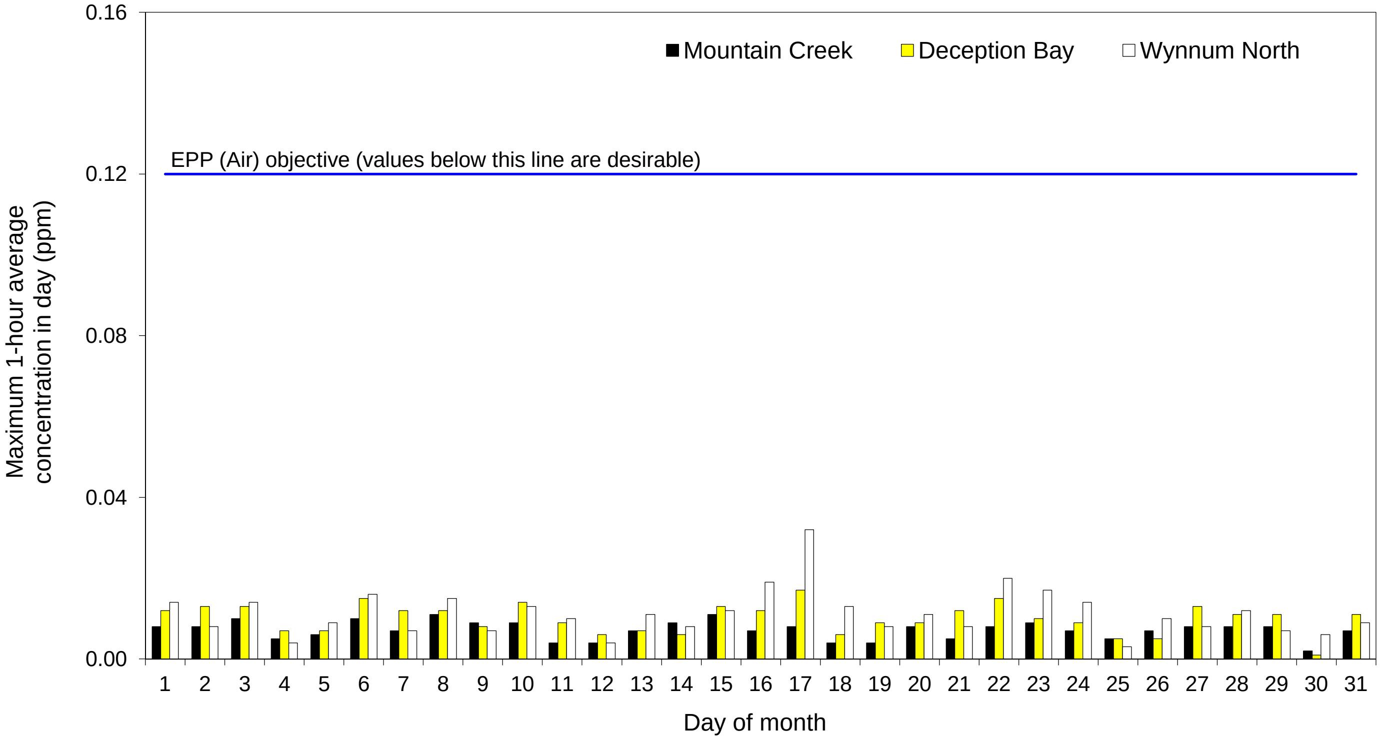

Figure 7. Ambient concentrations of nitrogen dioxide at South Brisbane and Woolloongabba sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

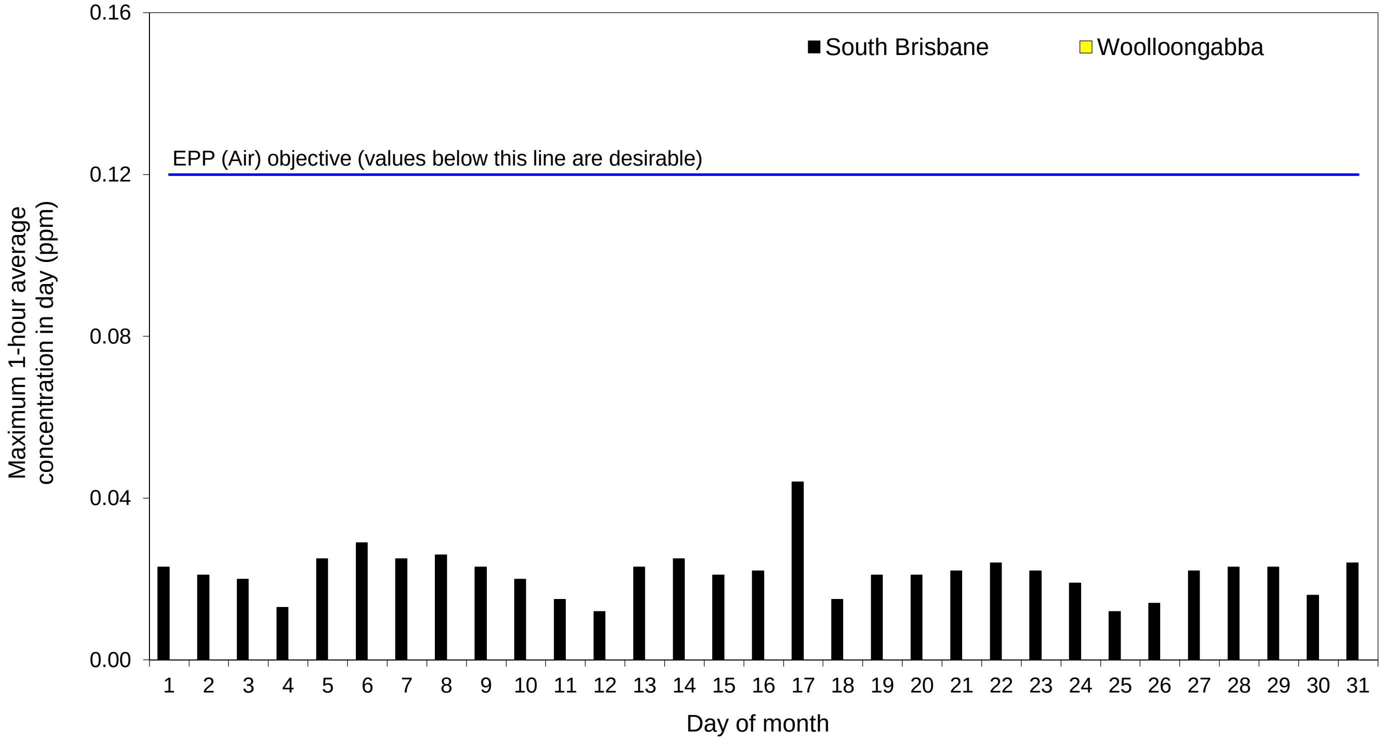

Figure 8. Ambient concentrations of nitrogen dioxide at Rocklea, Springwood and North Maclean sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

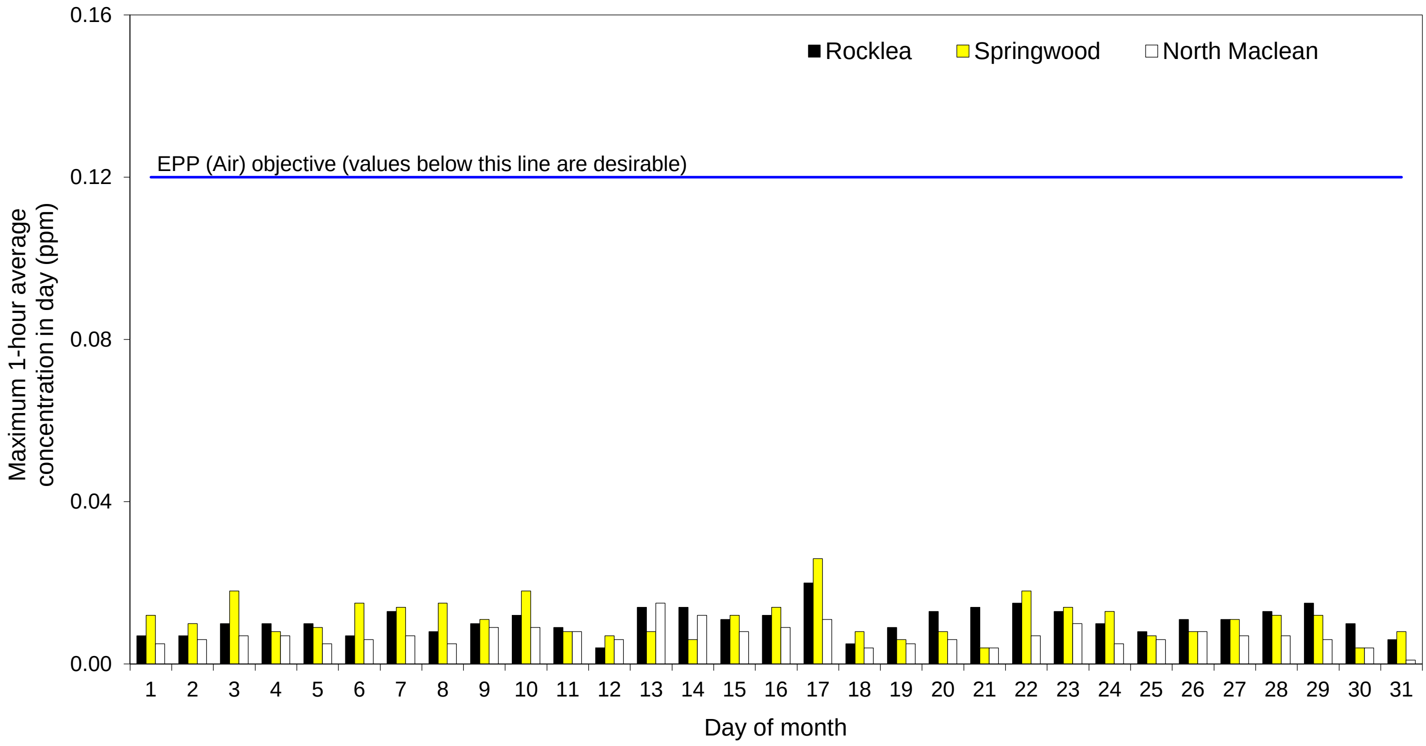

Figure 9. Ambient concentrations of nitrogen dioxide at Flinders View and Mutdapilly sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

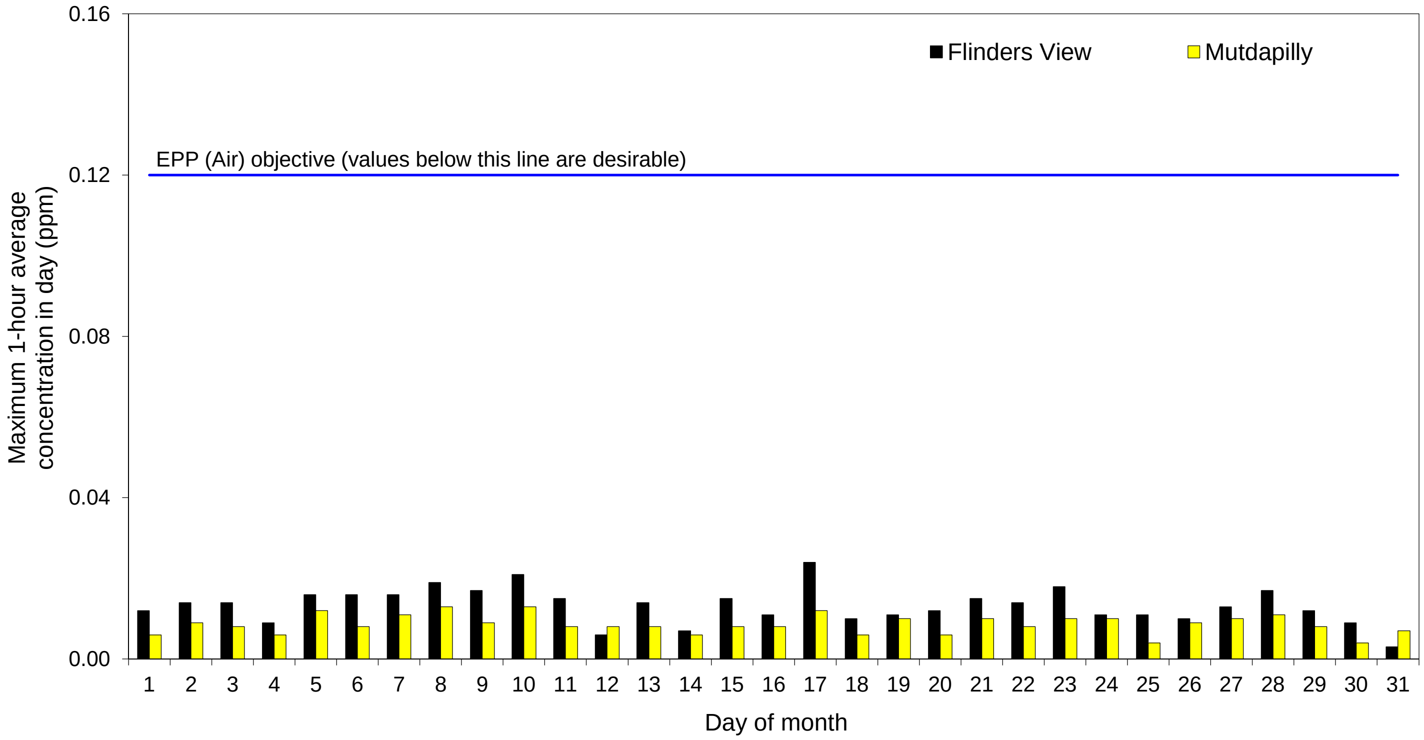

Table 5. Ambient concentrations of nitrogen dioxide. Annual average and monthly maximum 1-hour concentrations (ppm), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mountain Creek													
Annual average:	0.004												
Maximum 1-hour		0.016	0.030	0.025	0.031	0.026	0.023	0.023	0.014	0.018	0.011	0.012	0.011
% I.A.		98	98	97	98	98	98	98	98	98	98	97	97
Deception Bay													
Annual average:	0.005												
Maximum 1-hour		0.024	0.037	0.035	0.036	0.033	0.028	0.032	0.023	0.014	0.013	0.016	0.017
% I.A.		98	98	98	98	98	98	98	97	98	98	97	97
Wynnum North (industry-operated site)													
Annual average:	0.006												
Maximum 1-hour		0.023	0.039	0.034	0.041	0.034	0.032	0.037	0.023	0.024	0.019	0.019	0.032
% I.A.		98	97	98	98	98	92	98	98	91	97	98	97
South Brisbane													
Annual average:	0.015												
Maximum 1-hour		0.047	0.060	0.049	0.047	0.056	0.041	0.037	0.035	0.048	0.026	0.027	0.044
% I.A.		98	97	98	98	98	98	97	98	97	98	98	98
Woolloongabba†													
Annual average:	-												
Maximum 1-hour		0.044	0.062	-	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
% I.A.		98	98	31	0	0	0	0	0	0	0	0	0
Rocklea													
Annual average:	0.007												
Maximum 1-hour		0.034	0.057	0.037	0.037	0.035	0.024	0.026	0.021	0.032	0.020	0.014	0.020
% I.A.		98	97	98	98	98	94	98	97	98	98	97	97
Springwood													
Annual average:	0.006												
Maximum 1-hour		0.025	0.034	0.032	0.031	0.030	0.026	0.026	0.017	0.022	0.015	0.017	0.026
% I.A.		100	100	100	90	95	100	100	98	99	100	100	99
North Maclean													
Annual average:	0.003												
Maximum 1-hour		0.016	0.024	0.028	0.020	0.028	0.014	0.021	0.015	0.010	0.010	0.012	0.015
% I.A.		97	98	97	98	98	98	98	98	98	89	97	97
Flinders View													
Annual average:	0.008												
Maximum 1-hour		0.035	0.042	0.044	0.046	0.036	0.028	0.027	0.027	0.034	0.016	0.021	0.024
% I.A.		98	97	97	97	98	98	97	98	97	97	98	98
Mutdapilly													
Annual average:	0.003												
Maximum 1-hour		0.016	0.025	0.021	0.034	0.018	0.019	0.015	0.013	0.014	0.014	0.015	0.013
% I.A.		98	97	98	98	98	98	98	98	97	98	97	98

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

†Construction works forced the closure of the Woolloongabba monitoring site on 17 June 2016. Another location for the station is being investigated.

The *Environmental Protection (Air) Policy 2008* air quality objectives for nitrogen dioxide are an annual average of 0.03 ppm and a 1-hour average of 0.12 ppm (not to be exceeded on more than one day per year).

Sulfur dioxide

Figure 10. Ambient concentrations of sulfur dioxide at Wynnum North, Wynnum West and Lytton sites. Daily 24-hour average concentrations (ppm), March 2017.

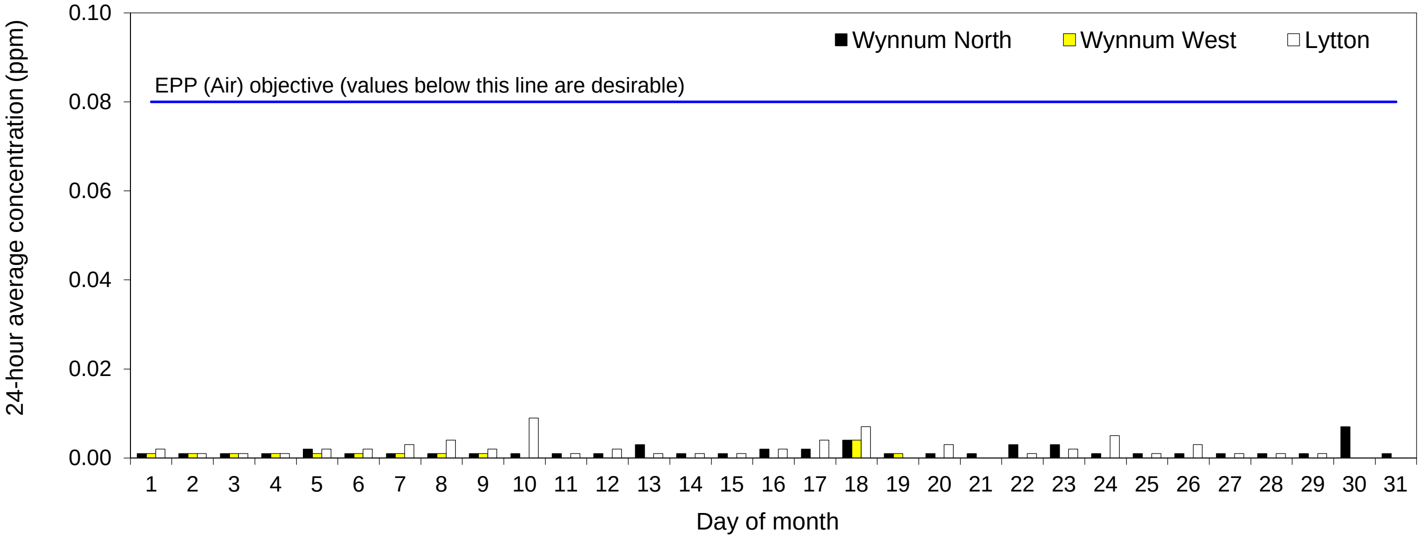

Figure 11. Ambient concentrations of sulfur dioxide at Springwood and Flinders View sites. Daily 24-hour average concentrations (ppm), March 2017.

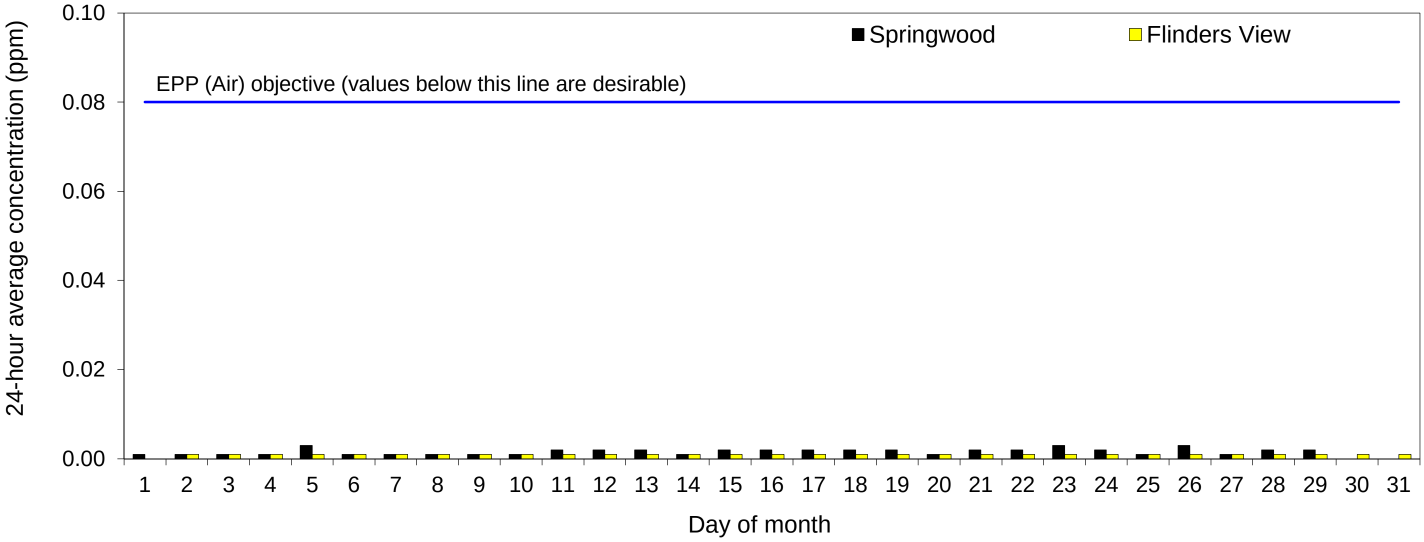

Figure 12. Ambient concentrations of sulfur dioxide at Wynnum North, Wynnum West and Lytton sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

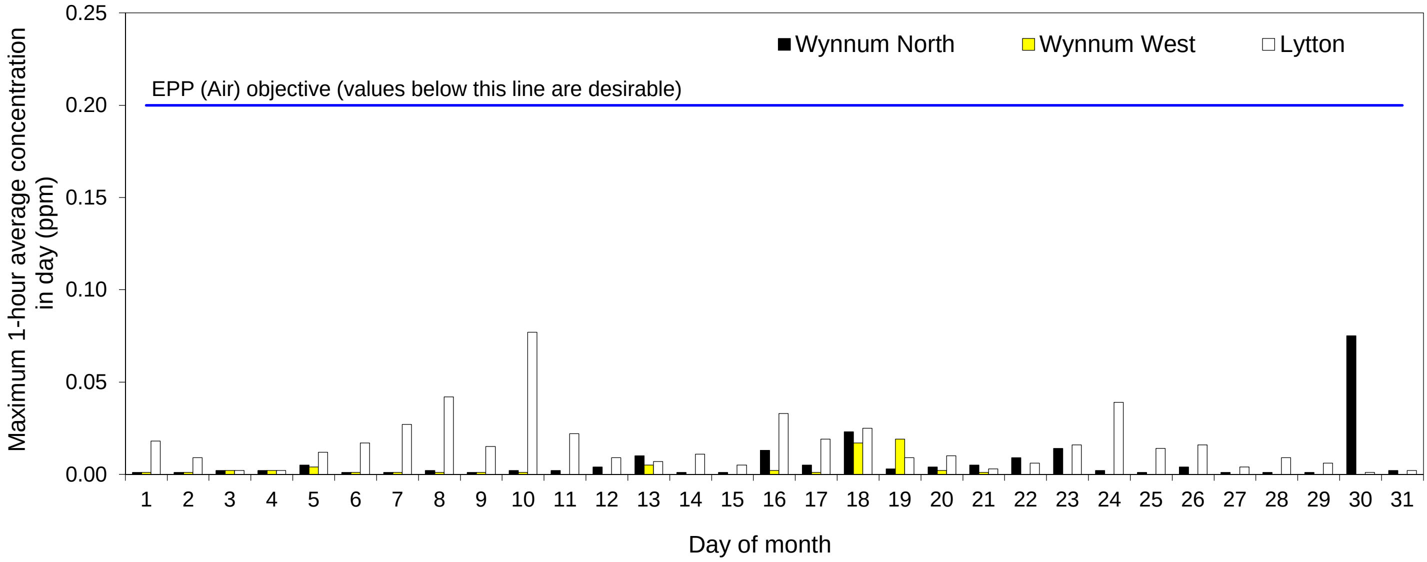

Figure 13. Ambient concentrations of sulfur dioxide at Springwood and Flinders View sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

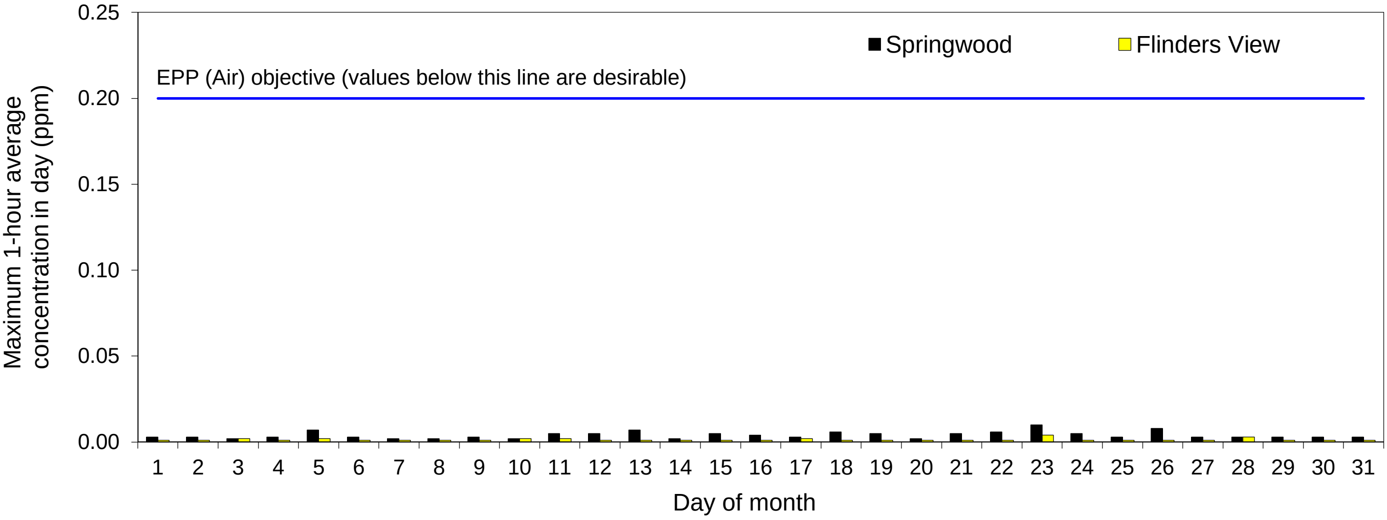

Table 6. Ambient concentrations of sulfur dioxide. Annual average and monthly maximum 24-hour and 1-hour concentrations (ppm), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Wynnum North (industry-operated site)													
Annual average:	0.002												
Maximum 24-hour		0.007	0.012	0.005	0.011	0.006	0.020	0.010	0.008	0.005	0.007	0.005	0.007
Maximum 1-hour		0.051	0.049	0.017	0.061	0.056	0.068	0.056	0.053	0.047	0.045	0.026	0.075
% I.A.		98	97	98	98	98	92	98	98	91	88	98	97
Wynnum West (industry-operated site)													
Annual average:	0.001												
Maximum 24-hour		0.003	0.007	0.005	0.004	0.001	0.010	0.010	0.011	0.010	0.006	0.006	0.004
Maximum 1-hour		0.020	0.043	0.014	0.025	0.003	0.033	0.050	0.048	0.035	0.022	0.034	0.019
% I.A.		98	98	97	98	97	97	97	98	94	98	98	86
Lytton (industry-operated site)													
Annual average:	0.003												
Maximum 24-hour		0.014	0.035	0.035	0.025	0.008	-	0.008	0.006	0.012	0.010	0.006	0.009
Maximum 1-hour		0.073	0.071	0.073	0.112	0.059	-	0.071	0.056	0.070	0.054	0.055	0.077
% I.A.		94	98	98	98	98	53	98	97	96	68	96	96
Springwood													
Annual average:	0.001												
Maximum 24-hour		0.001	0.002	0.002	0.003	0.001	0.002	0.002	0.003	0.004	0.005	0.004	0.003
Maximum 1-hour		0.004	0.005	0.006	0.012	0.005	0.006	0.017	0.011	0.012	0.014	0.012	0.010
% I.A.		100	100	99	90	95	100	97	91	99	100	100	96
Flinders View													
Annual average:	0.001												
Maximum 24-hour		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Maximum 1-hour		0.007	0.006	0.004	0.004	0.005	0.003	0.006	0.005	0.003	0.003	0.003	0.004
% I.A.		98	97	97	97	98	98	97	98	97	97	98	98

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for sulfur dioxide are an annual average of 0.020 ppm, a 24-hour average of 0.08 ppm (not to be exceeded on more than one day per year) and a maximum 1-hour average of 0.20 ppm (not to be exceeded on more than one day per year).

Benzene

Figure 14. Ambient concentrations of benzene at the Springwood site. Daily 24-hour average concentrations (ppb), March 2017.

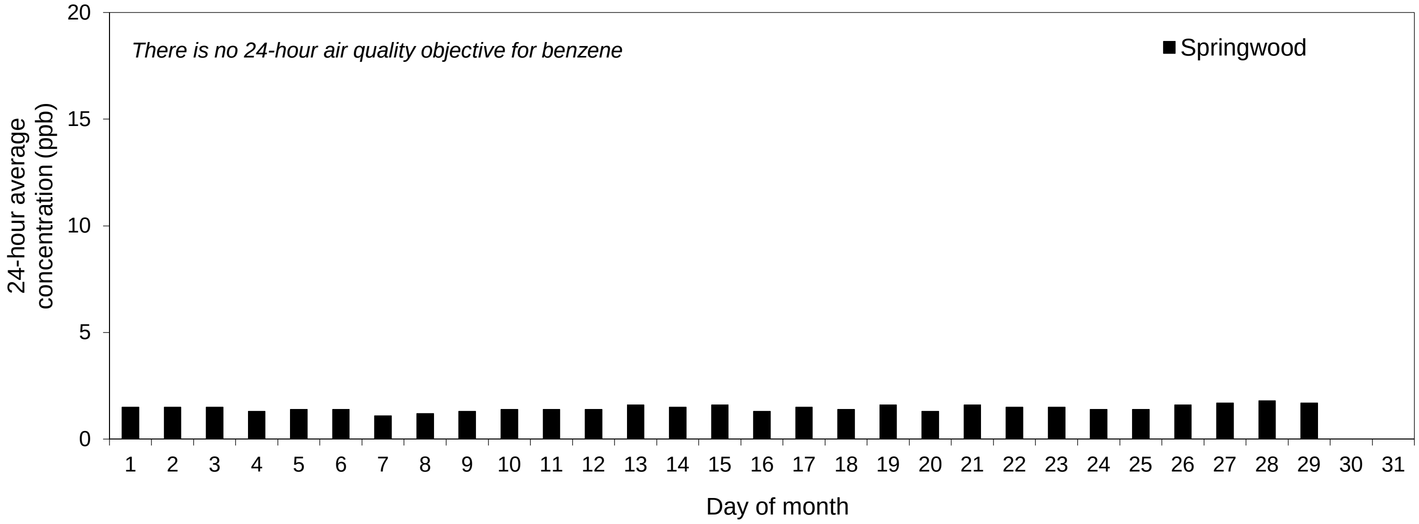

Table 7. Ambient concentrations of benzene. Annual average and monthly maximum 24-hour concentrations (ppb), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Springwood												
Annual average: -												
Maximum 24-hour	1.1	-	n.d.	n.d.	-	-	n.d.	-	1.1	1.5	1.4	1.8
% I.A.	73	50	0	0	31	42	0	44	99	99	99	93

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for benzene is an annual average of 0.003 ppm (3 ppb).

Toluene

Figure 15. Ambient concentrations of toluene at the Springwood site. Daily 24-hour average concentrations (ppb), March 2017.

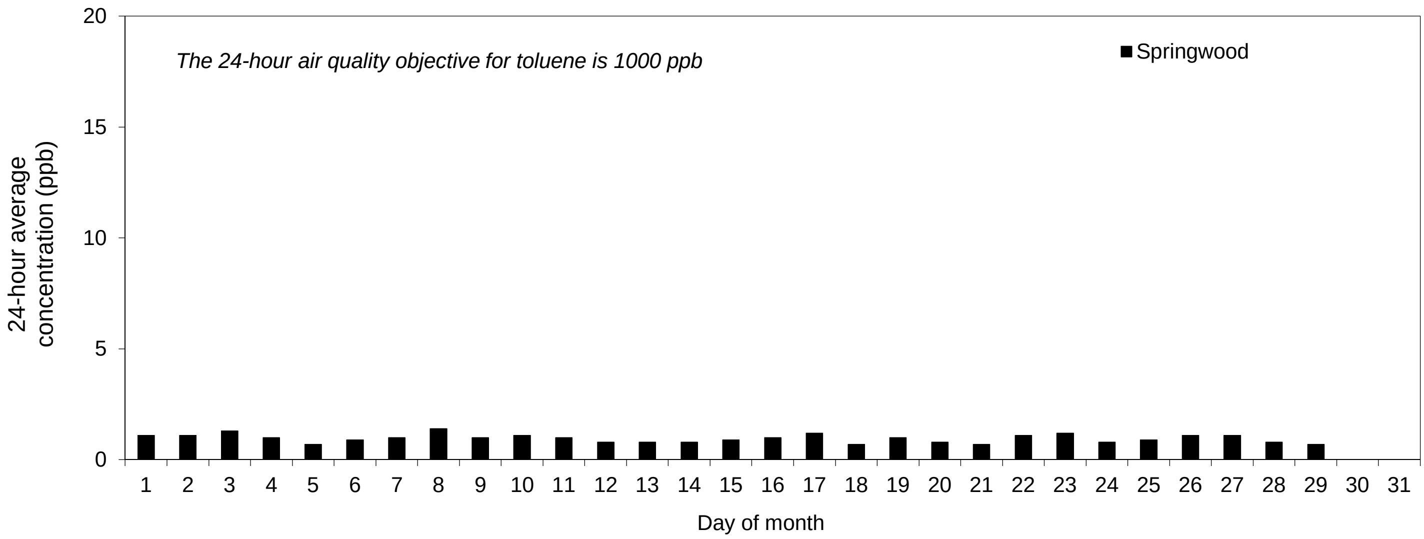

Table 8. Ambient concentrations of toluene. Annual average and monthly maximum 24-hour concentrations (ppb), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Springwood												
Annual average: 3.2												
Maximum 24-hour	7.3	6.8	11.3	8.4	6.6	3.4	-	-	2.3	1.7	1.9	1.4
% I.A.	99	84	87	61	87	92	47	44	97	99	99	92

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for toluene are an annual average of 0.1 ppm (100 ppb) and a maximum 24-hour average of 1 ppm (1000 ppb).

Total Xylenes

Figure 16. Ambient concentrations of total xylenes at the Springwood site. Daily 24-hour average concentrations (ppb), March 2017.

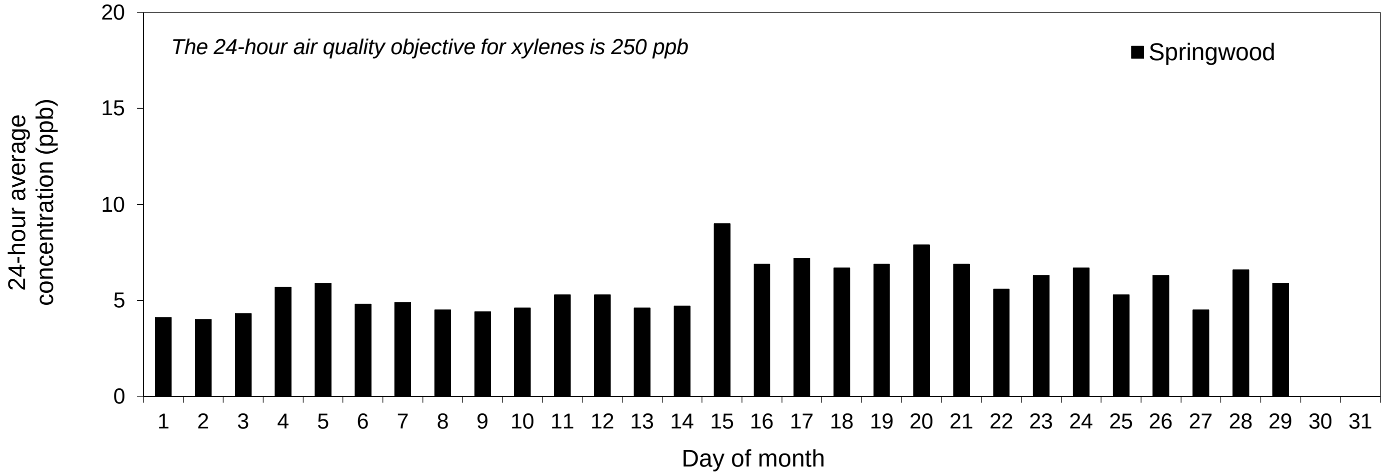

Table 9. Ambient concentrations of total xylenes. Annual average and monthly maximum 24-hour average concentrations (ppb), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Springwood												
Annual average: 8.0												
Maximum 24-hour	10.2	11.5	14.5	-	13.4	12.2	-	-	9.3	7.4	6.9	9.0
% I.A.	100	77	80	48	90	93	48	43	100	100	100	94

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for total xylenes are an annual average of 0.2 ppm (200 ppb) and a maximum 24-hour average of 0.25 ppm (250 ppb).

Formaldehyde

Figure 17. Ambient concentrations of formaldehyde at the Springwood site. Daily 24-hour average concentrations (ppb), March 2017.

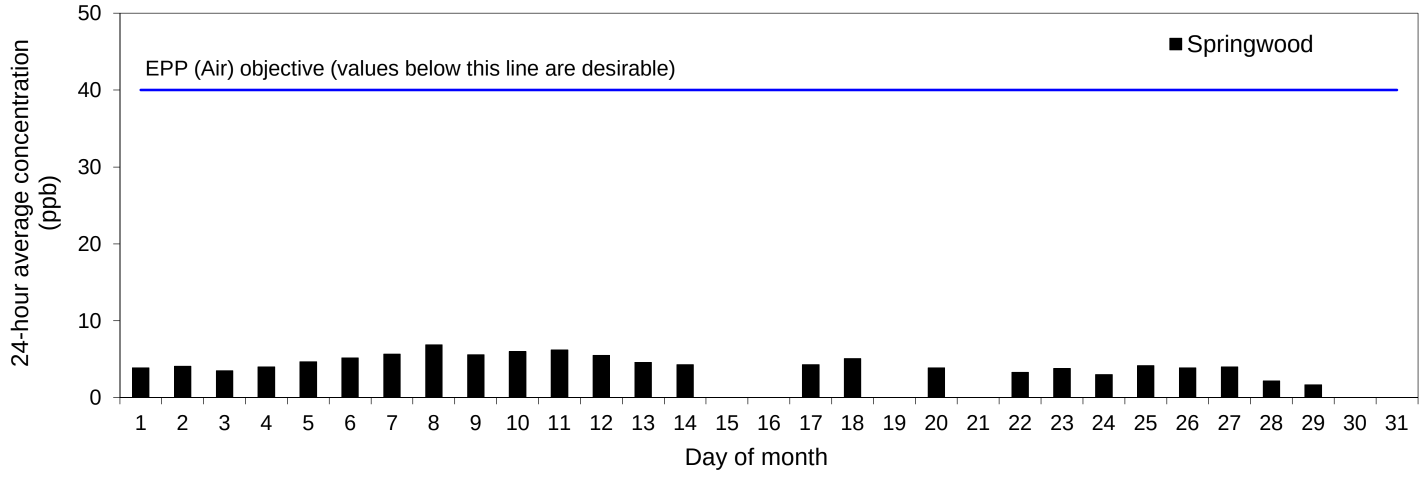

Table 10. Ambient concentrations of formaldehyde. Monthly maximum 24-hour average concentrations (ppb), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Springwood												
Maximum 24-hour	6.0	8.0	8.2	6.3	12.3	12.2	-	-	5.6	4.5	4.3	6.9
% I.A.	100	99	94	82	92	98	49	41	98	95	98	88

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for formaldehyde is a maximum 24-hour average of 0.04 ppm (40 ppb).

Visibility-reducing particles

Figure 18. Ambient visibility-reducing particle levels at Mountain Creek and Brisbane CBD sites. Daily maximum 1-hour average light scattering coefficient, b_{sp}, levels (Mm^{-1}), March 2017.

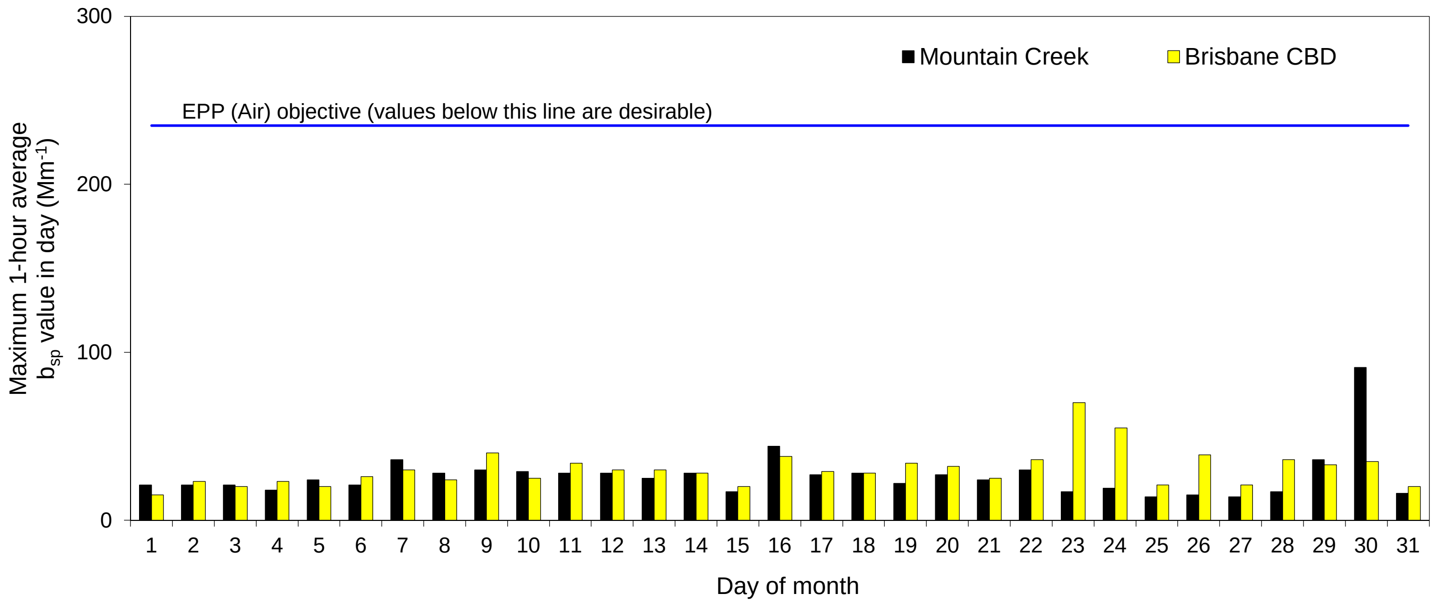

Figure 19. Ambient visibility-reducing particle levels at Rocklea and Flinders View sites. Daily maximum 1-hour average light scattering coefficient, b_{sp}, levels (Mm^{-1}), March 2017.

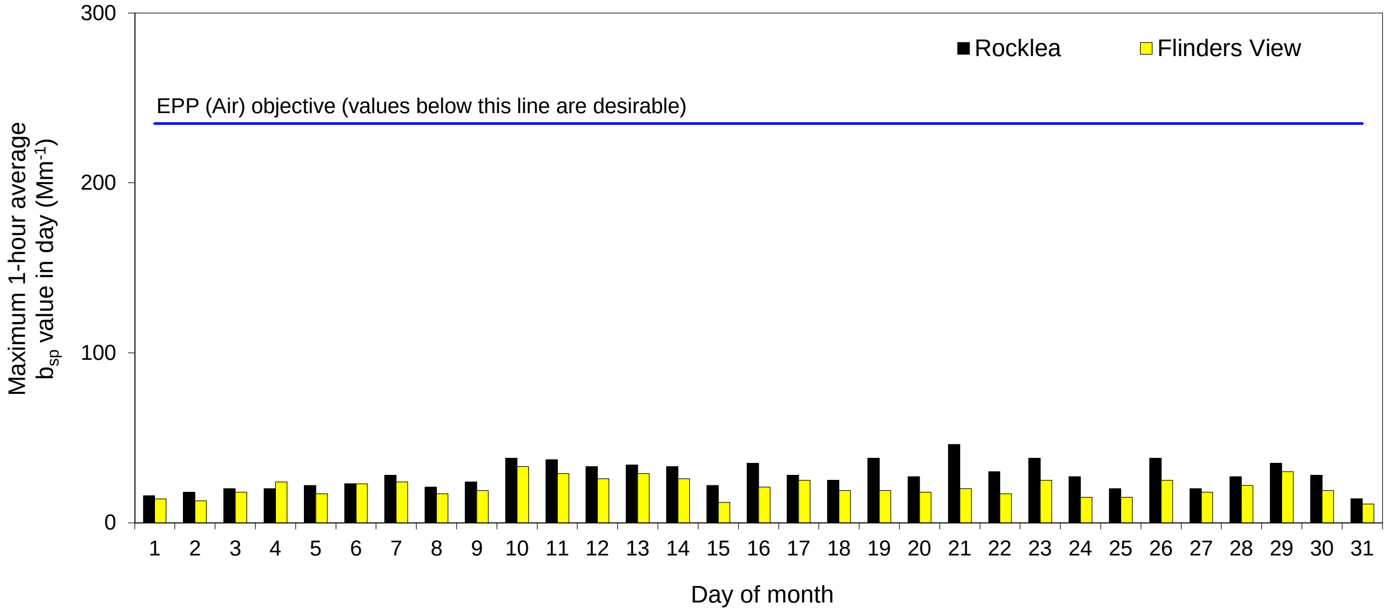

Table 11. Ambient visibility-reducing particle levels. Monthly maximum 1-hour average light scattering coefficient values (Mm^{-1}), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mountain Creek												
Maximum 1-hour	64	98	146	190	208	165	103	66	350	540	119	91
% I.A.	98	98	98	98	98	98	98	92	98	98	97	98
Brisbane CBD												
Maximum 1-hour	50	118	49	149	100	574	133	110	159	88	84	70
% I.A.	96	98	98	98	78	95	98	98	98	97	98	98
Rocklea												
Maximum 1-hour	46	125	88	147	n.d.	-	129	101	147	63	70	46
% I.A.	98	98	98	98	0	47	98	98	88	98	95	95
Flinders View												
Maximum 1-hour	48	121	193	264	121	109	184	770	143	202	68	33
% I.A.	98	98	97	97	98	98	98	98	98	98	98	98

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for visibility-reducing particles is 20 km visibility. This equates to light scattering coefficient values of 235 Mm^{-1} or less.

PM_{10}

Figure 20. Ambient concentrations of PM_{10} at Wynnum North, Wynnum West and Lytton sites. Daily 24-hour average concentrations (µg/m^3), March 2017.

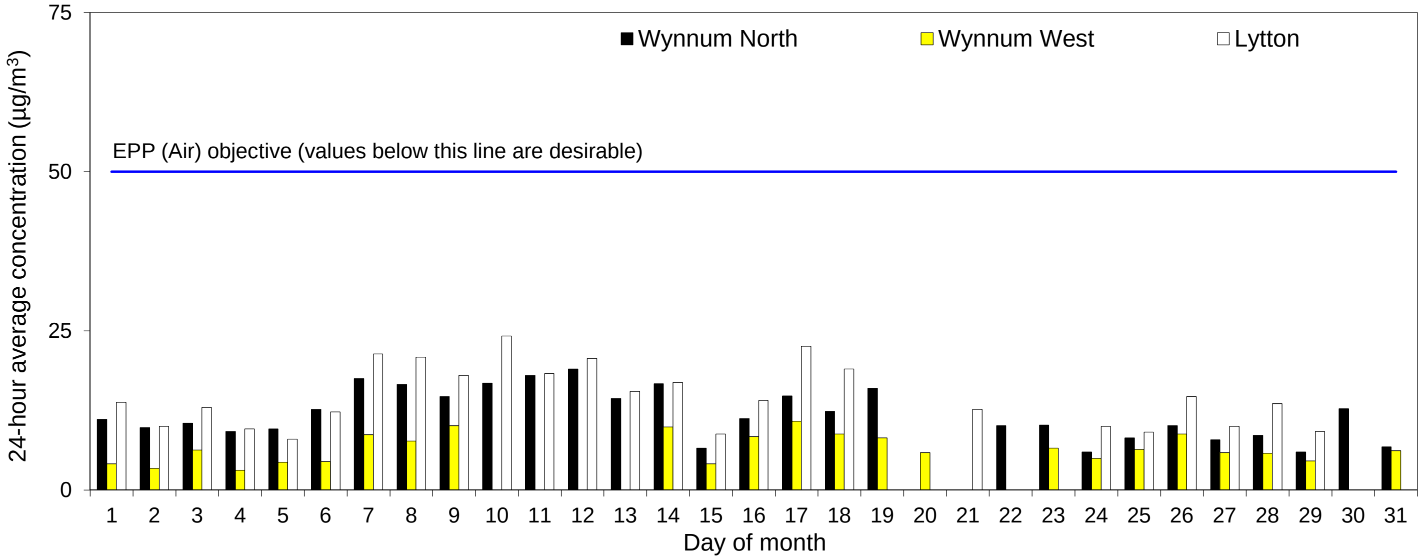

Figure 21. Ambient concentrations of PM_{10} at Mountain Creek, Cannon Hill and Brisbane CBD sites. Daily 24-hour average concentrations (µg/m^3), March 2017.

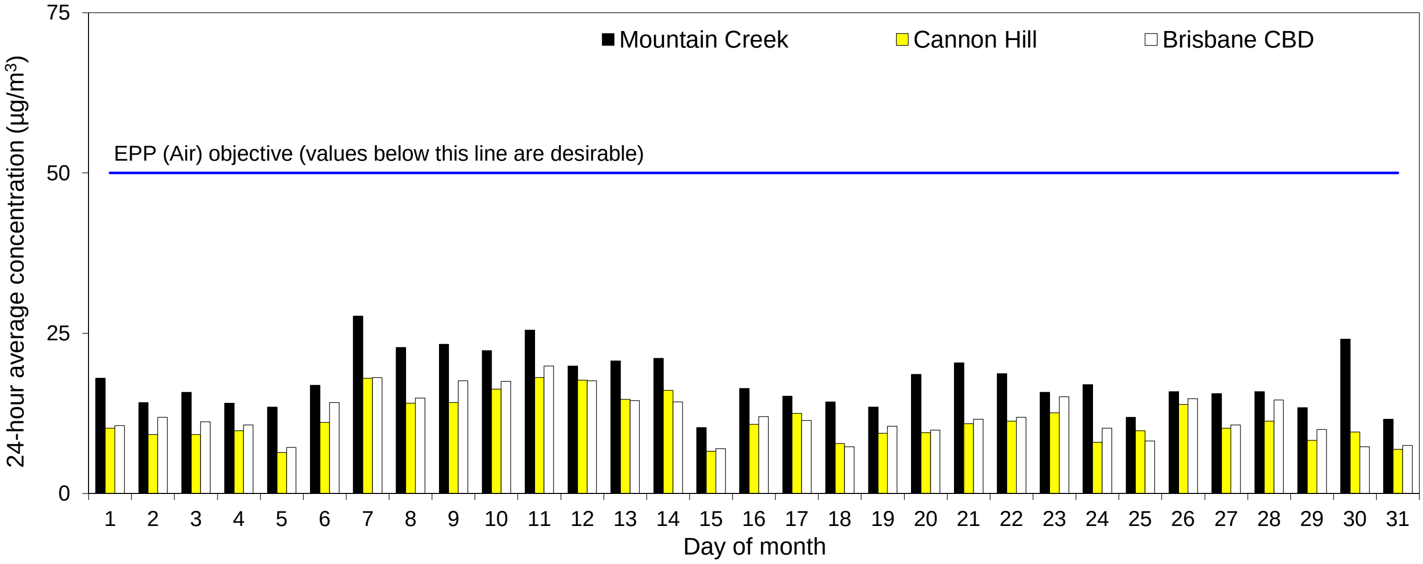

Figure 22. Ambient concentrations of PM_{10} at South Brisbane, Woolloongabba and Rocklea sites. Daily 24-hour average concentrations (µg/m^3), March 2017.

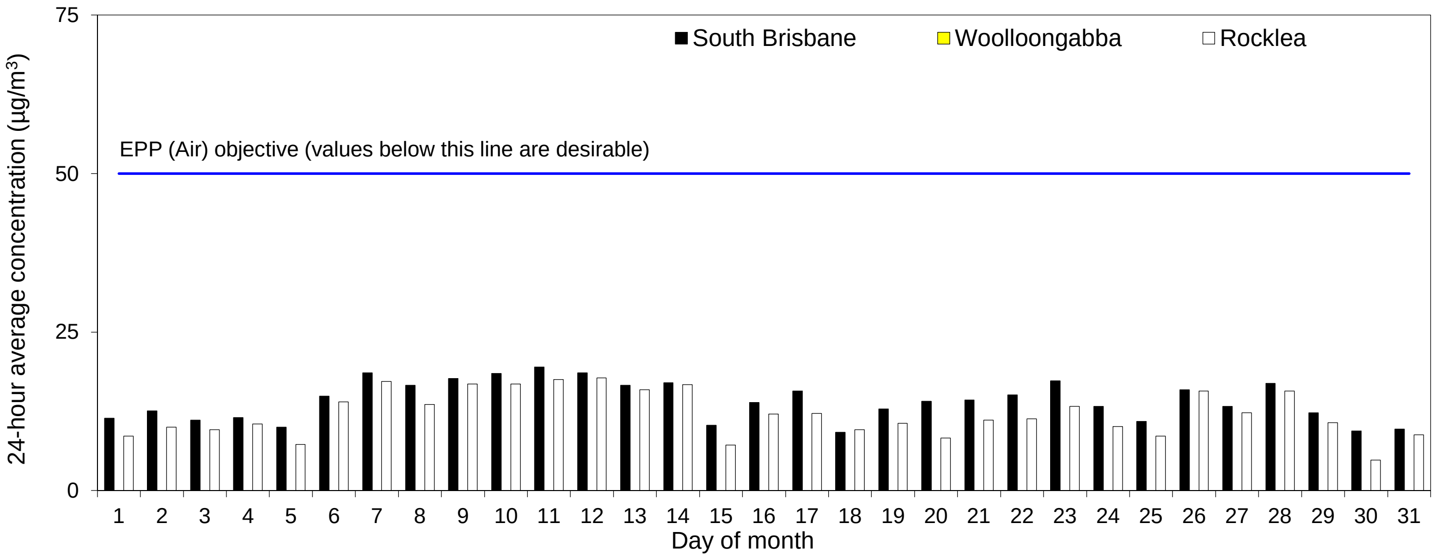

Figure 23. Ambient concentrations of PM_{10} at Springwood and Flinders View sites. Daily 24-hour average concentrations (µg/m^3), March 2017.

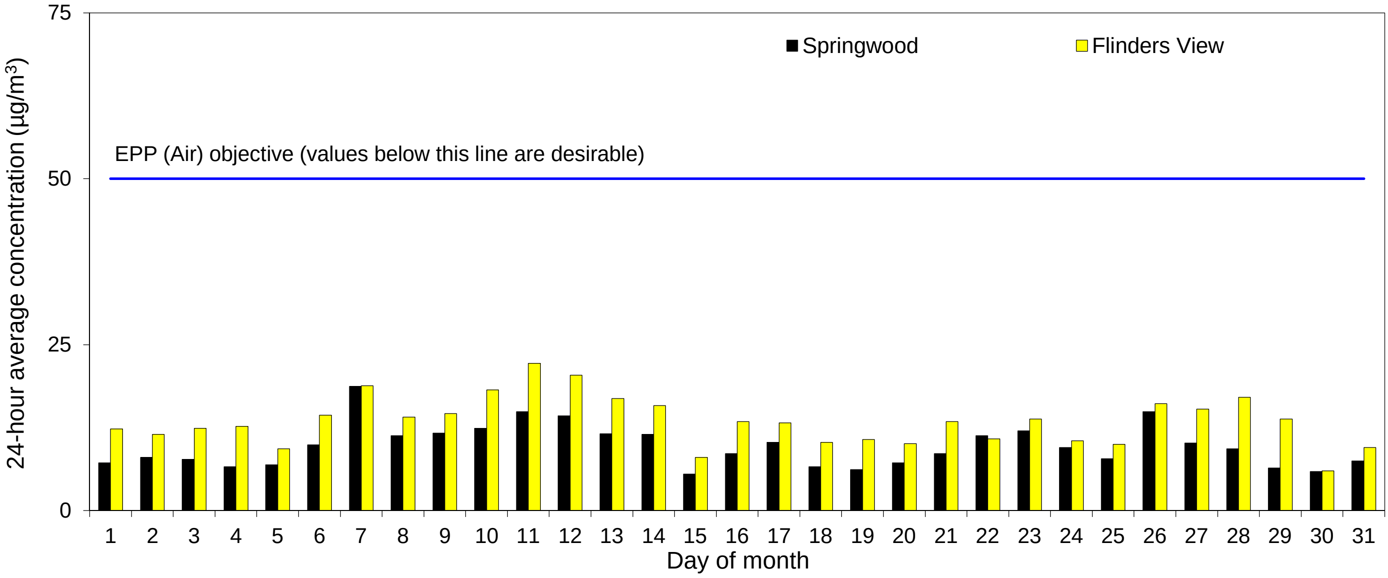

Table 12. Ambient concentrations of PM_{10}. Monthly maximum 24-hour average concentrations (µg/m^3), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Wynnum North (industry-operated site)													
Annual average:	14.5												
Maximum 24-hour		23.1	28.5	24.8	36.9	26.2	30.8	26.1	37.1	28.0	29.0	26.7	19.0
% I.A.		87	61	97	97	91	84	90	92	91	88	98	92
Wynnum West (industry-operated site)													
Annual average:	11.4												
Maximum 24-hour		21.2	35.0	34.2	35.7	21.9	21.8	24.3	23.4	19.3	20.0	16.1	10.8
% I.A.		99	97	81	95	100	97	98	99	91	82	99	84
Lytton (industry-operated site)													
Annual average:	17.6												
Maximum 24-hour		32.7	39.2	33.0	30.8	29.3	-	26.0	40.2	30.1	-	27.0	24.2
% I.A.		94	92	98	91	82	51	95	94	88	51	89	86
Mountain Creek													
Annual average:	16.1												
Maximum 24-hour		28.3	27.6	23.0	22.7	27.2	30.7	25.5	38.1	34.6	35.2	37.4	27.7
% I.A.		99	92	98	99	98	96	96	99	99	89	99	99
Cannon Hill													
Annual average:	14.0												
Maximum 24-hour		18.7	34.3	23.9	33.6	28.7	24.8	25.0	32.7	29.0	26.8	25.1	18.1
% I.A.		88	86	99	100	100	99	100	100	100	98	100	99

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for PM_{10} is a 24-hour average of 50 µg/m^3 (not to be exceeded on more than five days per year).

The *National Environment Protection (Ambient Air Quality) Measure* standards for PM_{10} are an annual average of 25 µg/m^3 and a 24-hour average of 50 µg/m^3.

Table 12 (contd). Ambient concentrations of PM_{10}. Monthly maximum 24-hour average concentrations (μg/m^3), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Brisbane CBD													
Annual average:	14.3												
Maximum 24-hour		25.0	32.0	22.3	23.9	24.5	22.2	23.4	32.7	28.6	31.1	28.1	19.9
% I.A.		99	100	99	98	79	96	97	100	99	99	89	100
South Brisbane													
Annual average:	16.3												
Maximum 24-hour		22.4	33.4	22.9	27.1	31.2	28.6	25.8	33.4	27.2	30.1	27.5	19.5
% I.A.		89	99	99	100	100	100	99	100	99	100	100	100
Woolloongabba†													
Annual average:	n.d.												
Maximum 24-hour		n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
% I.A.		0	0	0	0	0	0	0	0	0	0	0	0
Rocklea													
Annual average:	15.0												
Maximum 24-hour		24.2	31.2	21.1	28.2	27.0	25.5	24.6	30.9	27.3	27.3	27.7	17.8
% I.A.		99	96	68	97	96	83	79	99	96	98	99	98
Springwood													
Annual average:	12.3												
Maximum 24-hour		19.6	25.5	15.6	25.5	26.4	23.8	23.4	30.6	27.3	26.9	30.4	18.7
% I.A.		100	100	100	98	100	100	100	100	99	100	99	98
Flinders View													
Annual average:	13.6												
Maximum 24-hour		14.8	20.3	34.0	14.8	19.3	27.3	25.1	33.4	28.1	29.7	32.2	22.2
% I.A.		100	99	98	99	98	99	98	99	96	99	99	100

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

†Construction works forced the closure of the Woolloongabba monitoring site on 17 June 2016. Another location for the station is being investigated.

The *Environmental Protection (Air) Policy 2008* air quality objective for PM_{10} is a 24-hour average of 50 μg/m^3 (not to be exceeded on more than five days per year).

The *National Environment Protection (Ambient Air Quality) Measure* standards for PM_{10} are an annual average of 25 μg/m^3 and a 24-hour average of 50 μg/m^3.

$PM_{2.5}$

Figure 24. Ambient concentrations of $PM_{2.5}$ at Wynnum North, Wynnum West and Lytton sites. Daily 24-hour average concentrations (µg/m^3), March 2017.

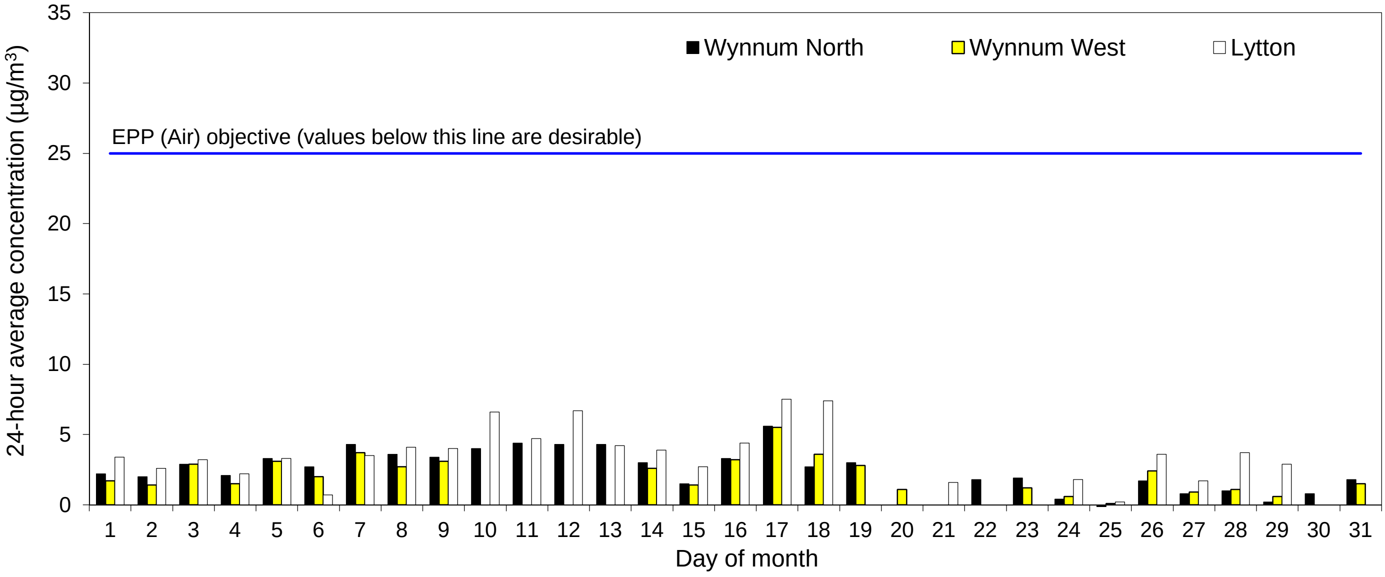

Figure 25. Ambient concentrations of $PM_{2.5}$ at Cannon Hill, South Brisbane and Woolloongabba sites. Daily 24-hour average concentrations (µg/m^3), March 2017.

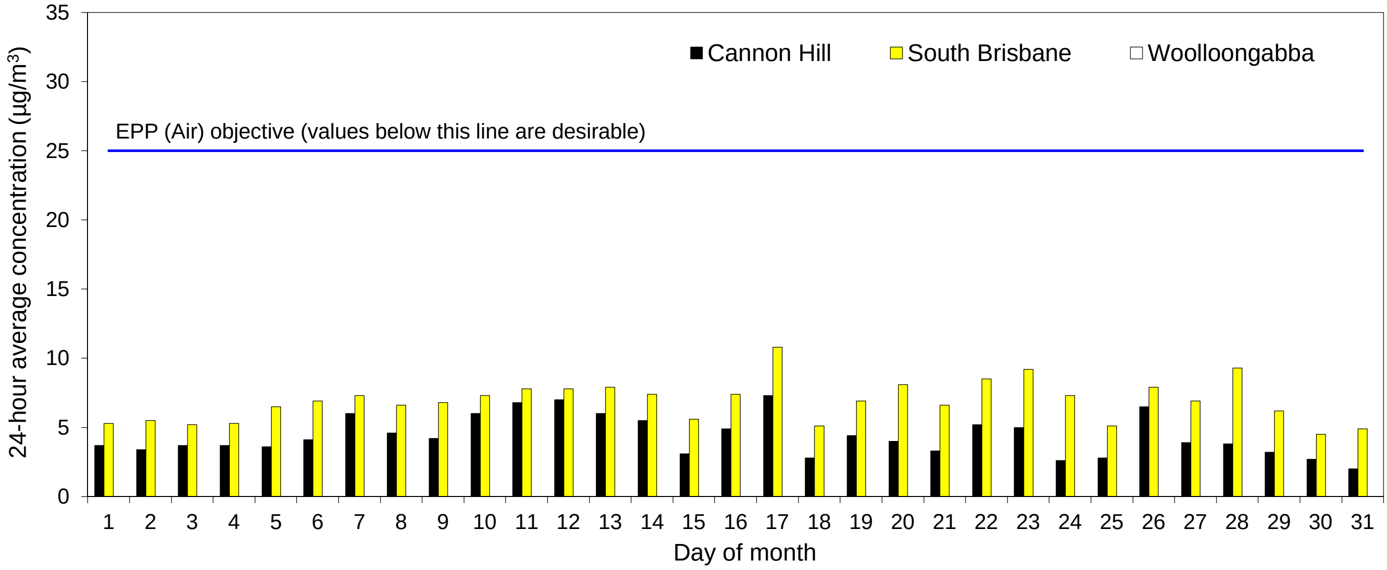

Figure 26. Ambient concentrations of $PM_{2.5}$ at Springwood and Rocklea sites. Daily 24-hour average concentrations (µg/m^3), March 2017.

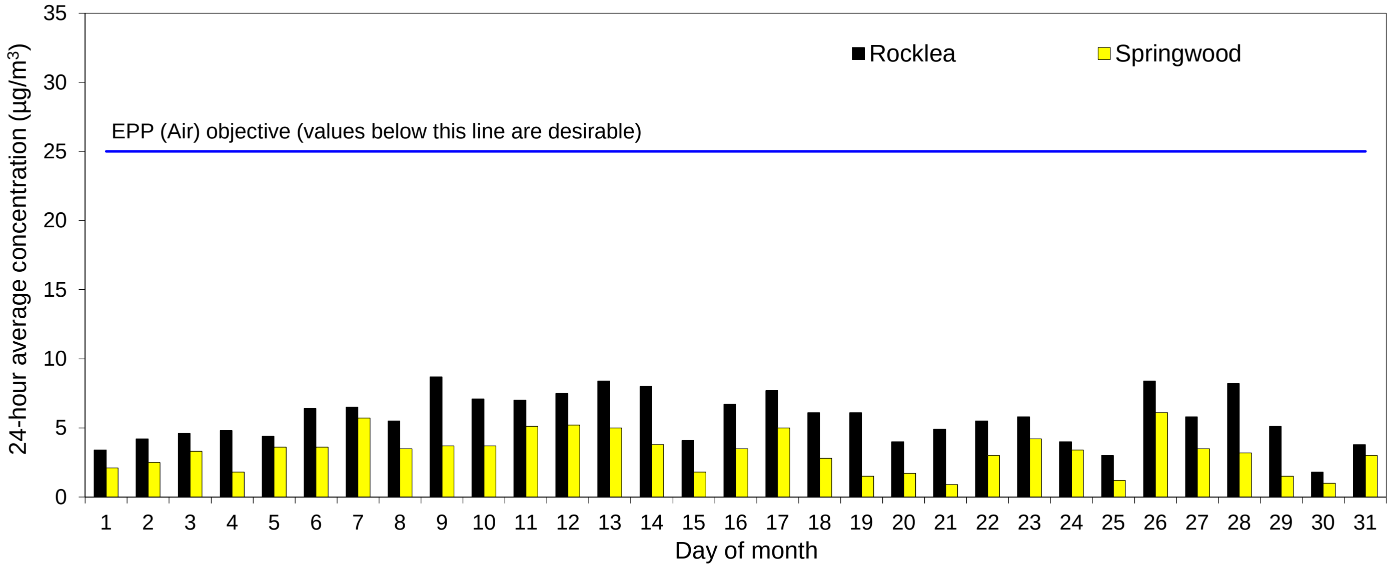

Table 13. Ambient concentrations of $PM_{2.5}$. Annual average and monthly maximum 24-hour average concentrations (µg/m^3), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Wynnum North (industry-operated site)													
Annual average:	4.3												
Maximum 24-hour		6.5	12.8	9.1	13.9	15.1	19.6	11.8	11.8	12.5	11.5	8.2	5.6
% I.A.		87	61	97	97	91	84	90	92	91	88	98	92
Wynnum West (industry-operated site)													
Annual average:	4.0												
Maximum 24-hour		5.5	12.6	10.7	12.7	12.3	16.8	16.8	11.1	10.4	6.1	6.5	5.5
% I.A.		99	97	81	95	100	97	98	99	91	82	99	84
Lytton (industry-operated site)													
Annual average:	5.0												
Maximum 24-hour		7.7	15.7	12.6	13.2	11.4	-	12.0	11.7	12.7	-	8.7	7.5
% I.A.		94	92	98	91	82	51	95	94	88	51	89	86
Cannon Hill													
Annual average:	6.9												
Maximum 24-hour		10.9	21.3	15.6	28.9	20.6	16.2	11.3	14.0	15.3	10.5	11.0	7.3
% I.A.		97	98	99	100	100	99	100	100	100	98	100	99
South Brisbane													
Annual average:	8.6												
Maximum 24-hour		11.8	19.0	13.7	21.2	22.0	19.9	14.5	17.0	15.0	13.3	11.6	10.8
% I.A.		89	99	99	100	100	100	99	100	99	100	100	100
Woolloongabba†													
Annual average:	n.d.												
Maximum 24-hour		n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
% I.A.		0	0	0	0	0	0	0	0	0	0	0	0
Rocklea													
Annual average:	7.0												
Maximum 24-hour		7.6	14.6	12.3	19.9	16.7	16.2	13.4	15.2	17.0	12.5	13.4	8.7
% I.A.		99	96	68	97	96	83	79	99	96	98	99	98
Springwood													
Annual average:	5.6												
Maximum 24-hour		10.5	13.4	10.1	20.1	19.2	16.0	11.4	13.2	14.3	10.7	11.3	6.1
% I.A.		100	100	100	98	100	100	100	100	99	100	99	98

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

†Construction works forced the closure of the Woolloongabba monitoring site on 17 June 2016. Another location for the station is being investigated.

The *Environmental Protection (Air) Policy 2008* air quality objectives for $PM_{2.5}$ are an annual average of 8 µg/m^3 and a maximum 24-hour average of 25 µg/m^3.

TSP

Figure 27. Ambient concentrations of TSP at Cannon Hill site. Daily 24-hour average concentrations (µg/m^3), March 2017.

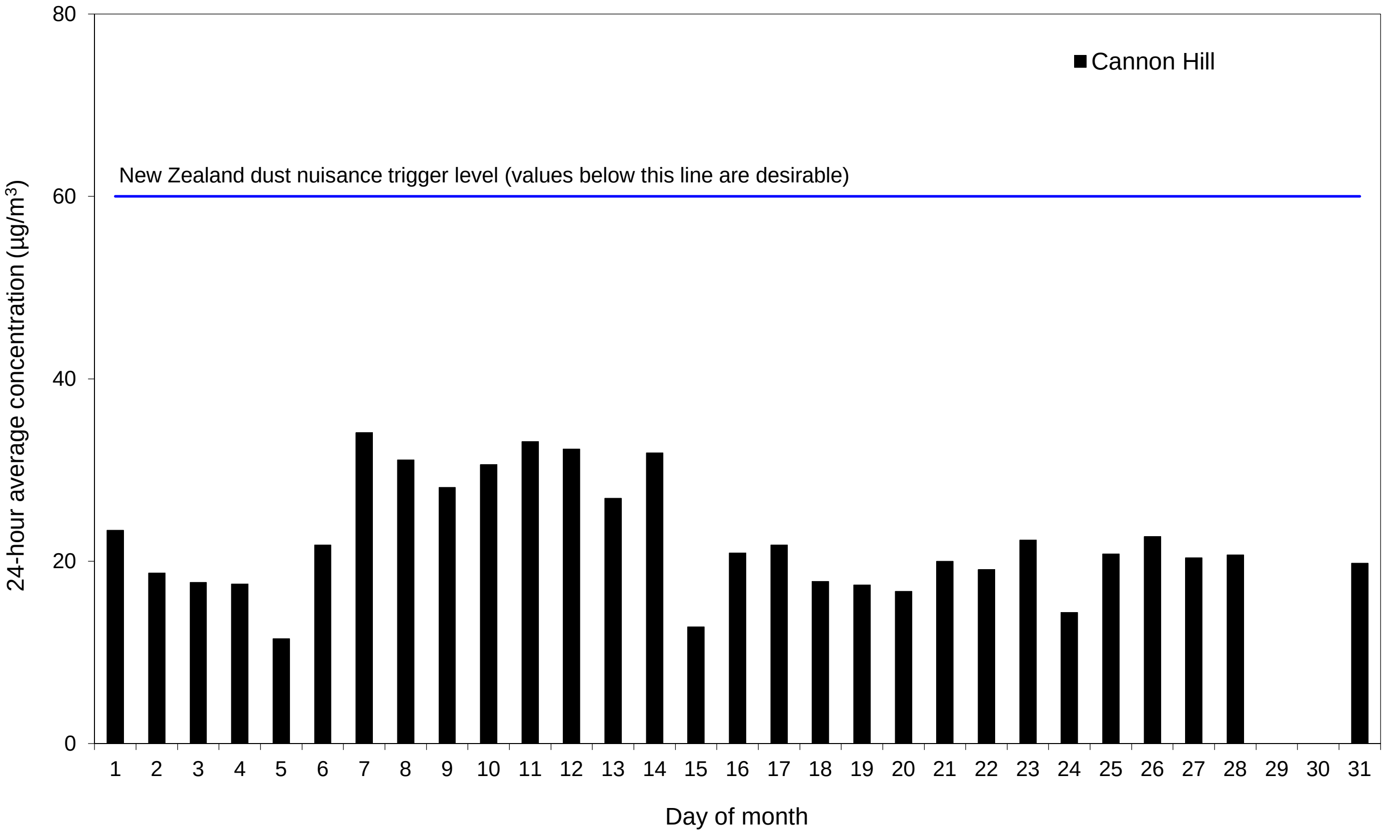

Table 14. Ambient concentrations of TSP. Annual average and monthly maximum 24-hour average concentrations (µg/m^3), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Cannon Hill													
Annual average:	24.9												
Maximum 24-hour		41.9	49.5	32.1	38.9	40.1	38.8	58.4	53.7	44.1	48.0	42.0	34.1
% I.A.		99	96	99	100	99	99	99	98	100	98	99	94

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for TSP is an annual average of 90 µg/m^3.

The Department of Environment and Heritage Protection Air Impacts Guideline recommends that short-term (24-hour) TSP concentrations be compared against the trigger levels provided in the New Zealand Ministry for the Environment's *Good practice guide for assessing and managing the environmental effects of dust emissions* to assess dust nuisance impacts. The New Zealand dust nuisance trigger level for high sensitivity areas is a 24-hour average of 60 µg/m^3.

Dustfall

Figure 28. Dust deposition rates at Cannon Hill and Fairfield sites. Daily dust (insoluble solids fraction) deposition rate ($mg/m^2/day$) for month of March 2017.

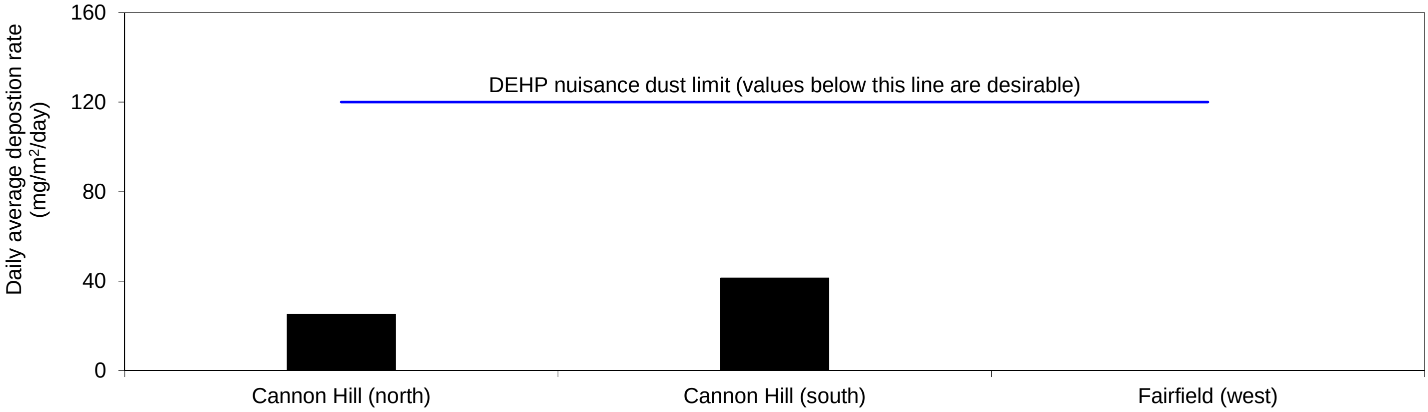

Figure 29. Dust deposition rates at Toowoomba site. Daily dust (insoluble solids fraction) deposition rate ($mg/m^2/day$) for month of March 2017.

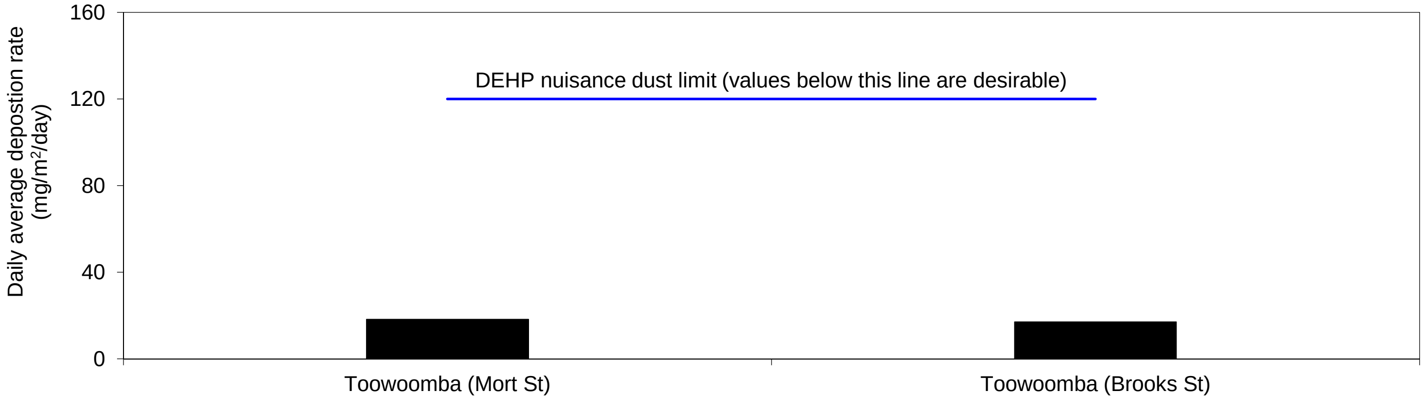

Table 15. Monthly average dust (insoluble solids fraction) deposition rate ($mg/m^2/day$), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Cannon Hill (north)†												
Daily average	37	22	13	17	31	23	42	33	44	26	43	25
Cannon Hill (south)†												
Daily average	58	29	44	31	36	42	66	36	65	123	50	41
Fairfield (west)†												
Daily average	27	24	21	19	25	29	16	n.d.	n.d.	22	23	n.d.
Toowoomba (Mort St)												
Daily average	22	38	28	37	31	25	40	74	80	203	43	18
Toowoomba (Brooks St)												
Daily average	3	n.d.	7	76	37	47	32	51	36	55	40	17

n.d. indicates no data are available.

†At the Cannon Hill site dustfall monitoring is carried out on both sides of the rail corridor. At Fairfield, monitoring is only carried out on the western site of the rail corridor following repeated vandalism of the sampler previously located on the eastern side.

The Department of Environment and Heritage Protection Air Impacts Guideline recommends a dust deposition limit of 120 $mg/m^2/day$, averaged over one month, be used to assess dust nuisance.

There is the minimum dust deposition rate that can be determined with the sampling equipment and laboratory method used. Dust deposition rates below this minimum reporting value are preceded by a "<" sign in this table.

Data Availability

When required, Table 16 summarises the reasons for data availability below the minimum criteria for reporting at South East Queensland monitoring sites.

Table 16. Reasons for low data availability at South East Queensland ambient air monitoring sites during March 2017.

Station	Air Pollutant	Cause
Woolloongabba	All parameters	Construction works required the station to close. Another location is being investigated.
Fairfield	Dustfall	Invalid sample - sampler damaged during roadworks

Related air quality information

Current hourly air quality data is available from the internet at www.ehp.qld.gov.au/air/data/search.php.

Additional information on air quality monitoring and related issues is also available from the above website.

Further information

For further information about the data presented in this bulletin or related publications, contact:

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Environmental Monitoring and Assessment Sciences
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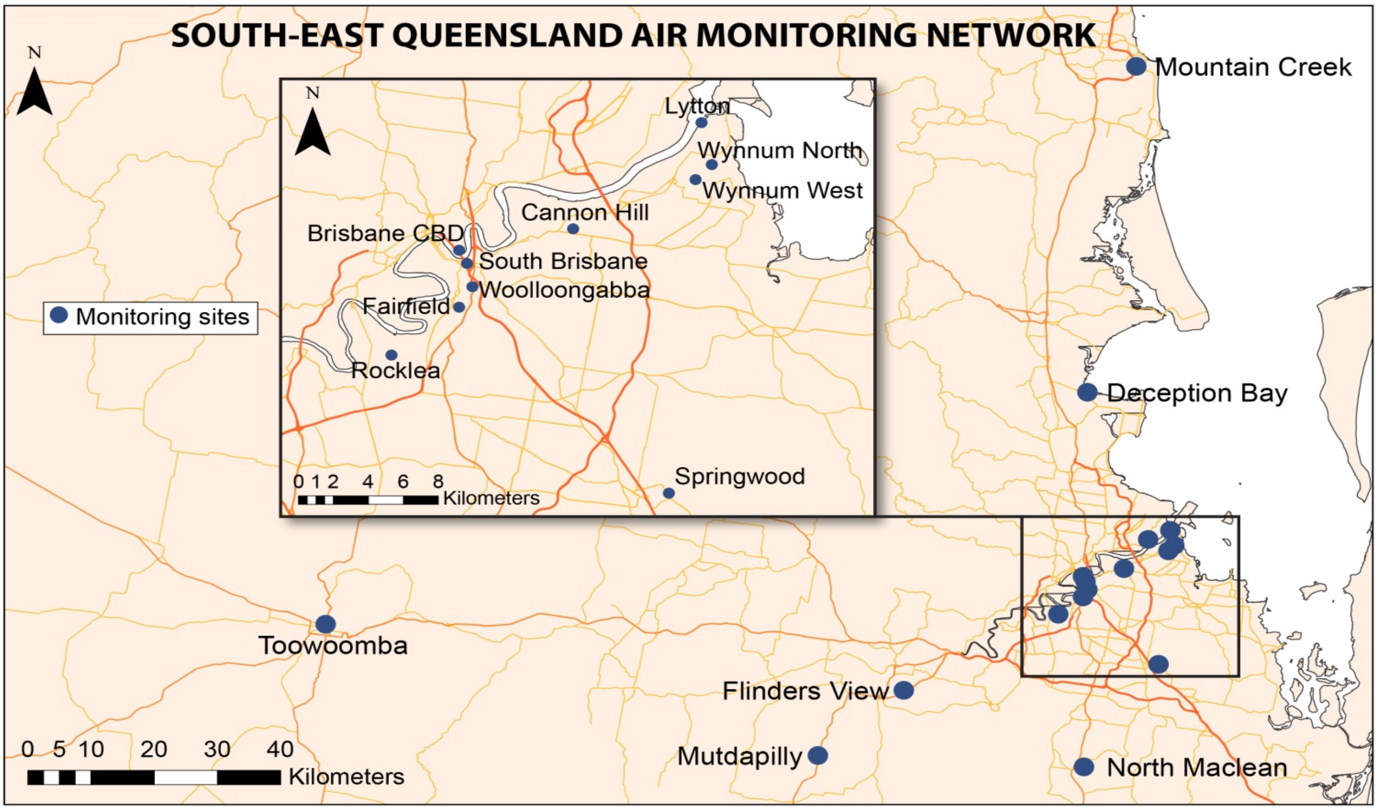
Department of Science, Information Technology and Innovation
Ecosciences Precinct
41 Boggo Rd
DUTTON PARK QLD 4102
Telephone (07) 3170 5477
Email: air.sciences@dsiti.qld.gov.au

Figure 30. South East Queensland ambient air quality monitoring station locations.



Department of Science, Information Technology and Innovation

Air quality bulletin

Central Queensland

March 2017

Queensland Government

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June 2017

Introduction

Air quality monitoring gathers information on the quality of the air environment. The objectives of the monitoring are to check compliance with ambient air quality guidelines, identify long-term trends in air quality, investigate local air quality concerns and assess the effectiveness of air quality management strategies.

In Central Queensland, air quality monitoring was carried out by the Queensland Government at eight sites in the Gladstone region, one site in Mackay and one site in Moranbah during March 2017.

Air pollutants monitored included nitrogen oxides, sulfur dioxide, carbon monoxide, ozone, benzene, toluene, total xylenes, formaldehyde, PM_{10} and $PM_{2.5}$ (particles with diameters less than 10 µm and 2.5 µm respectively) and visibility-reducing particles. The air pollutants monitored at Central Queensland sites are shown in Table 1. Site locations are shown in Figure 23 at the end of this bulletin.

The monitoring site in central Gladstone (Memorial Park) uses an open-path monitoring method. Gaseous pollutant measurements at this site are the average concentration over the light path running from the Gladstone Entertainment Centre to Memorial Park (see Figure 23).

The monitoring site at Fisherman's Landing was established in March 2016 in close proximity to Curtis Island to measure the impact of any emissions from LNG facilities. The site is located on industrial land and, as such, measured pollutant levels do not reflect typical population exposure in the Gladstone region.

Reporting protocol

Data presented in this bulletin are based on clock hours. Hourly or other averages are constrained to start and finish on a clock hour.

Air quality summary graphs

Figures 1 to 22 summarise available air quality data for each day of March. Only the maximum recorded level for each day is used to show the day-to-day variation in air quality.

Air quality summary tables

Tables 4 to 17 present monthly summaries of air quality data for the preceding 12 months. These tables show the month-to-month variation in air quality. A monthly entry is given when at least three-fifths of the maximum possible number of observations during the month are available. When data is not available for the entire month, due to equipment malfunction or other reason, this is indicated by the abbreviation 'n.d.' (no data). A dash is inserted when less than three-fifths of the data are available. Where no data is recorded, the reason for the low data availability is summarised in Table 18 at the end of this bulletin.

Guidelines

Air quality measurements are compared against air quality standards contained in the Queensland Government *Environmental Protection (Air) Policy 2008* (EPP (Air)) to assess whether pollutant levels could harm health and well being. Twelve-month average PM_{10} concentrations are also compared against the *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) annual standard. The EPP (Air) visibility objective is used to assess the impact of visibility-reducing particles on visual air quality. The relevant guidelines are shown in the air quality summary table for each pollutant.

Table 1. Air pollutants monitored at Central Queensland sites.

	Nitrogen dioxide	Sulfur dioxide	Carbon monoxide	Ozone	Benzene	Toluene	Total xylenes	Formaldehyde	PM_{10}	$PM_{2.5}$	Visibility-reducing particles
Gladstone											
Targinie	✓	✓							✓	✓	✓
Fisherman's Landing	✓	✓							✓	✓	✓
Boat Creek	✓	✓							✓	✓	✓
Clinton	✓	✓							✓	✓	✓
Auckland Point									✓		
Memorial Park	✓	✓		✓	✓	✓	✓	✓			
South Gladstone	✓	✓							✓	✓	✓
Boyne Island	✓	✓	✓						✓	✓	✓
Mackay											
West Mackay									✓		✓
Moranbah											
Moranbah									✓		

Compliance with air quality guidelines - Gladstone

During March, measured pollutant levels, with the exception of PM_{10}, did not exceed the relevant EPP (Air) air quality objective or Air NEPM standard at the Queensland Government air monitoring sites in the Gladstone region.

The Air NEPM annual average PM_{10} standard was exceeded at the Fisherman's Landing site for the 12-month period ending March 2017 due to dust emissions within the industrial area.

Table 2. Number of occasions during March 2017 when measured levels exceeded EPP (Air) objectives or Air NEPM standards for nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone, benzene, toluene, xylenes, formaldehyde, visibility-reducing particles, PM_{10} and $PM_{2.5}$ at the Queensland Government air monitoring sites in Gladstone.

Air pollutant	Averaging period	Exceedences
Nitrogen dioxide	*EPP (Air)*	
	Annual	0
	1-hour	0
Sulfur dioxide	*EPP (Air)*	
	Annual	0
	24-hour	0
	1-hour	0
Carbon monoxide	*EPP (Air)*	
	8-hour	0
Ozone	*EPP (Air)*	
	4-hour	0
	1-hour	0
Benzene	*EPP (Air)*	
	Annual	0
Toluene	*EPP (Air)*	
	Annual	0
	24-hour	0
Xylenes	*EPP (Air)*	
	Annual	0
	24-hour	0
Formaldehyde	*EPP (Air)*	
	24-hour	0
PM_{10}	*Air NEPM*	
	Annual	1
	EPP (Air)	
	24-hour	0
$PM_{2.5}$	*EPP (Air)*	
	Annual	0
	24-hour	0
Visibility-reducing particles (objective refers to protecting aesthetic environment, not health and wellbeing)	*EPP (Air)*	
	1-hour	0

Compliance with air quality guidelines - Mackay and Moranbah

During March measured pollutant levels did not exceed the relevant EPP (Air) air quality objective or Air NEPM standard at the Queensland Government air monitoring site in Mackay.

In Moranbah, PM_{10} levels did not exceed EPP (Air) air quality objective or Air NEPM standards during March.

Table 3. Number of occasions during March 2017 when measured levels exceeded the EPP (Air) air quality objectives or Air NEPM standards $_a$t the Queensland Government air monitoring sites in Mackay and Moranbah.

Air pollutant	Averaging period	Exceedences
PM_{10}	*Air NEPM*	
	Annual	0
	EPP (Air)	
	24-hour	0
	EPP (Air)	
	1-hour	0

Measured ambient concentrations - Gladstone

Nitrogen dioxide

Figure 1. Ambient concentrations of nitrogen dioxide at Targinie, Fisherman's Landing, Boat Creek and Clinton sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

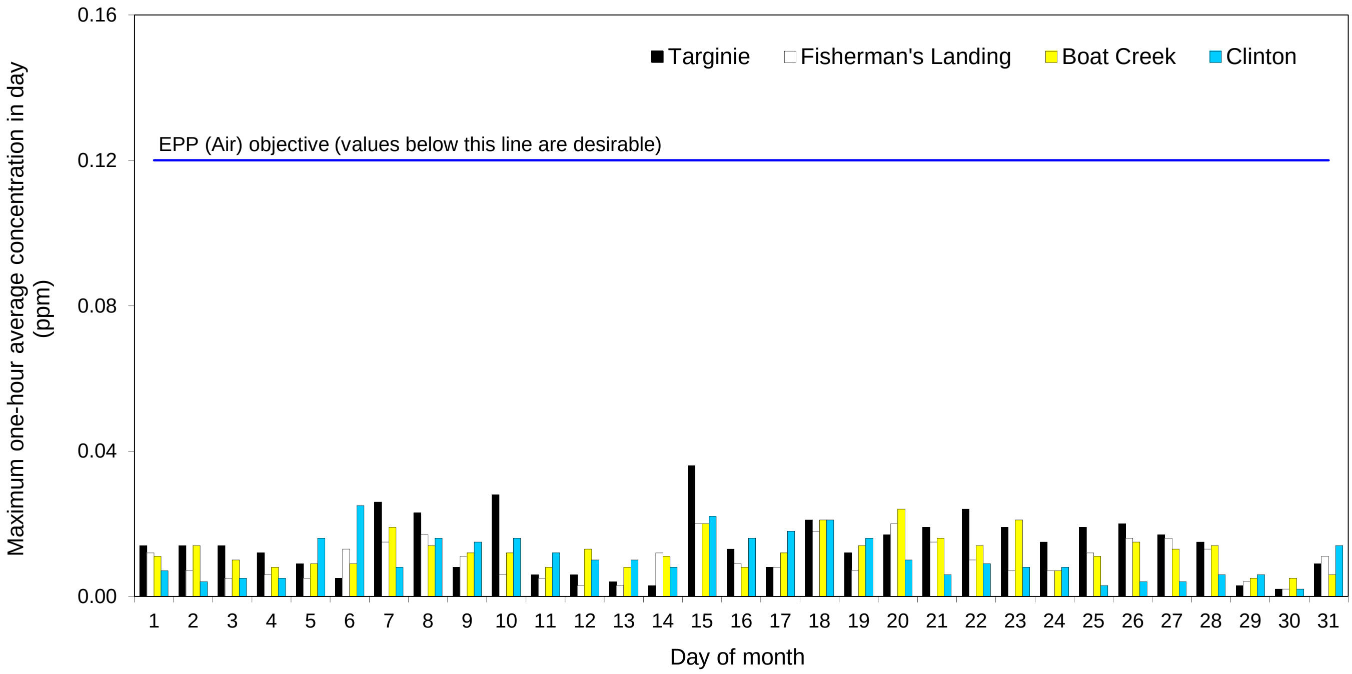

Figure 2. Ambient concentrations of nitrogen dioxide at Memorial Park, South Gladstone and Boyne Island sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

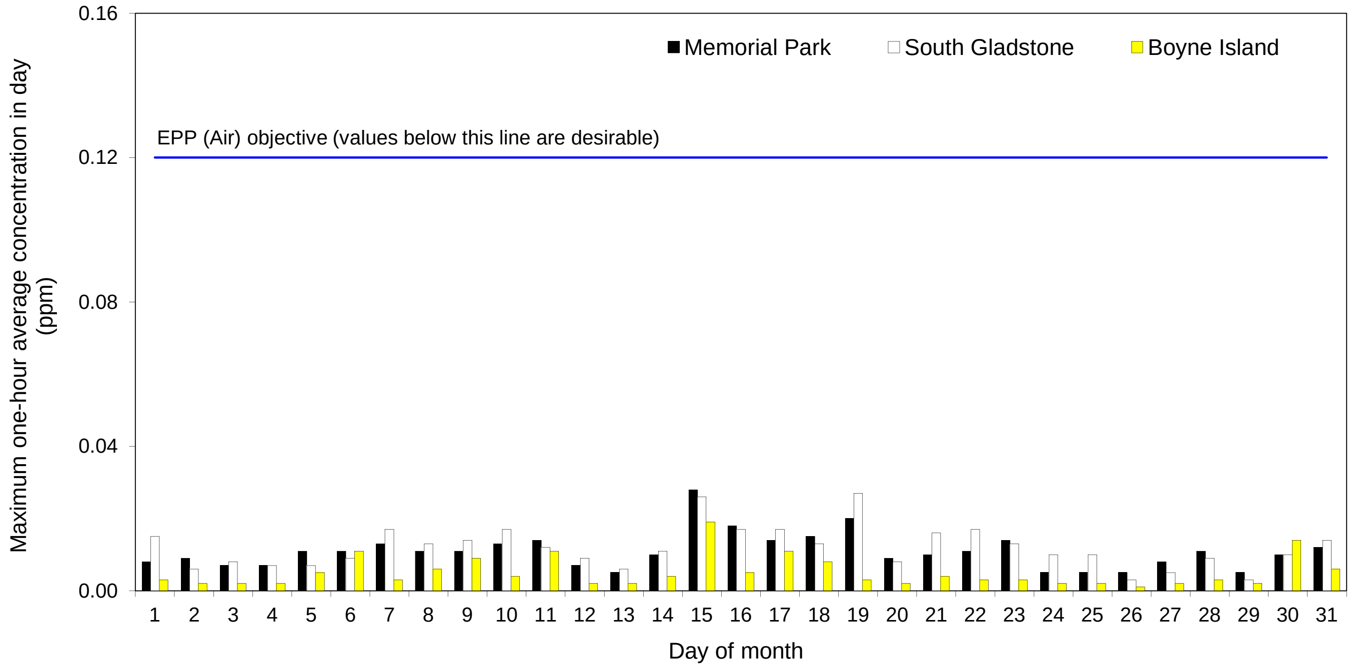

Table 4. Ambient concentrations of nitrogen dioxide. Annual average and monthly maximum 1-hour concentrations (ppm), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region													
Targinie													
Annual average:	0.004												
Maximum 1-hour		0.035	0.043	0.032	0.039	0.033	0.036	0.027	0.031	0.029	0.025	0.026	0.036
% I.A.		97	98	98	98	97	98	98	97	98	98	96	98
Fisherman's Landing													
Annual average:	0.003												
Maximum 1-hour		0.027	0.022	0.030	0.028	0.032	0.022	0.016	0.024	0.024	0.022	0.019	0.020
% I.A.		98	98	98	98	97	98	98	98	98	98	97	93
Boat Creek													
Annual average:	0.005												
Maximum 1-hour		0.025	0.032	0.033	0.029	0.030	0.033	0.024	0.028	0.024	0.023	0.025	0.024
% I.A.		98	97	97	98	97	97	98	98	98	98	97	97
Clinton													
Annual average:	0.005												
Maximum 1-hour		0.013	0.029	0.031	0.028	0.026	0.025	0.030	0.020	0.017	0.017	0.026	0.025
% I.A.		98	98	98	84	98	97	98	97	98	79	98	97
Memorial Park													
Annual average:	0.004												
Maximum 1-hour		0.020	0.032	0.031	0.032	0.028	0.030	0.028	0.028	0.020	0.012	0.015	0.028
% I.A.		100	100	100	91	100	100	87	100	100	81	82	98
South Gladstone													
Annual average:	0.005												
Maximum 1-hour		0.024	0.033	0.037	0.029	0.032	0.035	0.029	0.030	0.024	0.026	0.027	0.027
% I.A.		98	98	98	98	98	98	98	97	98	98	98	97
Boyne Island													
Annual average:	0.001												
Maximum 1-hour		0.008	0.027	0.025	0.022	0.021	0.027	0.016	0.022	0.010	0.018	0.021	0.019
% I.A.		98	98	98	98	98	97	98	98	98	97	98	95

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for nitrogen dioxide are an annual average of 0.030 ppm and a 1-hour average of 0.120 ppm (not to be exceeded on more than one day per year).

Sulfur Dioxide

Figure 3. Ambient concentrations of sulfur dioxide at Targinie, Fisherman's Landing, Boat Creek and Clinton sites. Daily 24-hour average concentrations (ppm), March 2017.

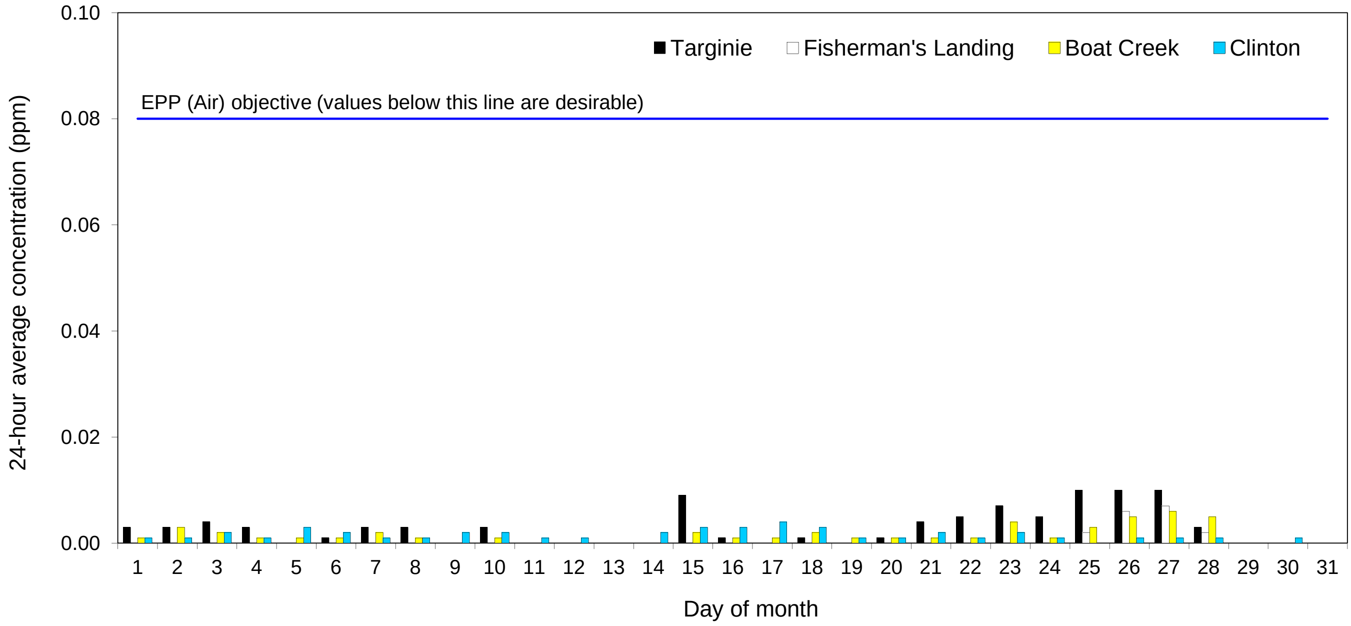

Figure 4. Ambient concentrations of sulfur dioxide at Memorial Park, South Gladstone and Boyne Island sites. Daily 24-hour average concentrations (ppm), March 2017.

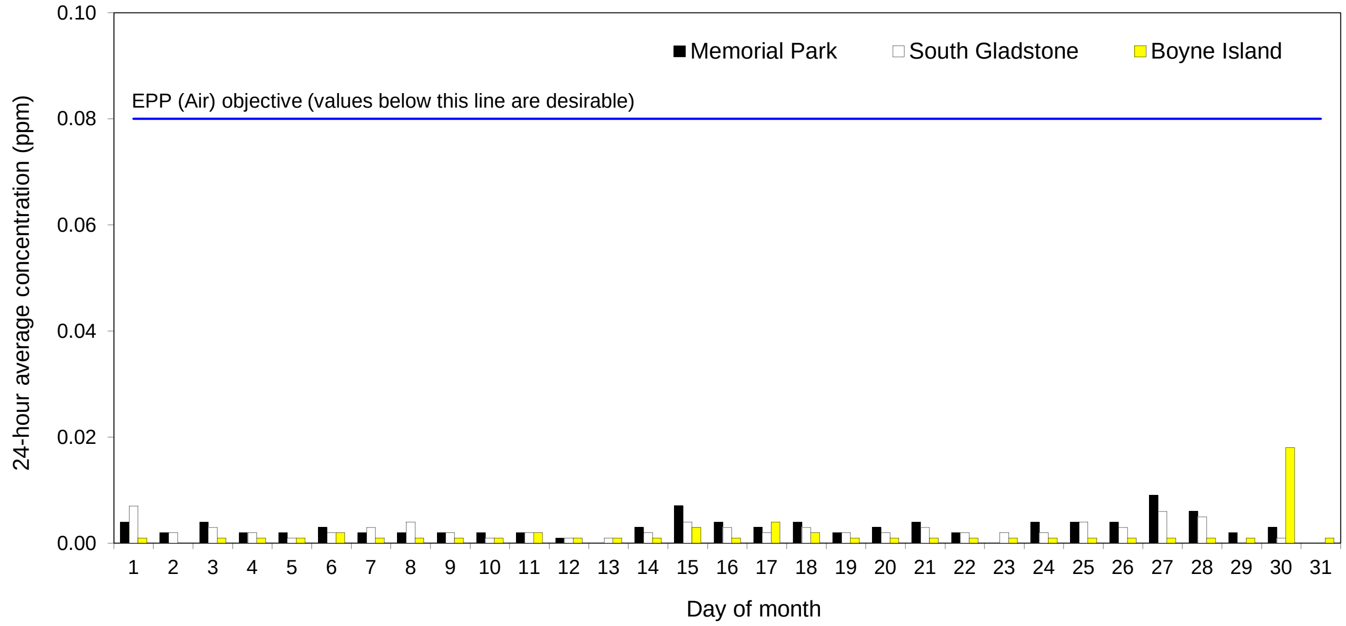

Figure 5. Ambient concentrations of sulfur dioxide at Targinie, Fisherman's Landing, Boat Creek and Clinton sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

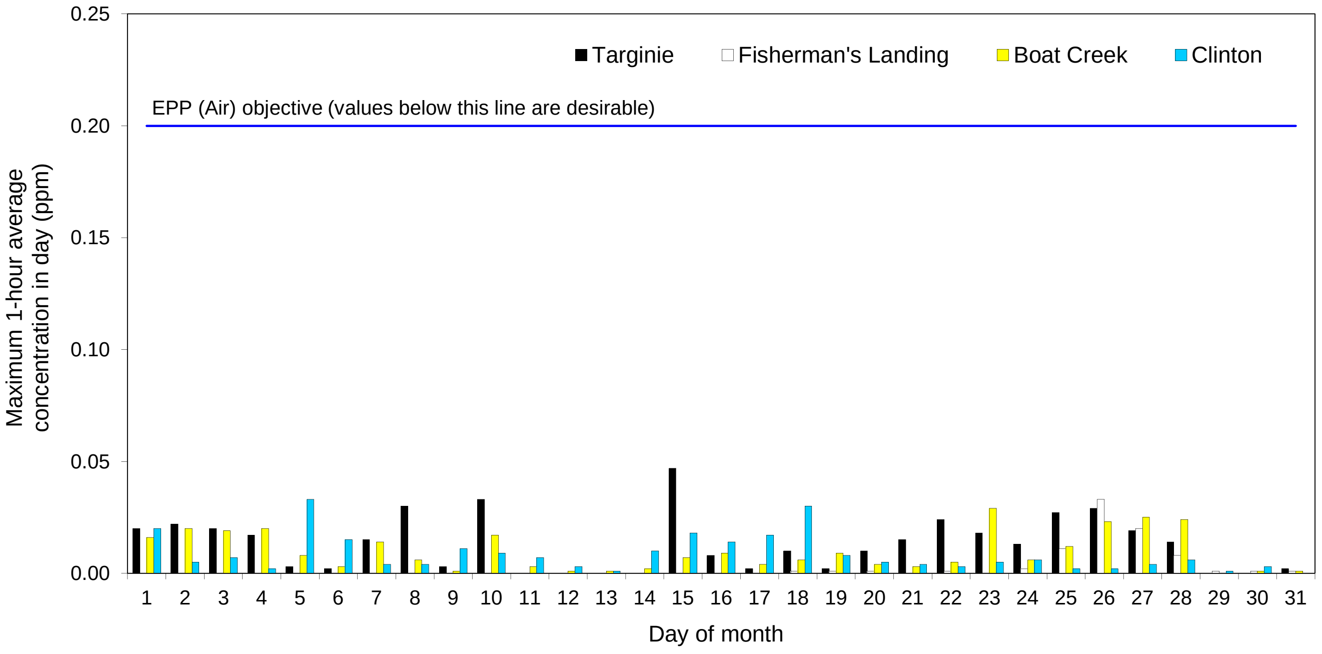

Figure 6. Ambient concentrations of sulfur dioxide at Memorial Park, South Gladstone and Boyne Island sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

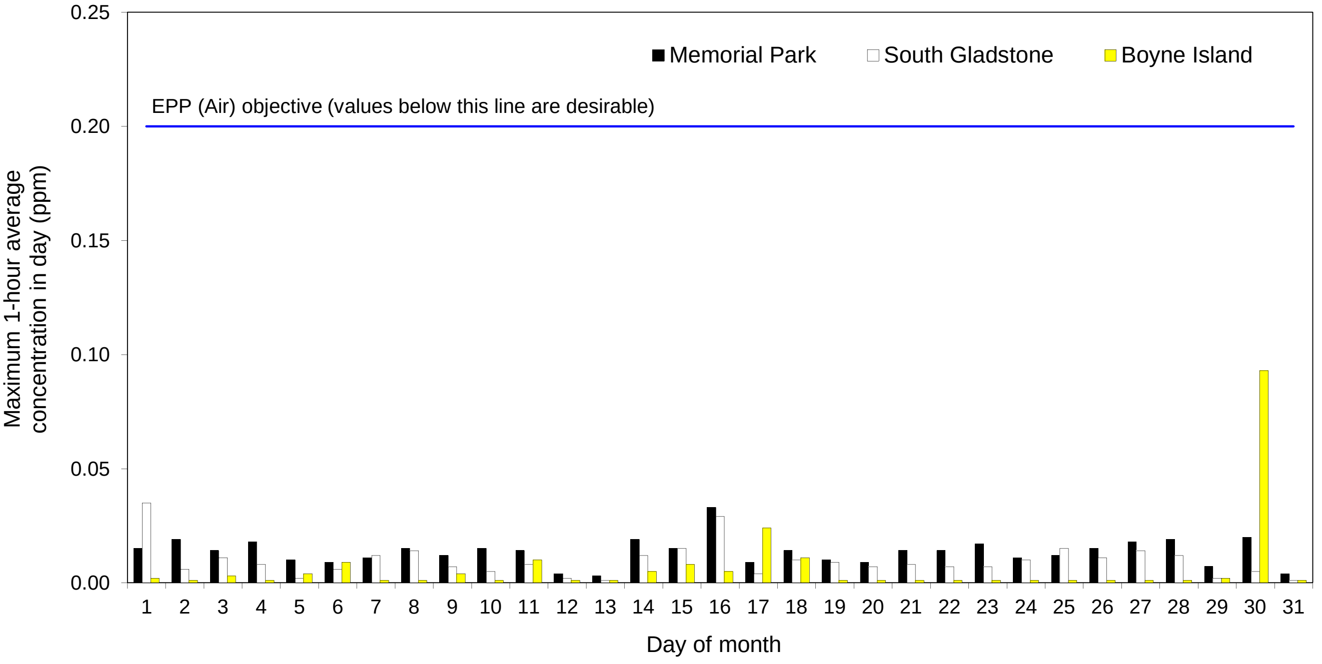

Table 5. Ambient concentrations of sulfur dioxide. Annual average and monthly maximum 24-hour and 1-hour average concentrations (ppm), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region													
Targinie													
Annual average:	0.003												
Maximum 24-hour		0.008	0.009	0.007	0.012	0.011	0.006	0.004	0.006	0.009	0.009	0.004	0.010
Maximum 1-hour		0.028	0.049	0.072	0.042	0.031	0.029	0.024	0.026	0.029	0.024	0.025	0.047
% I.A.		97	98	95	98	97	98	98	97	98	98	96	98
Fisherman's Landing													
Annual average:	0.001												
Maximum 24-hour		0.007	0.005	0.004	0.004	0.004	0.002	0.003	0.002	0.002	0.001	0.001	0.007
Maximum 1-hour		0.046	0.021	0.030	0.014	0.032	0.016	0.015	0.014	0.008	0.005	0.003	0.033
% I.A.		97	98	98	98	97	98	98	98	98	98	97	97
Boat Creek													
Annual average:	0.002												
Maximum 24-hour		0.008	0.009	0.007	0.013	0.006	0.004	0.004	0.004	0.009	0.014	0.005	0.006
Maximum 1-hour		0.042	0.049	0.060	0.041	0.038	0.044	0.031	0.031	0.036	0.041	0.033	0.029
% I.A.		97	98	97	98	80	97	98	98	98	98	96	97
Clinton													
Annual average:	0.001												
Maximum 24-hour		0.002	0.005	0.004	0.004	0.007	0.004	0.004	0.005	0.004	0.004	0.004	0.004
Maximum 1-hour		0.010	0.047	0.047	0.033	0.052	0.047	0.038	0.023	0.027	0.027	0.031	0.033
% I.A.		98	98	98	84	98	97	98	97	98	79	98	97
Memorial Park													
Annual average:	0.003												
Maximum 24-hour		0.006	0.007	0.009	0.016	0.009	0.006	0.005	0.007	0.007	0.008	0.005	0.009
Maximum 1-hour		0.030	0.041	0.057	0.077	0.045	0.039	0.044	0.091	0.045	0.023	0.025	0.033
% I.A.		99	100	100	91	100	100	87	100	100	81	82	97
South Gladstone													
Annual average:	0.002												
Maximum 24-hour		0.005	0.005	0.006	0.005	0.008	0.012	0.009	0.011	0.011	0.011	0.010	0.007
Maximum 1-hour		0.046	0.039	0.059	0.018	0.061	0.058	0.051	0.053	0.046	0.073	0.038	0.035
% I.A.		97	98	98	98	98	98	98	97	98	98	98	97
Boyne Island													
Annual average:	0.001												
Maximum 24-hour		0.001	0.014	0.005	0.004	0.007	0.007	0.003	0.007	0.001	0.003	0.007	0.018
Maximum 1-hour		0.002	0.087	0.028	0.034	0.054	0.040	0.027	0.048	0.005	0.019	0.024	0.093
% I.A.		98	98	84	97	98	97	98	98	98	97	98	95

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for sulfur dioxide are an annual average of 0.020 ppm,a 24-hour average of 0.080 ppm (not to be exceeded on more than one day per year) and a 1-hour average of 0.200 ppm (not to be exceeded on more than one day per year).

Carbon monoxide

Figure 7. Ambient concentrations of carbon monoxide at Boyne Island site. Daily maximum 8-hour average concentrations (ppm), March 2017.

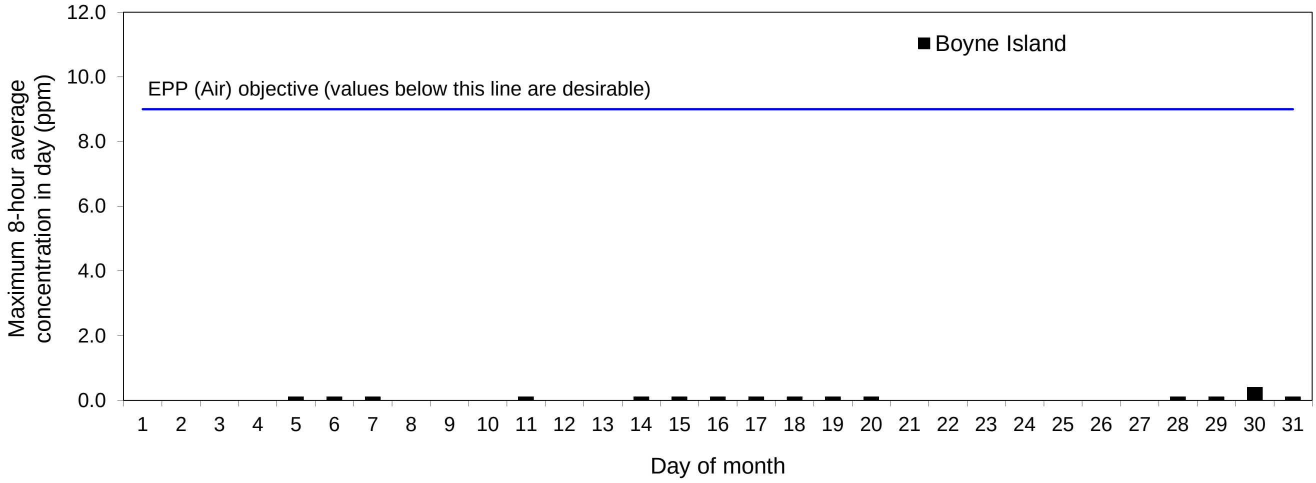

Table 6. Ambient concentrations of carbon monoxide. Monthly maximum 8-hour concentrations (ppm), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region												
Boyne Island												
Maximum 8-hour	0.1	0.2	0.3	0.2	0.4	0.3	0.3	0.6	0.2	0.1	0.1	0.4
% I.A.	98	98	98	98	98	97	98	98	98	98	98	93

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for carbon monoxide is an 8-hour average of 9 ppm (not to be exceeded on more than one day per year).

Ozone (photochemical oxidants)

Figure 8. Ambient concentrations of ozone at Memorial Park site. Daily maximum 4-hour average concentrations (ppm), March 2017.

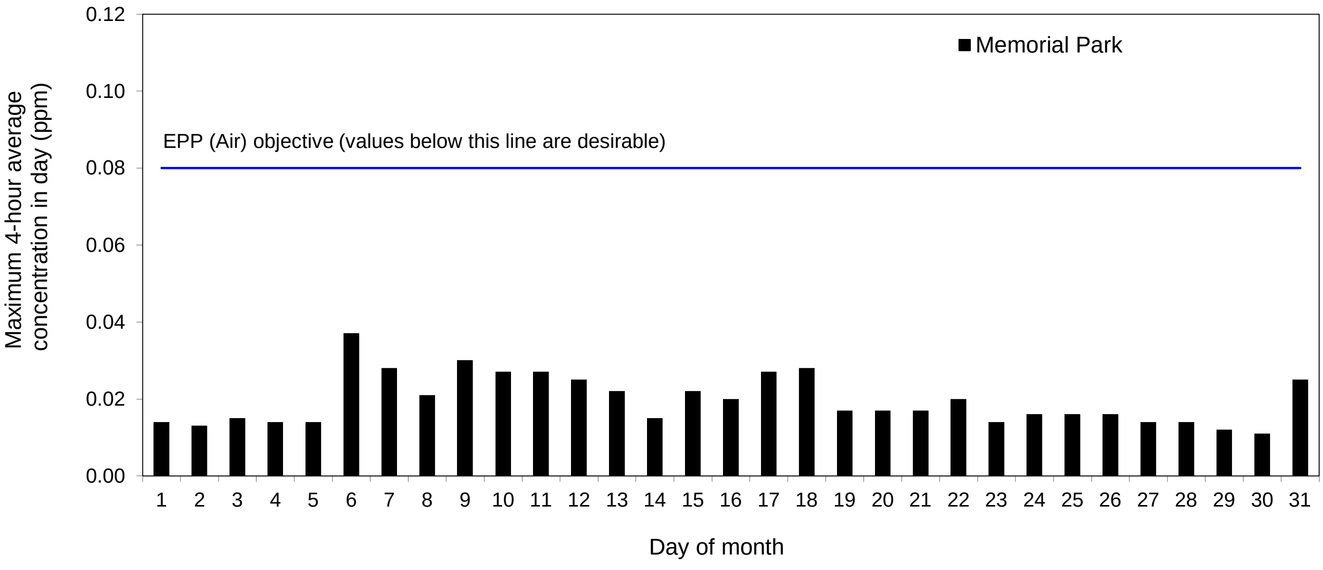

Figure 9. Ambient concentrations of ozone at Memorial Park site. Daily maximum 1-hour average concentrations (ppm), March 2017.

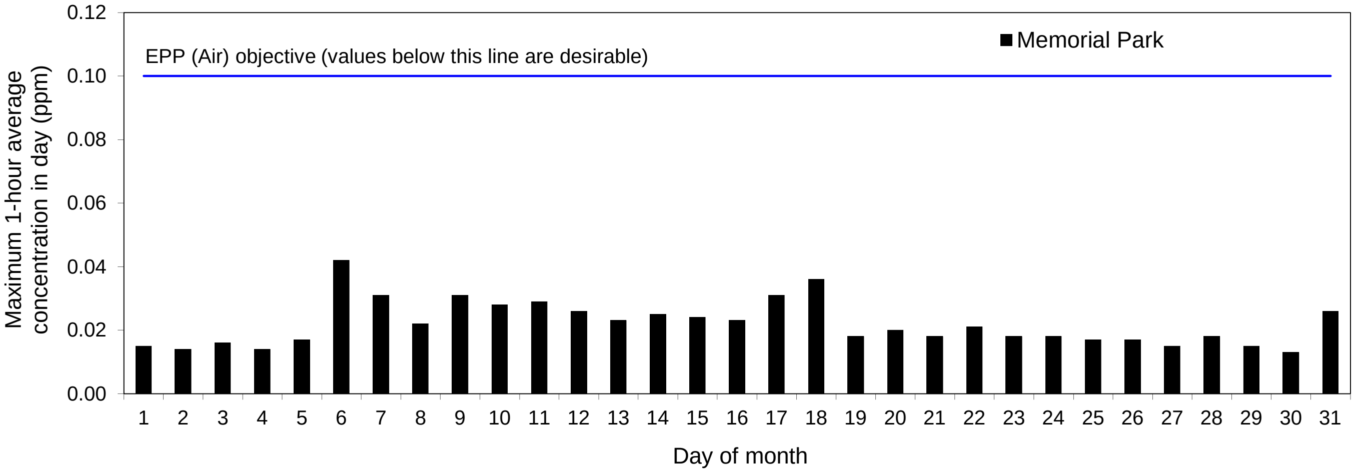

Table 7. Ambient concentrations of ozone. Monthly maximum 4-hour and 1-hour concentrations (ppm), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region												
Memorial Park												
Maximum 4-hour	0.029	0.032	0.031	0.030	0.031	0.035	0.032	0.049	0.033	0.022	0.036	0.037
Maximum 1-hour	0.031	0.035	0.033	0.032	0.032	0.036	0.036	0.055	0.039	0.024	0.037	0.042
% I.A.	99	100	100	88	100	100	87	100	100	81	82	97

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for ozone are a 4-hour average of 0.080 ppm (not to be exceeeded on more than one day per year) and a 1-hour average of 0.100 ppm (not to be exceeeded on more than one day per year).

Benzene

Figure 10. Ambient concentrations of benzene at Memorial Park site. Daily 24-hour average concentrations (ppb), March 2017.

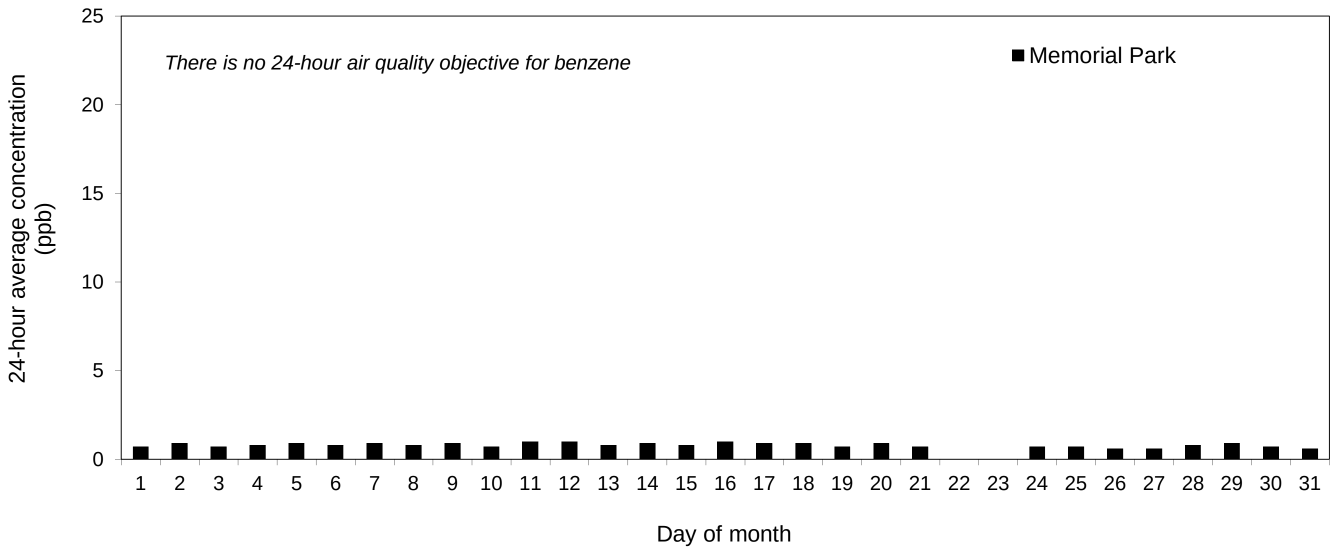

Table 8. Ambient concentrations of benzene. Annual average and monthly maximum 24-hour concentrations (ppb), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region													
Memorial Park													
Annual average:	0.9												
Maximum 24-hour		1.5	1.7	1.5	1.4	1.0	1.3	1.1	1.1	0.9	0.9	1.1	1.0
% I.A.		97	93	97	79	99	100	86	98	97	75	78	89

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for bezene is an annual average of 0.003 ppm (3 ppb).

Toluene

Figure 11. Ambient concentrations of toluene at Memorial Park site. Daily 24-hour average concentrations (ppb), March 2017.

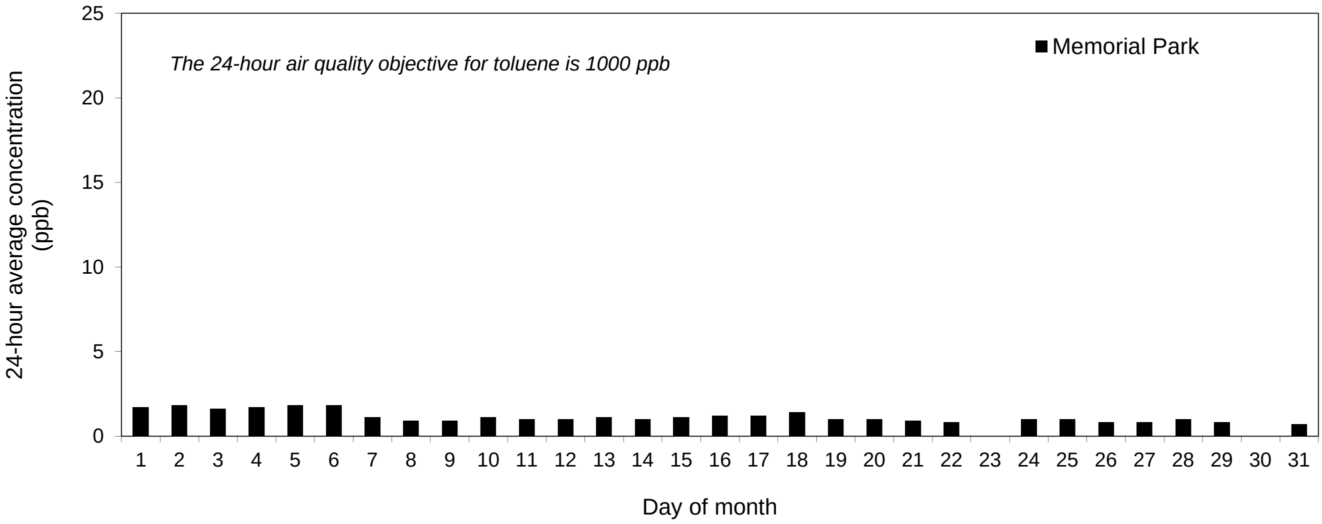

Table 9. Ambient concentrations of toluene. Annual average and monthly maximum 24-hour concentrations (ppb), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region													
Memorial Park													
Annual average	1.2												
Maximum 24-hour		1.6	1.6	1.8	2.8	1.4	2.5	2.2	2.4	1.5	1.9	3.3	1.8
% I.A.		97	94	97	86	99	99	86	99	99	80	82	94

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for toluene are an annual average of 0.1 ppm (100 ppb) and a 24-hour average of 1 ppm (1000 ppb).

Total xylenes

Figure 12. Ambient concentrations of total xylenes at Memorial Park site. Daily 24-hour average concentrations (ppb), March 2017.

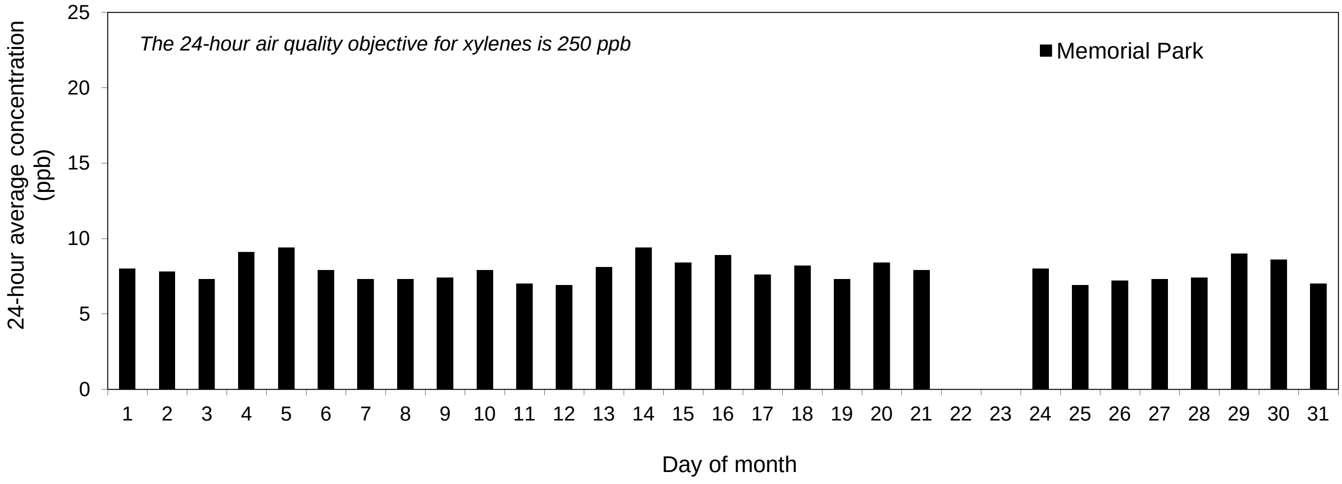

Table 10. Ambient concentrations of total xylenes. Annual average and monthly maximum 24-hour average concentrations (ppb), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region													
Memorial Park													
Annual average	7.8												
Maximum 24-hour		13.2	13.6	11.1	14.7	10.2	16.8	20.6	15.5	7.8	8.6	18.7	9.4
% I.A.		100	100	100	90	100	100	84	100	100	77	75	93

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for total xylenes are an annual average of 0.2 ppm (200 ppb) and a 24-hour average of 0.25 ppm (250 ppb).

Formaldehyde

Figure 13. Ambient concentrations of formaldehyde at Memorial Park site. Daily 24-hour average concentrations (ppb), March 2017.

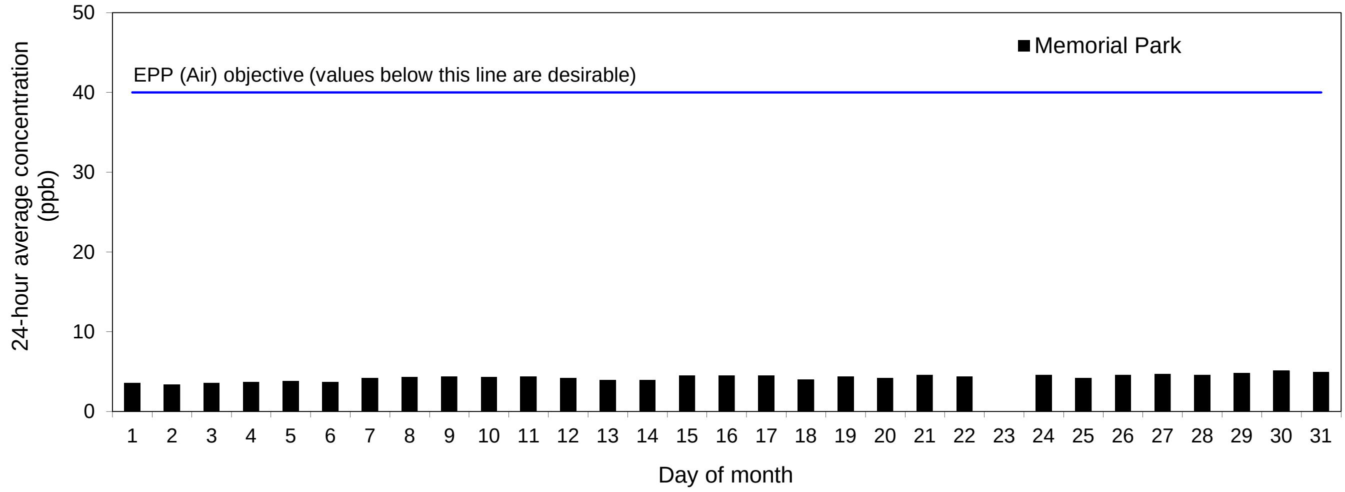

Table 11. Ambient concentrations of formaldehyde. Monthly maximum 24-hour concentrations (ppb), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region												
Memorial Park												
Maximum 24-hour	2.5	2.8	2.1	2.4	3.0	3.1	3.5	3.4	2.7	3.6	4.4	5.1
% I.A.	99	98	99	88	100	100	87	99	99	78	81	97

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for formaldehyde is a 24-hour average of 0.04 ppm (40 ppb).

PM_{10}

Figure 14. Ambient concentrations of PM_{10} at Targinie, Fisherman's Landing, Boat Creek and Clinton sites. Daily 24-hour average concentrations ($\mu g/m^3$), March 2017.

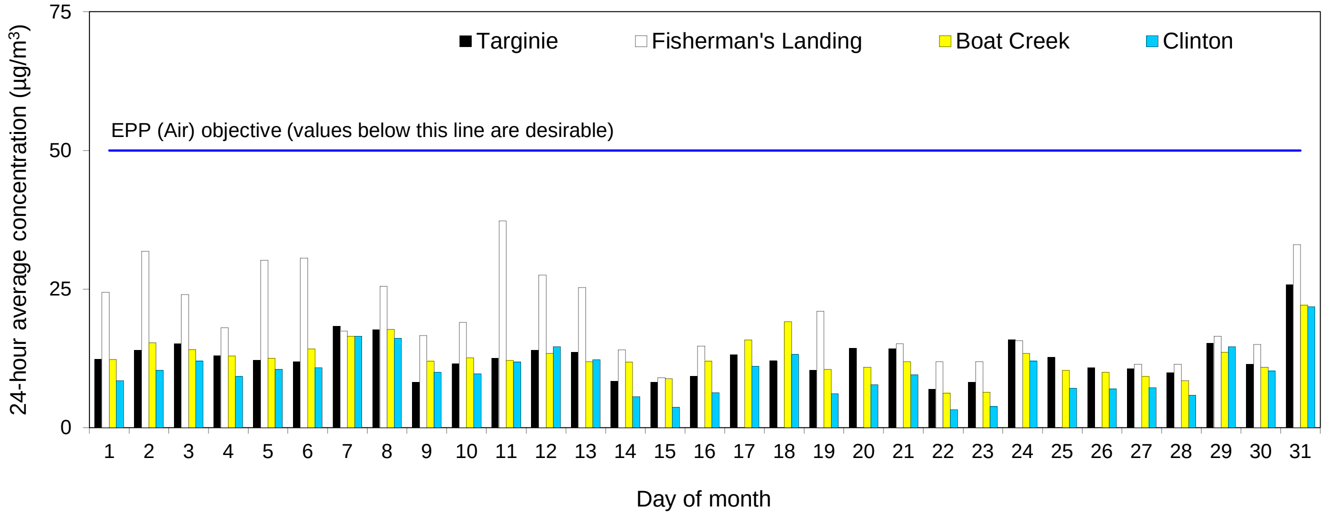

Figure 15. Ambient concentrations of PM_{10} at Auckland Point, South Gladstone and Boyne Island sites. Daily 24-hour average concentrations ($\mu g/m^3$), March 2017.

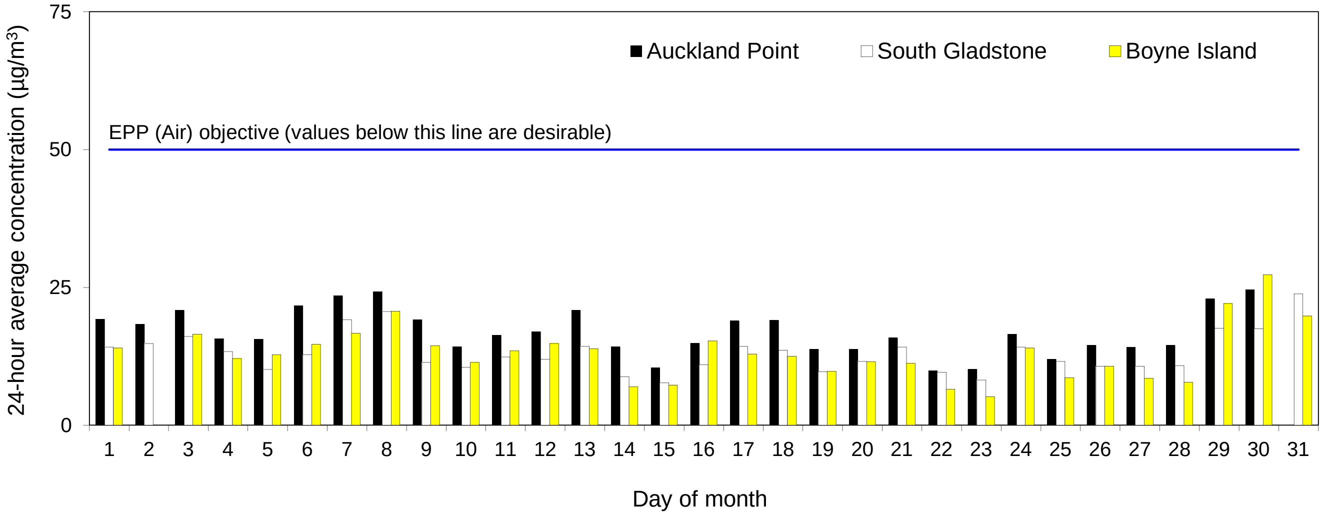

Table 12. Ambient concentrations of PM_{10}. Annual average and monthly maximum 24-hour average concentrations (µg/m^3), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region													
Targinie													
Annual Average:	12.3												
Maximum 24-hour		23.3	-	-	13.8	22.0	16.4	25.9	23.1	-	38.9	33.5	25.8
% I.A.		100	56	48	100	99	100	100	96	8	77	98	98
Fisherman's Landing													
Annual average:	25.9												
Maximum 24-hour		52.1	65.4	117.2	62.7	40.0	47.8	63.1	78.9	36.8	36.1	52.6	37.3
% I.A.		100	100	69	100	82	99	100	99	100	96	95	88
Boat Creek													
Annual average:	14.0												
Maximum 24-hour		30.6	22.3	15.6	24.9	20.7	25.4	30.4	29.0	22.7	16.8	26.2	22.1
% I.A.		100	95	85	99	99	100	75	73	71	99	99	98
Clinton													
Annual average:	11.8												
Maximum 24-hour		23.7	18.4	14.9	14.8	18.7	21.6	27.7	28.0	20.5	16.0	22.2	21.8
% I.A.		99	99	99	85	89	99	99	100	100	93	99	98
Auckland Point													
Annual average:	17.7												
Maximum 24-hour		29.6	27.1	23.1	22.6	29.7	28.8	30.7	40.9	46.1	23.1	29.1	24.5
% I.A.		97	89	96	96	74	63	78	100	99	68	80	94
South Gladstone													
Annual average:	14.2												
Maximum 24-hour		24.1	21.9	19.4	15.6	23.2	25.8	25.1	27.6	21.1	21.5	26.5	23.8
% I.A.		99	97	88	100	99	99	98	97	97	96	98	97
Boyne Island													
Annual average:	13.1												
Maximum 24-hour		25.0	18.2	15.5	13.9	17.8	32.4	27.3	42.6	23.6	16.5	24.5	27.3
% I.A.		86	70	69	98	99	99	100	100	85	87	99	96

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for PM_{10} is a 24-hour average of 50 µg/m^3 (not to be exceeded on more than five days per year).

The *National Environment Protection (Ambient Air Quality) Measure* standards for PM_{10} are an annual average of 25 µg/m^3 and a 24-hour average of 50 µg/m^3.

$PM_{2.5}$

Figure 16. Ambient concentrations of $PM_{2.5}$ at Targinie, Fisherman's Landing and Boat Creek sites. Daily 24-hour average concentrations (µg/m^3), March 2017.

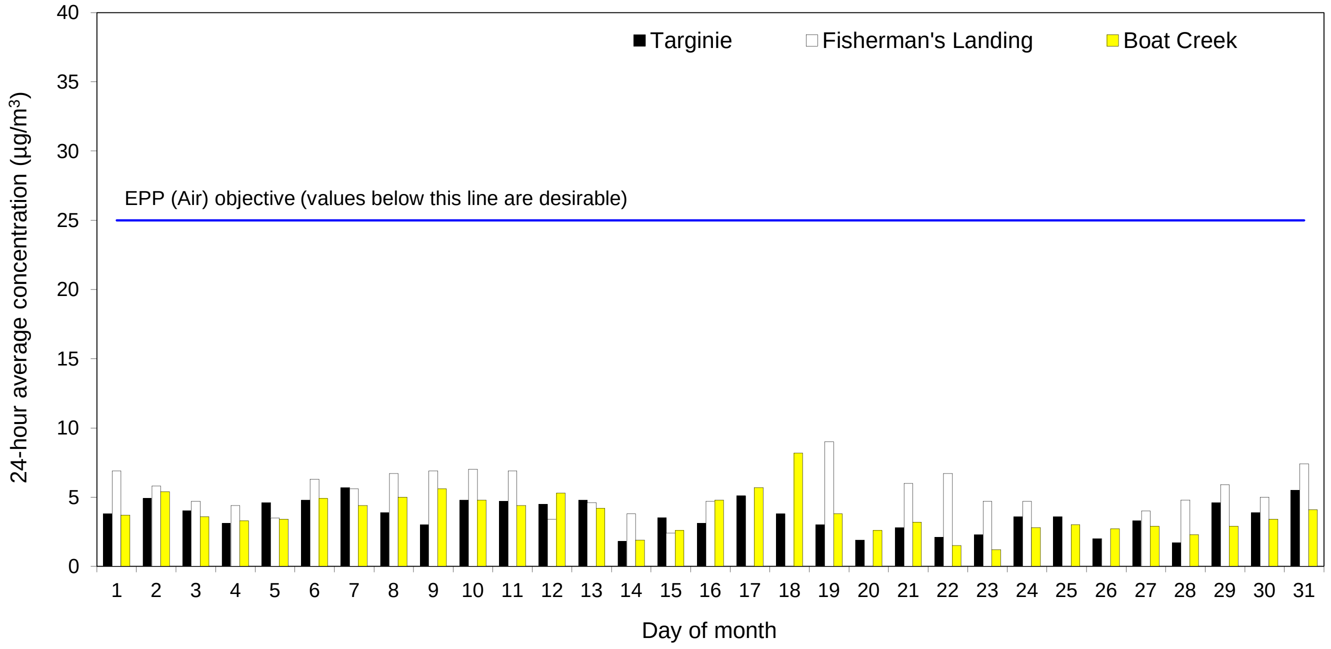

Figure 17. Ambient concentrations of $PM_{2.5}$ at Clinton, South Gladstone and Boyne Island sites. Daily 24-hour average concentrations (µg/m^3), March 2017.

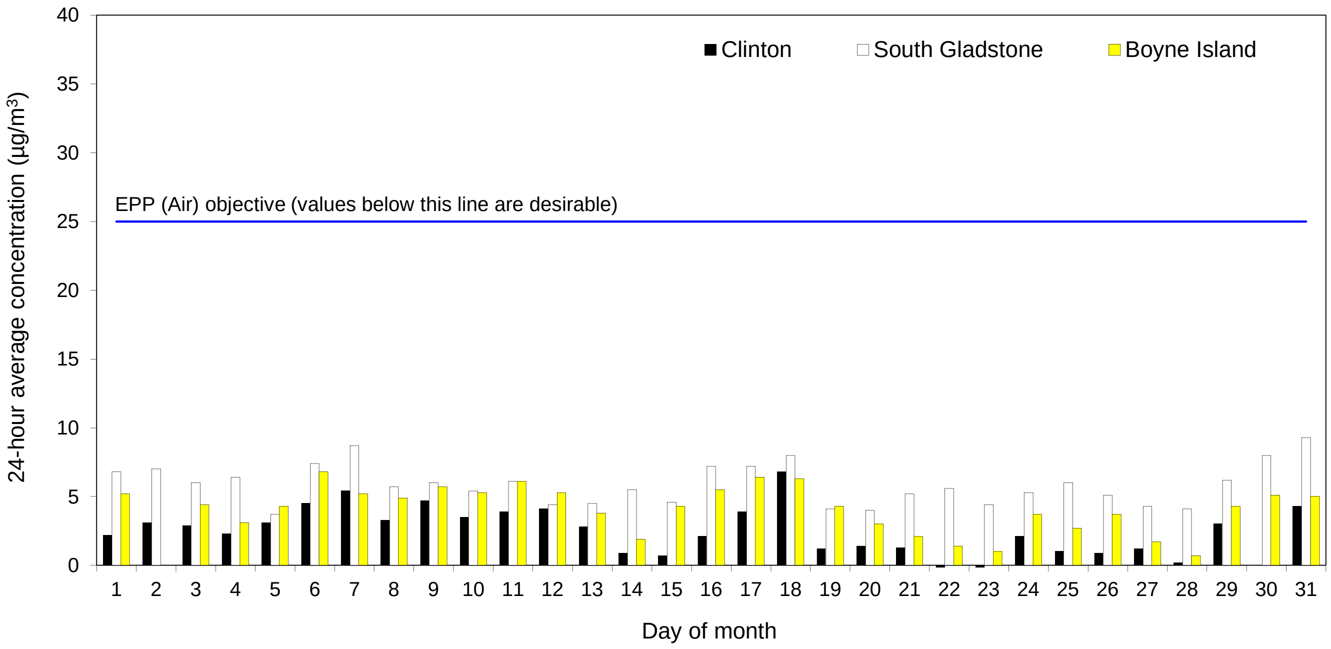

Table 13. Ambient concentrations of $PM_{2.5}$. Annual average and monthly maximum 24-hour average concentrations (µg/m^3), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region													
Targinie													
Annual average:	4.6												
Maximum 24-hour		7.6	7.3	5.1	8.4	6.8	8.9	11.3	11.6	-	27.1	21.4	5.7
% I.A.		100	96	98	100	99	100	100	96	7	77	98	98
Fisherman's Landing													
Annual average:	5.0												
Maximum 24-hour		5.4	7.1	9.0	9.6	6.2	13.0	11.4	12.2	12.3	7.9	13.6	9.0
% I.A.		100	100	69	100	82	99	100	99	100	96	95	88
Boat Creek													
Annual average:	4.5												
Maximum 24-hour		6.7	10.7	4.7	8.5	6.9	10.5	13.2	11.6	9.8	4.8	9.6	8.2
% I.A.		100	95	85	99	99	100	75	91	99	99	99	98
Clinton													
Annual average:	4.6												
Maximum 24-hour		8.3	10.5	9.1	10.5	9.8	16.8	15.1	16.3	12.3	3.9	12.9	6.8
% I.A.		99	99	99	85	89	99	99	100	100	93	99	98
South Gladstone													
Annual average:	5.8												
Maximum 24-hour		6.3	8.5	11.9	8.4	7.9	15.9	13.0	15.1	10.8	7.0	9.8	9.3
% I.A.		99	97	88	100	99	99	98	97	97	96	98	97
Boyne Island													
Annual average:	4.7												
Maximum 24-hour		6.3	8.0	9.9	8.0	6.8	26.0	13.1	32.1	12.9	4.4	9.4	6.8
% I.A.		86	70	69	98	99	99	100	100	85	87	99	96

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.
The *Environmental Protection (Air) Policy 2008* air quality objectives for $PM_{2.5}$ are an annual average of 8 µg/m^3 and a 24-hour average of 25 µg/m^3.

Visibility-reducing particles

Figure 18. Ambient visibility-reducing particle levels at Targinie, Fisherman's Landing and Boat Creek sites. Daily maximum 1-hour average light scattering coefficient, b_{sp}, levels (Mm^{-1}), March 2017.

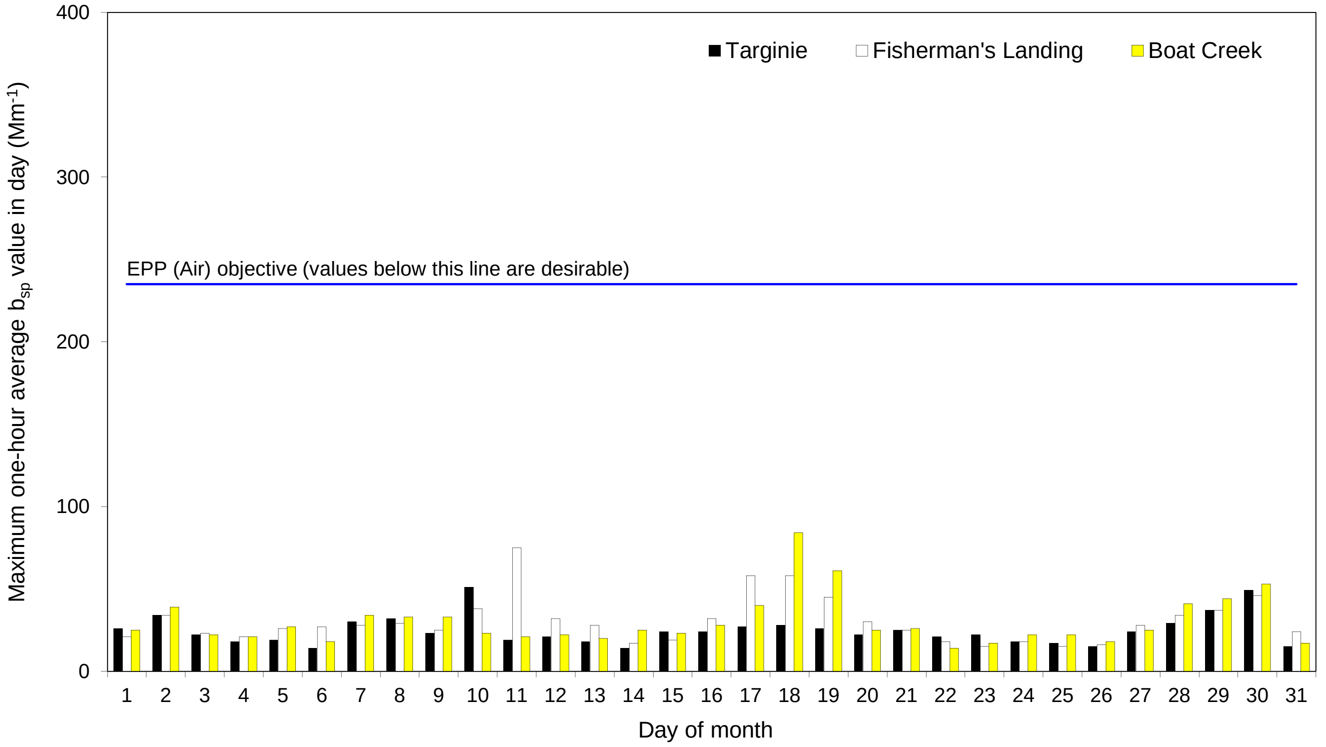

Figure 19. Ambient visibility-reducing particle levels at Clinton, South Gladstone and Boyne Island sites. Daily maximum 1-hour average light scattering coefficient, b_{sp}, levels (Mm^{-1}), March 2017.

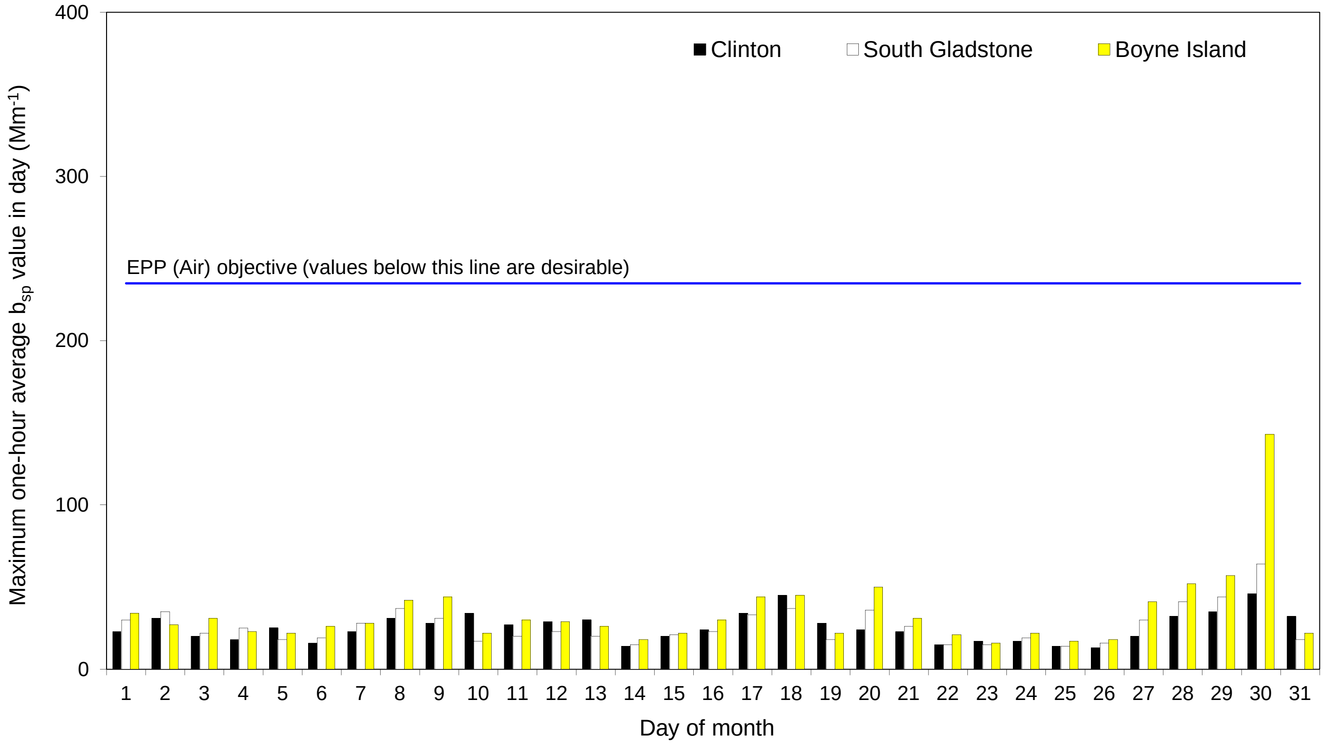

Table 14. Ambient visibility-reducing particle levels. Monthly maximum 1-hour average light scattering coefficient values (Mm^{-1}), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Gladstone region												
Targinie												
Maximum 1-hour	36	56	59	50	66	155	169	125	283	659	535	51
% I.A.	98	98	98	98	97	98	98	98	98	98	98	98
Fisherman's Landing												
Maximum 1-hour	38	138	115	88	50	226	135	182	216	44	262	75
% I.A.	98	98	98	98	97	98	98	98	98	98	97	98
Boat Creek												
Maximum 1-hour	33	182	35	124	50	148	82	141	101	63	243	84
% I.A.	98	98	80	96	97	98	89	73	78	98	97	98
Clinton												
Maximum 1-hour	197	177	60	160	96	149	104	172	160	30	563	46
% I.A.	98	98	98	84	98	97	98	98	98	93	98	97
South Gladstone												
Maximum 1-hour	39	47	81	85	44	141	114	208	85	46	126	64
% I.A.	88	98	98	98	98	95	98	98	98	98	98	97
Boyne Island												
Maximum 1-hour	37	50	268	88	49	271	100	367	125	40	52	143
% I.A.	98	98	98	98	98	97	98	98	98	97	98	95

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for visibility-reducing particles is 20 km visibility. This equates to light scattering coefficient values of 235 Mm^{-1} or less.

Measured ambient concentrations - Mackay

PM_{10}

Figure 20. Ambient concentrations of PM_{10} at West Mackay site. Daily 24-hour average concentrations (µg/m^3), March 2017.

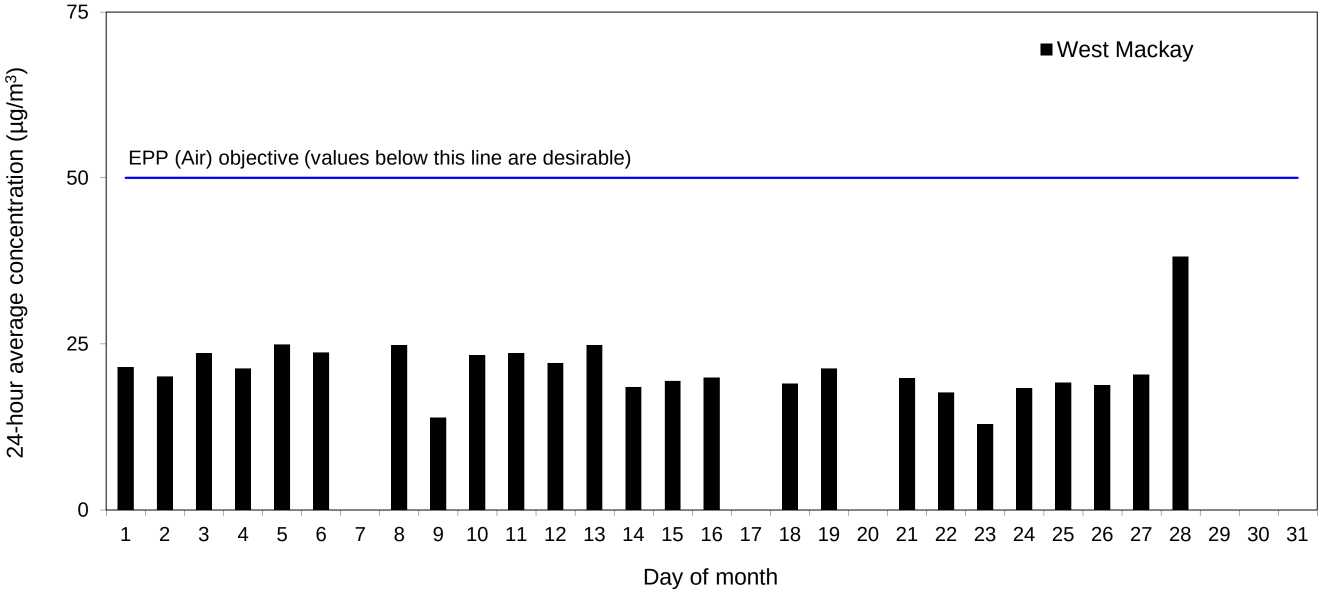

Table 15. Ambient concentrations of PM_{10}. Annual average and monthly maximum 24-hour average concentrations (µg/m^3), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mackay													
West Mackay													
Annual Average:	20.4												
Maximum 24-hour		33.0	28.4	24.0	22.9	31.3	34.6	44.5	34.4	28.1	29.1	31.2	38.1
% I.A.		95	92	98	96	98	99	97	100	96	83	94	82

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for PM_{10} is a 24-hour average of 50 µg/m^3 (not to be exceeded on more than five days per year).

The *National Environment Protection (Ambient Air Quality) Measure* standards for PM_{10} are an annual average of 25 µg/m^3 and a 24-hour average of 50 µg/m^3.

Visibility-reducing particles

Figure 21. Ambient visibility-reducing particle levels at West Mackay site. Daily maximum 1-hour average light scattering coefficient, b_{sp}, levels (Mm^{-1}), March 2017.

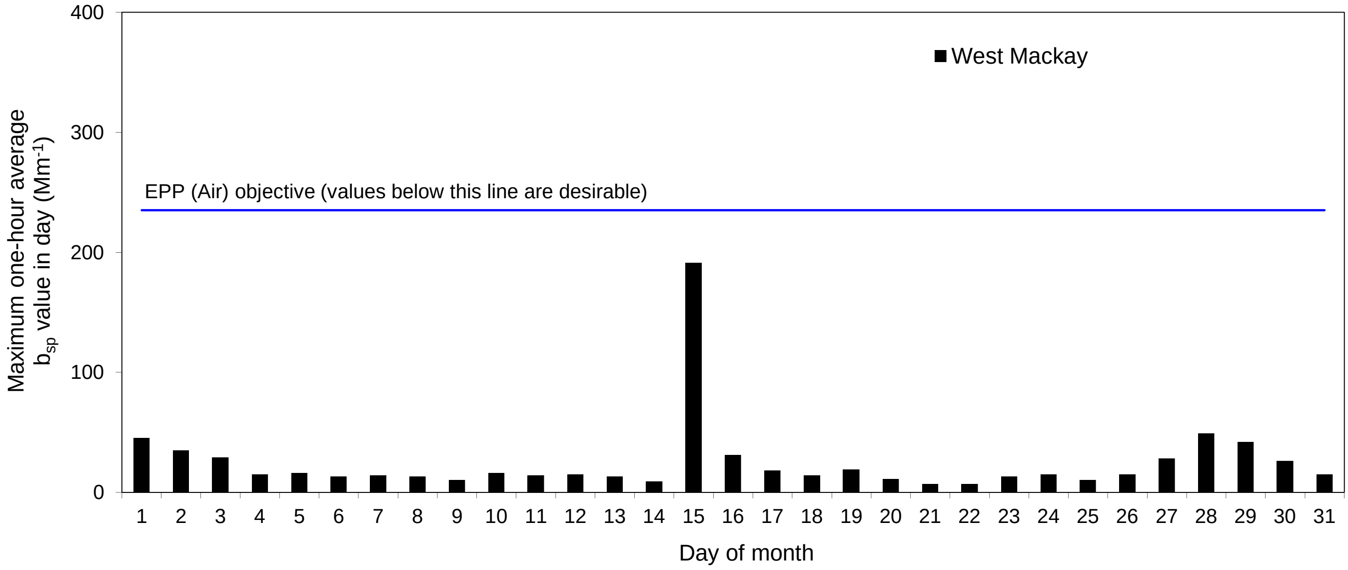

Table 16. Ambient visibility-reducing particle levels. Monthly maximum 1-hour average light scattering coefficient values (Mm^{-1}), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mackay region												
West Mackay												
Maximum 1-hour	33	142	240	133	116	324	74	203	51	44	34	191
% I.A.	98	98	98	98	98	98	93	98	98	98	98	96

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for visibility-reducing particles is 20 km visibility. This equates to light scattering coefficient values of 235 Mm^{-1} or less.

Measured ambient concentrations - Moranbah

PM_{10}

Figure 22. Ambient concentrations of PM_{10} at Moranbah site. Daily 24-hour average concentrations (µg/m^3), March 2017.

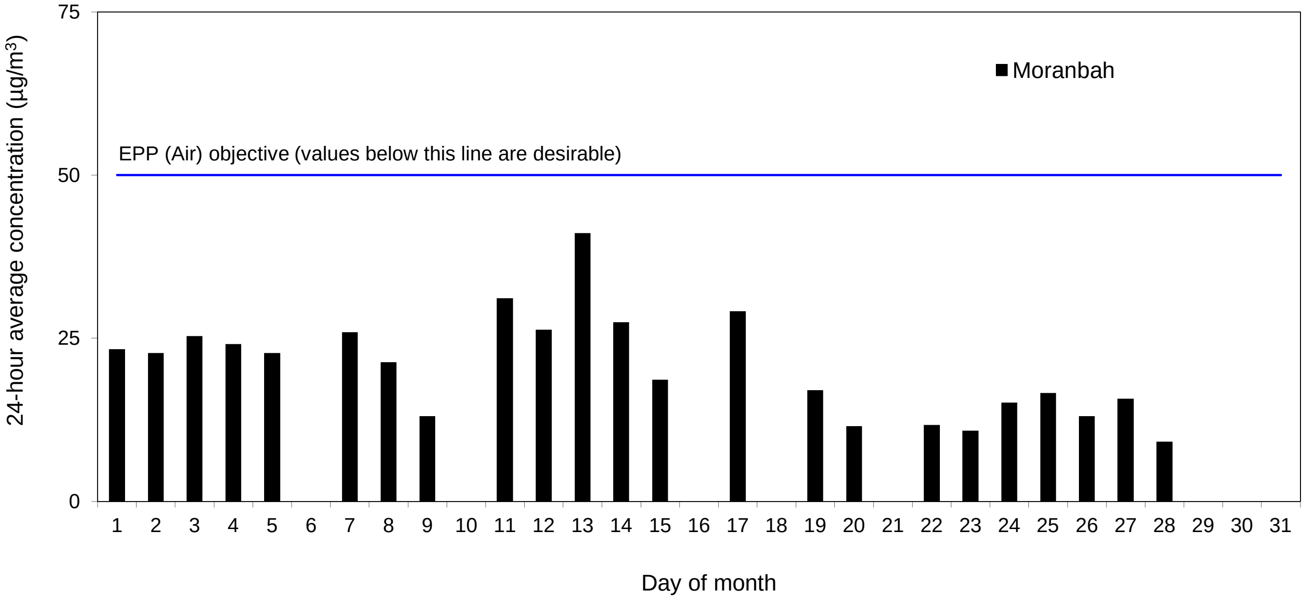

Table 17. Ambient concentrations of PM_{10}. Annual average and monthly maximum 24-hour average concentrations (µg/m^3), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Moranbah													
Moranbah													
Annual Average:	22.1												
Maximum 24-hour		38.9	45.8	30.5	29.2	29.6	32.8	49.5	36.5	-	33.8	37.9	41.1
% I.A.		98	93	90	95	95	95	98	86	50	94	93	76

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective PM_{10} is a 24-hour average of 50 µg/m^3 (not to be exceeded on more than five days per year).

The *National Environment Protection (Ambient Air Quality) Measure* standards for PM_{10} are an annual average of 25 µg/m^3 and a 24-hour average of 50 µg/m^3.

Data Availability

When required, Table 18 summarises the reasons for data availability below the minimum criteria for reporting at Central Queensland monitoring sites.

Table 18. Reasons for low data availability at Central Queensland ambient air monitoring sites during March 2017.

Station	Air Pollutant	Cause
Nil		

Related air quality information

Current hourly air quality data is available from the internet at www.ehp.qld.gov.au/air/data/search.php.

Additional information on air quality monitoring and related issues is also available from the above website.

Further information

For further information about the data presented in this bulletin or related publications, contact:

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Department of Science, Information Technology and Innovation
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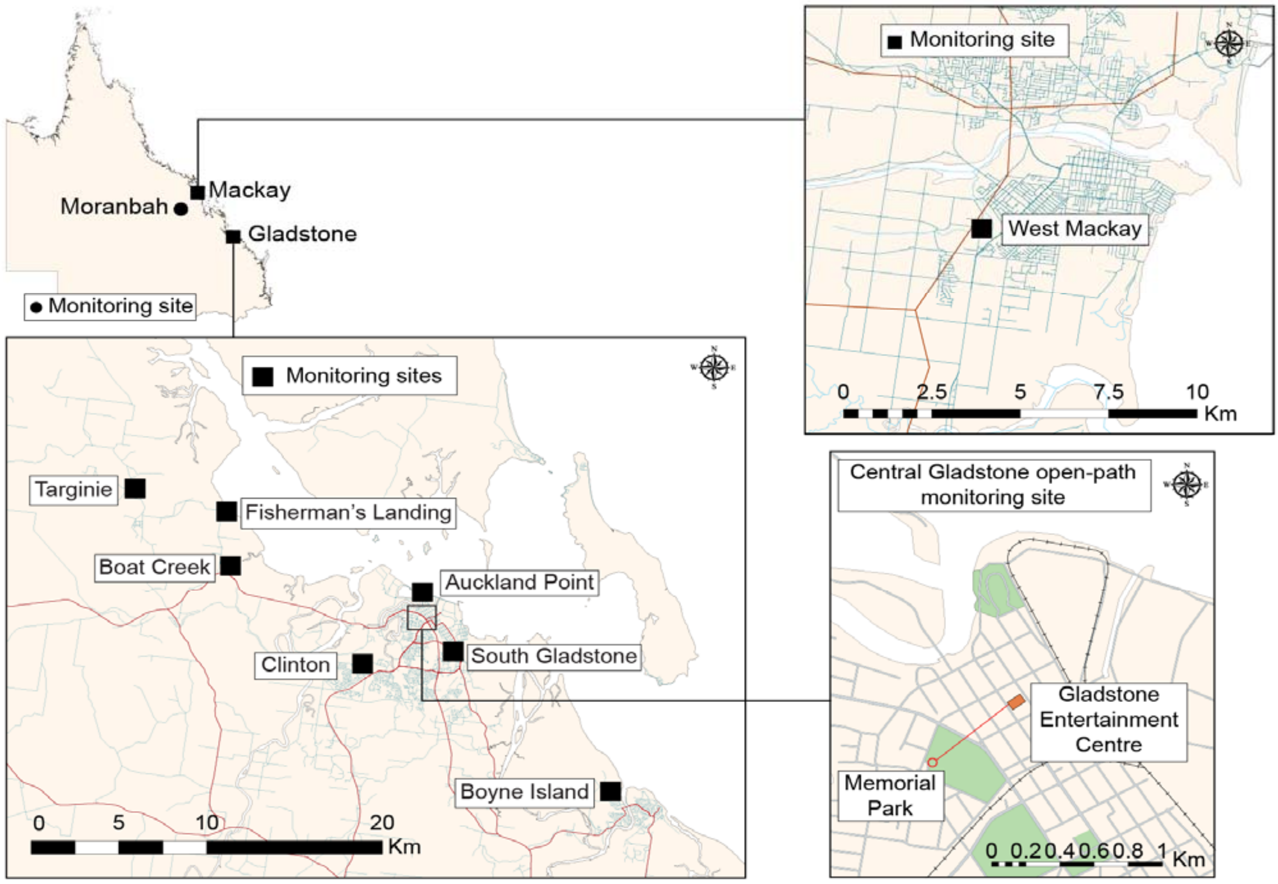
41 Boggo Rd
DUTTON PARK QLD 4102
Telephone (07) 3170 5477
Email: air.sciences@dsitia.qld.gov.au

Figure 23. Central Queensland ambient air quality monitoring station locations.



Department of Science, Information Technology and Innovation

Air quality bulletin

North Queensland

March 2017

Queensland Government

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Acknowledgements

This report has been prepared by the Department of Science, Information Technology and Innovation.
Acknowledgement is made of the following organisations that have supplied air quality monitoring data for this bulletin:
• Sun Metals Corporation
• Port of Townsville Limited

June 2017

Introduction

Air quality monitoring gathers information on the quality of the air environment. The objectives of the monitoring are to check compliance with ambient air quality guidelines, identify long-term trends in air quality, investigate local air quality concerns, and assess the effectiveness of air quality management strategies.

Air quality monitoring was carried out by the Queensland Government at two sites in Townsville and two sites in Mount Isa during March 2017. In addition, monitoring was also conducted by Port of Townsville Limited and Sun Metals Corporation in Townsville. In May 2014 the former Townsville Port monitoring site operated by Port of Townsville Limited and the Queensland Government's Townsville Coast Guard monitoring site were amalgamated into a single monitoring site located at the Townsville Coast Guard.

Air pollutants monitored included sulfur dioxide, PM_{10} (particles less than 10µm in diameter), TSP (total suspended particulate matter - particles less than 100µm approximately in diameter) and dustfall (particles large enough to settle from the air). The TSP and dustfall samples were analysed for metal content.

Reporting protocol

Data presented in this bulletin are based on clock hours. Hourly or other averages are constrained to start and finish on a clock hour.

Air quality summary graphs

Figures 1 to 11 summarise available air quality data for sampling days at Townsville sites during March 2017. Monthly average dustfall and deposited lead for Townsville sites are shown in figures 12 and 13. Figures 14 to 19 summarise air quality data for sampling days at Mount Isa sites during March. The maximum recorded level for each day is used to show the day-to-day variation in air quality.

Air quality summary tables

Tables 5 to 20 present monthly summaries of air quality data for the preceding 12 months. These tables show the month-to-month variation in air quality. A monthly entry is given when at least three-fifths of the maximum possible number of observations during the month are available. When data is not available for the entire month, due to equipment malfunction, this is indicated by the abbreviation 'n.d.' (no data). A dash is inserted when less than three-fifths of data are available. Where no data is recorded, the reason for the low data availability is summarised in Table 21 at the end of this bulletin.

Table 1. Air pollutants monitored at North Queensland sites

	Sulfur dioxide	PM_{10}	TSP	Lead	Copper	Zinc	Nickel	Arsenic	Cadmium	Dustfall	Dustfall lead
Townsville											
Coast Guard		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
North Ward (Warburton St)										✓	✓
Stuart (industry)	✓										
Mount Isa											
Menzies	✓										
The Gap	✓	✓		✓				✓	✓		

Guidelines

Wherever possible, air quality measurements are compared against Australian air quality standards. In their absence relevant international standards are used for comparison.

Measured concentrations of sulfur dioxide, PM_{10}, TSP, lead, nickel, cadmium and arsenic are compared to the air quality objectives contained in the Queensland *Environmental Protection (Air) Policy 2008* (EPP (Air)) to assess whether pollutant levels could harm health and wellbeing. Twelve-month average PM_{10} concentrations are also compared against the *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) annual standard.

Sulfur dioxide, PM_{10} and arsenic levels in Mount Isa are also compared against the air quality limits specified in the Mount Isa Mines Limited Environmental Authority EPML00977513.

Compliance with air quality guidelines - Townsville

During March, measured pollutant levels did not exceed the relevant air quality guideline at Queensland Government and industry air monitoring sites in Townsville.

Table 2. Number of occasions during March when measured levels exceeded EPP (Air) objectives or Air NEPM standards for sulfur dioxide, PM_{10}, TSP, lead, nickel, arsenic and cadmium; Ontario Ministry of Environment air quality criteria for copper and zinc; and DEHP nuisance dust limits for TSP and dustfall at Queensland Government and industry air monitoring sites in Townsville.

Pollutant	Averaging Period	Exceedences
Sulfur dioxide	*EPP (Air)*	
	Annual	0
	24-hour	0
	1-hour	0
PM_{10}	*Air NEPM*	
	Annual	0
	EPP (Air)	
	24-hour	0
TSP (24-hour period refers to dust nuisance, not health and wellbeing)	*EPP (Air)*	
	Annual	0
	DEHP limit	
	24-hour	0
TSP Lead	*EPP (Air)*	
	Annual	0
TSP Copper	*Ontario criterion*	
	24-hour	0
TSP Zinc	*Ontario criterion*	
	24-hour	0
PM_{10} Nickel	*EPP (Air)*	
	Annual	0
PM_{10} Arsenic	*EPP (Air)*	
	Annual	0
PM_{10} Cadmium	*EPP (Air)*	
	Annual	0
Dustfall (30-day period refers to dust nuisance, not health and wellbeing)	*DEHP limit*	
	30-day	0

Compliance with air quality guidelines - Mount Isa

During March, measured pollutant levels, with the exception of sulfur dioxide and arsenic, did not exceed the relevant air quality guideline at Queensland Government air monitoring sites in Mount Isa.

Sulfur dioxide levels exceeded the 1-hour EPP (Air) objective for a total of four hours at the Menzies monitoring site on 13 March and 15 March, and three hours at The Gap monitoring site on 6 March due to industrial emissions.

The average arsenic concentration at The Gap monitoring site for the 12-month period ending March 2017 exceeded the annual EPP (Air) objective.

Compliance with smelter air quality limits

From January 2016 smelter operations in Mount Isa have been operating under an amended Environmental Authority (EA) which sets alternative air quality limits for some air pollutants as part of the Copper Smelter Extension Project. Table 4 details the EA air quality limit values applying in 2017 where these differ from the EPP (Air) objectives. As compliance with the EA limits is to be determined over the 2017 calendar year, no assessment of compliance is possible at this time. Information on the progressive status against the EA limit values for the Queensland Government air monitoring sites is provided below.

Since 1 January 2017, 24-hour sulfur dioxide concentrations have not exceeded the EA air quality limit value at the Menzies or The Gap monitoring sites.

At the Menzies site 1-hour sulfur dioxide concentrations have exceeded 0.200 ppm for nine hours and 0.400 ppm for one hour since 1 January 2017. At The Gap site 1-hour sulfur dioxide concentrations have exceeded 0.200 ppm for eight hours and 0.400 ppm for two hours since 1 January 2017.

At The Gap site 24-hour PM_{10} concentrations have not exceeded 50 µg/m^3 since 1 January 2017.

The average arsenic concentration at The Gap site for the 12-month period ending March 2017 was less than the EA air quality limit value.

Table 3. Number of occasions during March when measured levels exceeded EPP (Air) objectives or Air NEPM standards for sulfur dioxide, PM_{10}, lead, arsenic and cadmium at Queensland Government air monitoring sites in Mount Isa.

Pollutant	Averaging Period	Exceedences
Sulfur dioxide	*EPP (Air)*	
	Annual	0
	24-hour	0
	1-hour	7
PM_{10}	*Air NEPM*	
	Annual	0
	EPP (Air)	
	24-hour	0
TSP Lead	*EPP (Air)*	
	Annual	0
PM_{10} Arsenic	*EPP (Air)*	
	Annual	1
PM_{10} Cadmium	*EPP (Air)*	
	Annual	0

Table 4. Environmental Authority (EA) air quality limits applying to smelter operations in Mount Isa

Pollutant	Averaging period	Limit value	Assessment criterion[a]	Period when limit value applies
Sulfur dioxide	24-hour	230 µg/m^3 (= 0.080 ppm)	<= 1% of total days	1 January to 31 December 2017
	1-hour	570 µg/m^3 (= 0.200 ppm)	<= 2% of total hours	
		1140 µg/m^3 (= 0.400 ppm)	<= 0.4% of total hours	
PM_{10}	24-hour	50 µg/m^3	<= 5 days	1 January to 31 December 2017
Arsenic	Annual	0.017 µg/m^3	Does not exceed	1 January to 31 December 2017

[a] Compliance is on an individual monitoring site basis, not across the monitoring network

Measured ambient concentrations - Townsville

Sulfur dioxide

Figure 1. Ambient concentrations of sulfur dioxide at the Stuart site. Daily 24-hour average concentrations (ppm), March 2017.

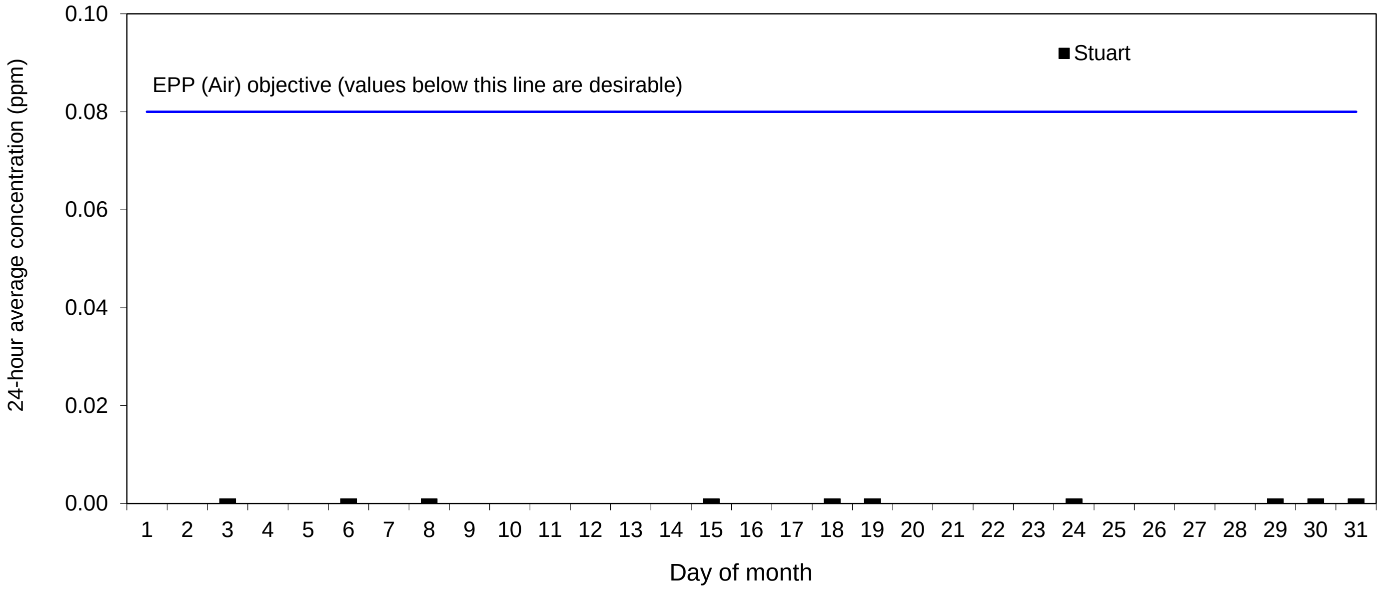


Figure 2. Ambient concentrations of sulfur dioxide at the Stuart site. Daily maximum 1-hour average concentrations (ppm), March 2017.

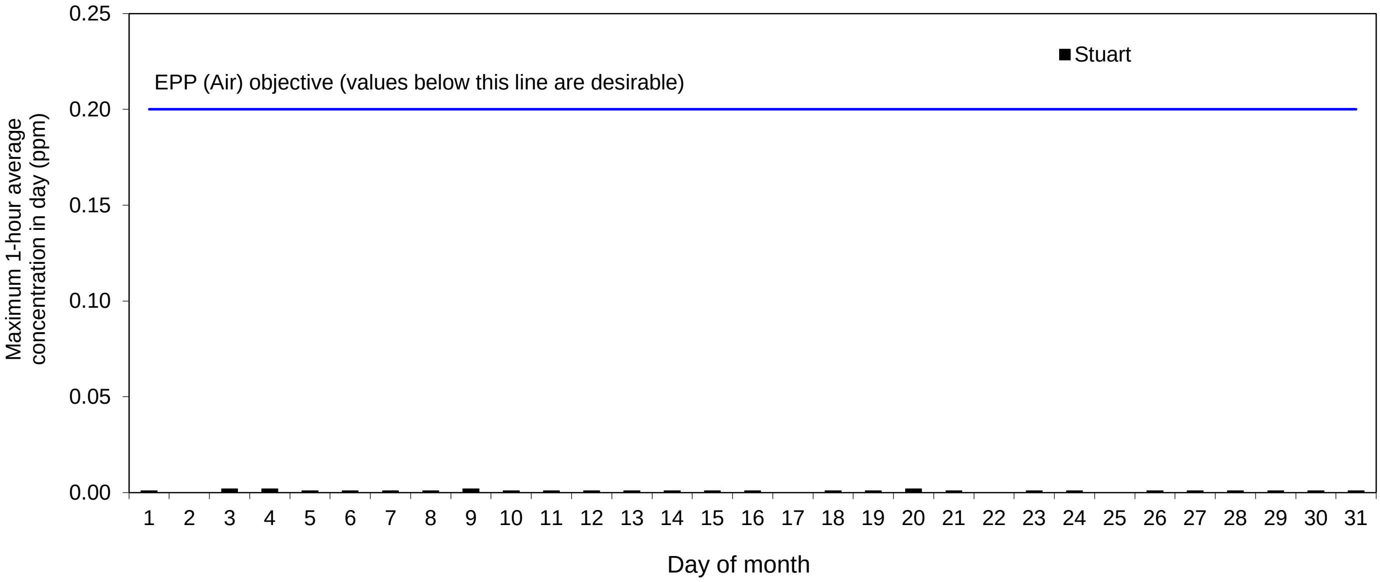


Table 5. Ambient concentrations of sulfur dioxide. Annual average and monthly maximum 24-hour and 1-hour average concentrations (ppm), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville												
Stuart (industry-operated site)												
Annual average: 0.001												
Maximum 24-hour	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.003	0.001	0.001	0.001	0.001
Maximum 1-hour	0.008	0.003	0.012	0.007	0.013	0.007	0.012	0.014	0.003	0.002	0.003	0.002
% I.A.	98	98	98	98	98	98	96	98	97	98	98	97

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for sulfur dioxide are an annual average of 0.020 ppm, a 24-hour average of 0.080 ppm (not to be exceeded on more than one day per year) and a 1-hour average of 0.200 ppm (not to be exceeded on more than one day per year).

PM_{10}

Figure 3. Ambient concentrations of PM_{10} at the Coast Guard site. Daily 24-hour average concentrations ($\mu g/m^3$), March 2017.

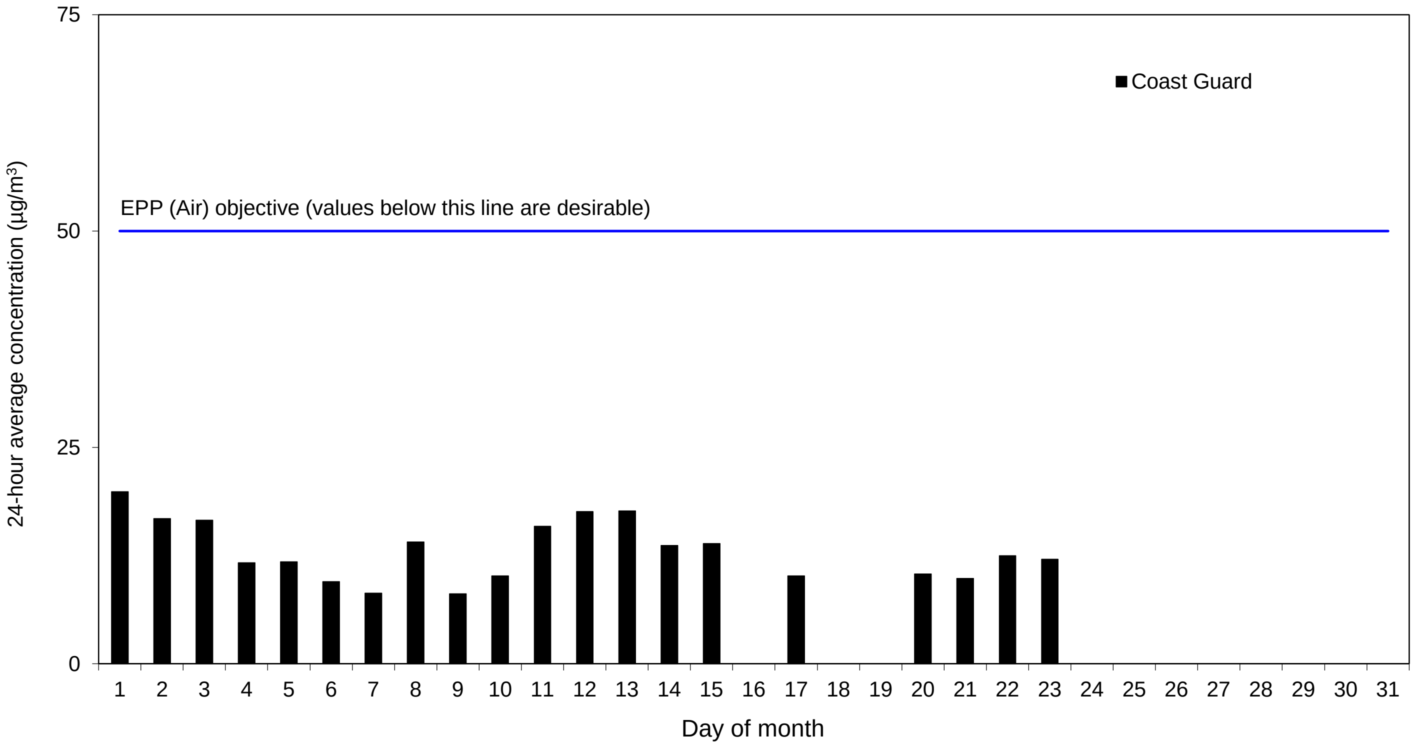


Table 6. Ambient concentrations of PM_{10}. Annual average and monthly maximum 24-hour average concentrations ($\mu g/m^3$), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville													
Coast Guard													
Annual average:	-												
Maximum 24-hour		28.5	22.3	23.6	28.6	n.d.	n.d.	n.d.	n.d.	-	22.8	24.5	19.9
% I.A.		99	98	95	78	0	0	0	0	59	99	96	69

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for PM_{10} is a 24-hour average of 50 $\mu g/m^3$ (not to be exceeded on more than five days per year).

The *National Environment Protection (Ambient Air Quality) Measure* standards for PM_{10} are an annual average of 25 $\mu g/m^3$ and a 24-hour average of 50 $\mu g/m^3$.

TSP

Figure 4. Ambient concentrations of TSP (continuous monitoring) at the Coast Guard site. Daily 24-hour average concentrations (µg/m³), March 2017.

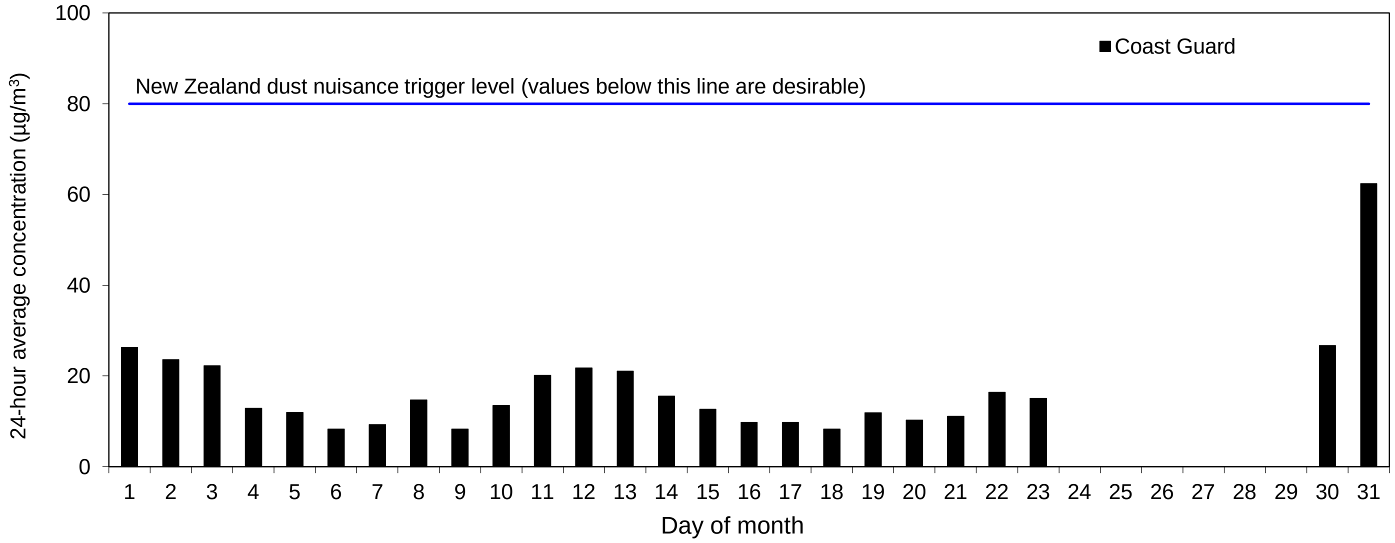


Figure 5. Ambient concentrations of TSP (one day in six monitoring) at the Coast Guard site. 24-hour average concentrations (µg/m³), March 2017.

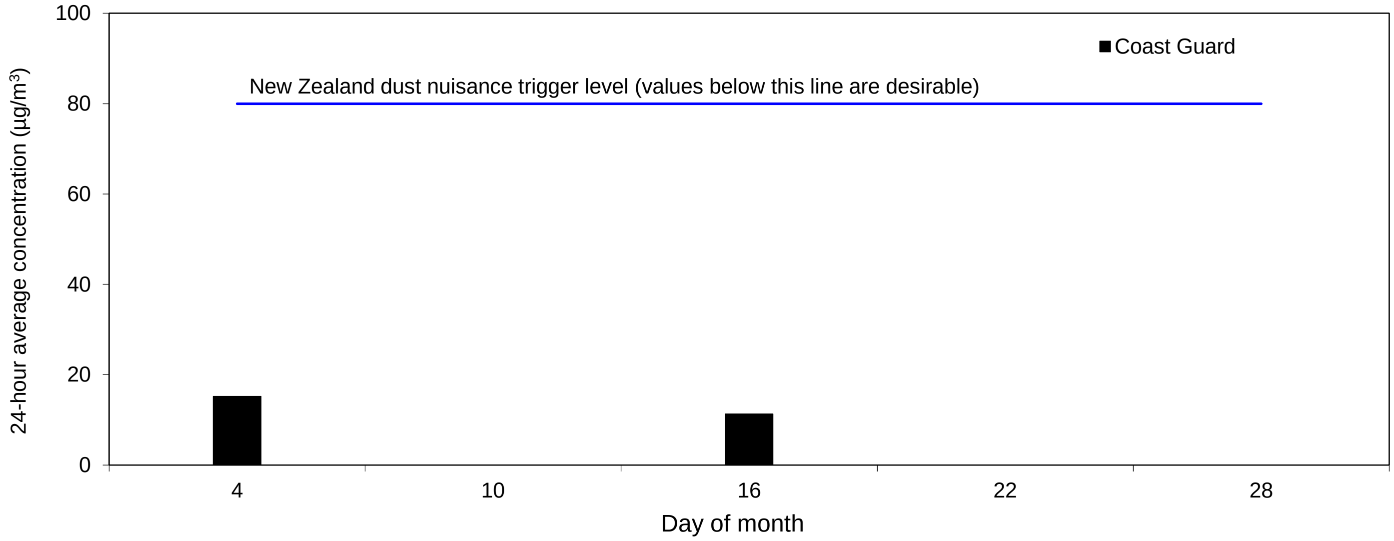


Table 7. Ambient concentrations of TSP. Annual average and monthly maximum 24-hour average concentrations (µg/m³), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville													
Coast Guard (continuous monitoring)													
Annual average:	23.8												
Maximum 24-hour		43.0	31.9	35.0	36.0	37.0	50.5	42.4	52.6	34.9	24.9	33.4	62.4
% I.A.		100	99	95	79	95	98	96	92	92	98	86	83
Coast Guard (one day in six monitoring)													
Annual average:	28.2												
Maximum 24-hour		48.7	39.4	36.9	31.7	40.6	48.6	47.6	47.5	34.7	27.2	39.6	-
% I.A.		100	100	100	67	100	100	100	60	80	80	100	40

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for TSP is an annual average of 90 µg/m³.

The Department of Environment and Heritage Protection Air Impacts Guideline recommends that short-term (24-hour) TSP concentrations be compared against the trigger levels provided in the New Zealand Ministry for the Environment's *Good practice guide for assessing and managing the environmental effects of dust emissions to assess dust nuisance impacts*. The New Zealand dust nuisance trigger level for areas of moderate sensitivity is a 24-hour average of 80 µg/m³.

TSP Lead

Figure 6. Ambient concentrations of TSP lead (one day in six monitoring) at the Coast Guard site. Annual average concentration (µg/m³), April 2016 to March 2017.

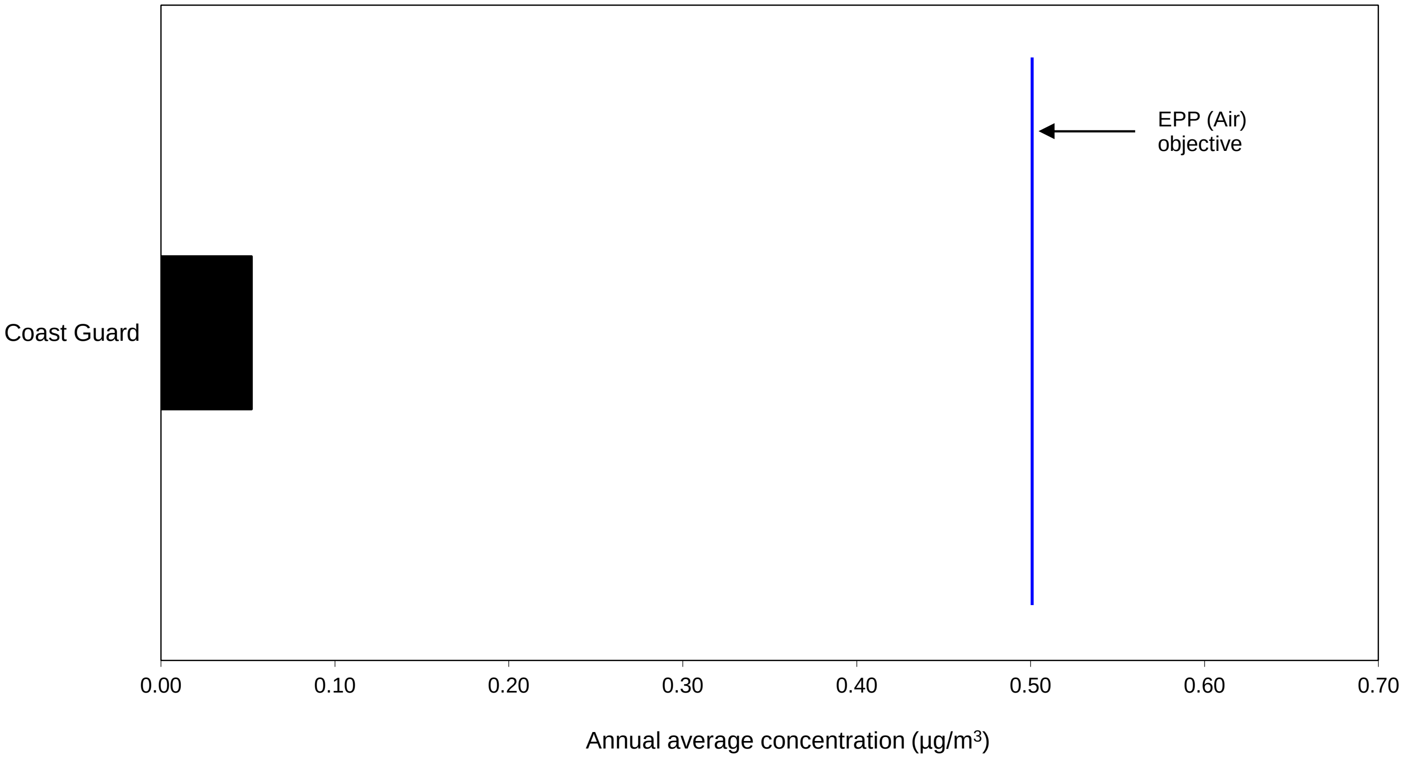


Table 8. Ambient concentrations of TSP lead. Annual average and monthly maximum 24-hour average concentrations (µg/m³) for one day in six monitoring, April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville													
Coast Guard													
Annual average:	0.05												
Maximum 24-hour		0.09	0.04	0.07	0.13	0.12	0.11	0.16	0.38	0.09	0.09	0.13	0.10
% I.A.		100	100	100	67	100	100	100	60	80	80	100	80

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for lead is an annual average of 0.5 µg/m³.

The limit of reporting is the minimum measured lead concentration that can be determined with the sampling equipment and laboratory method used. Lead concentrations below this limit are preceded by a "<" sign in the table. The annual average concentration has been calculated using half the minimum measurable concentration value for samples where no lead was detected.

TSP Copper

Figure 7. Ambient concentrations of TSP copper (one day in six monitoring) at the Coast Guard site. Maximum 24-hour average concentrations (µg/m^3), March 2017.

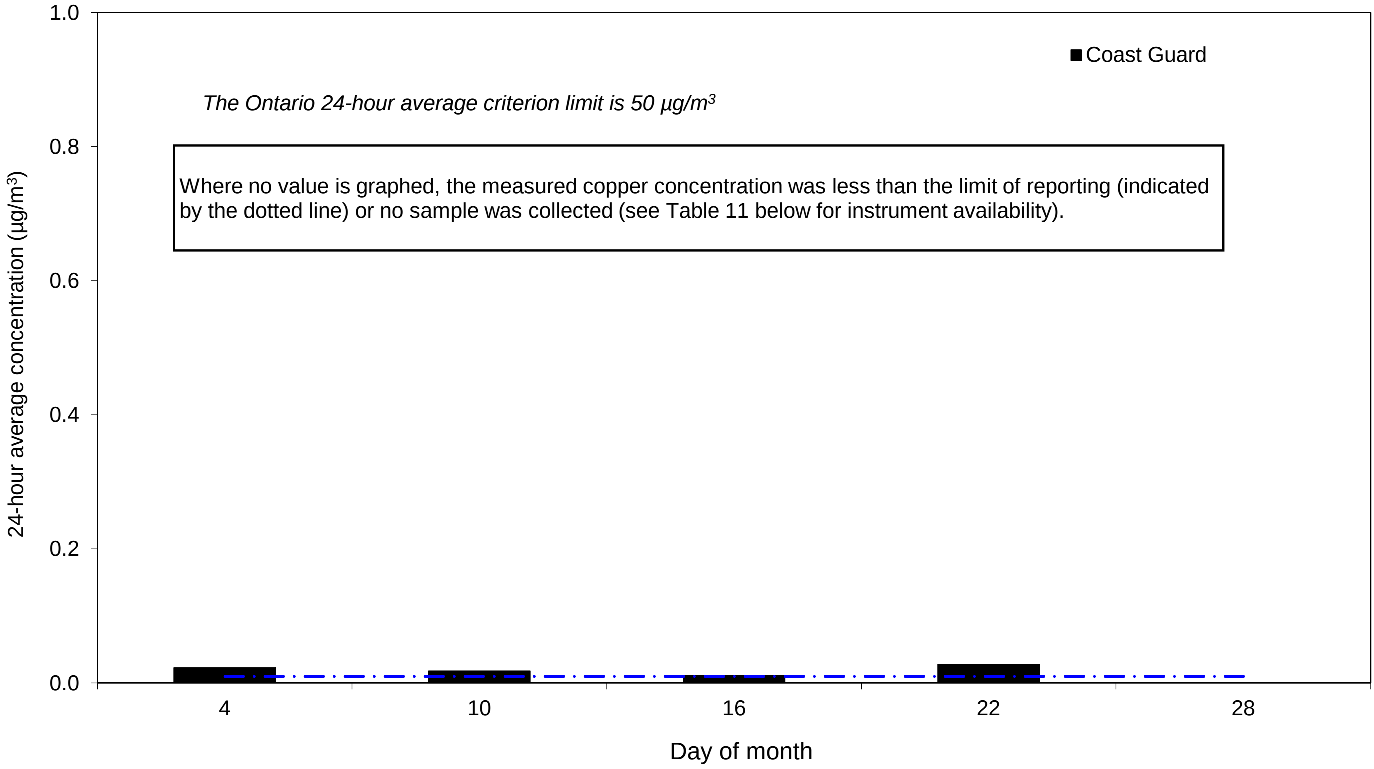


Table 9. Ambient concentrations of TSP copper. Monthly maximum 24-hour average concentrations (µg/m^3) for one day in six monitoring, April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville												
Coast Guard												
Maximum 24-hour	0.12	0.08	0.05	0.17	0.12	0.09	0.08	0.15	0.07	0.03	0.14	0.03
% I.A.	100	100	100	67	100	100	100	60	80	80	100	80

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The Ontario Ministry of Environment ambient air quality criterion for copper is a 24-hour average of 50 µg/m^3.

The limit of reporting is the minimum measured copper concentration that can be determined with the sampling equipment and laboratory method used. Copper concentrations below this limit are preceded by a "<" sign in the table.

TSP Zinc

Figure 8. Ambient concentrations of TSP zinc (one day in six monitoring) at the Coast Guard site. Maximum 24-hour average concentrations (µg/m³), March 2017.

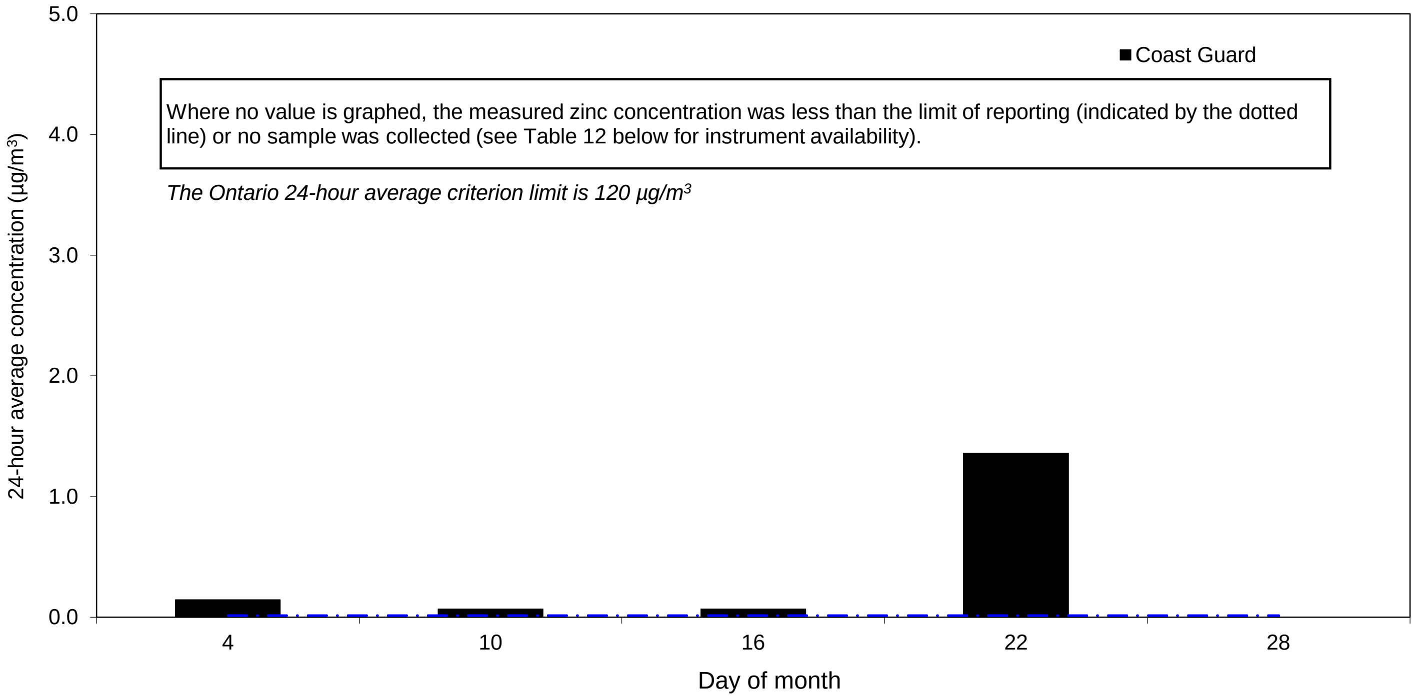


Table 10. Ambient concentrations of TSP zinc. Monthly maximum 24-hour average concentrations (µg/m³) for one day in six monitoring, April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville												
Coast Guard												
Maximum 24-hour	0.64	0.24	1.38	0.75	2.52	1.09	0.51	2.46	0.88	0.56	2.12	1.36
% I.A.	100	100	100	67	100	100	100	60	80	80	100	80

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The Ontario Ministry of Environment ambient air quality criterion for zinc is a 24-hour average of 120 µg/m³.

The limit of reporting is the minimum measured zinc concentration that can be determined with the sampling equipment and laboratory method used. Zinc concentrations below this limit are preceded by a "<" sign in the table.

TSP Nickel

Figure 9. Ambient concentrations of TSP nickel (one day in six monitoring) at the Coast Guard site. Annual average concentrations (µg/m^3), April 2016 to March 2017.

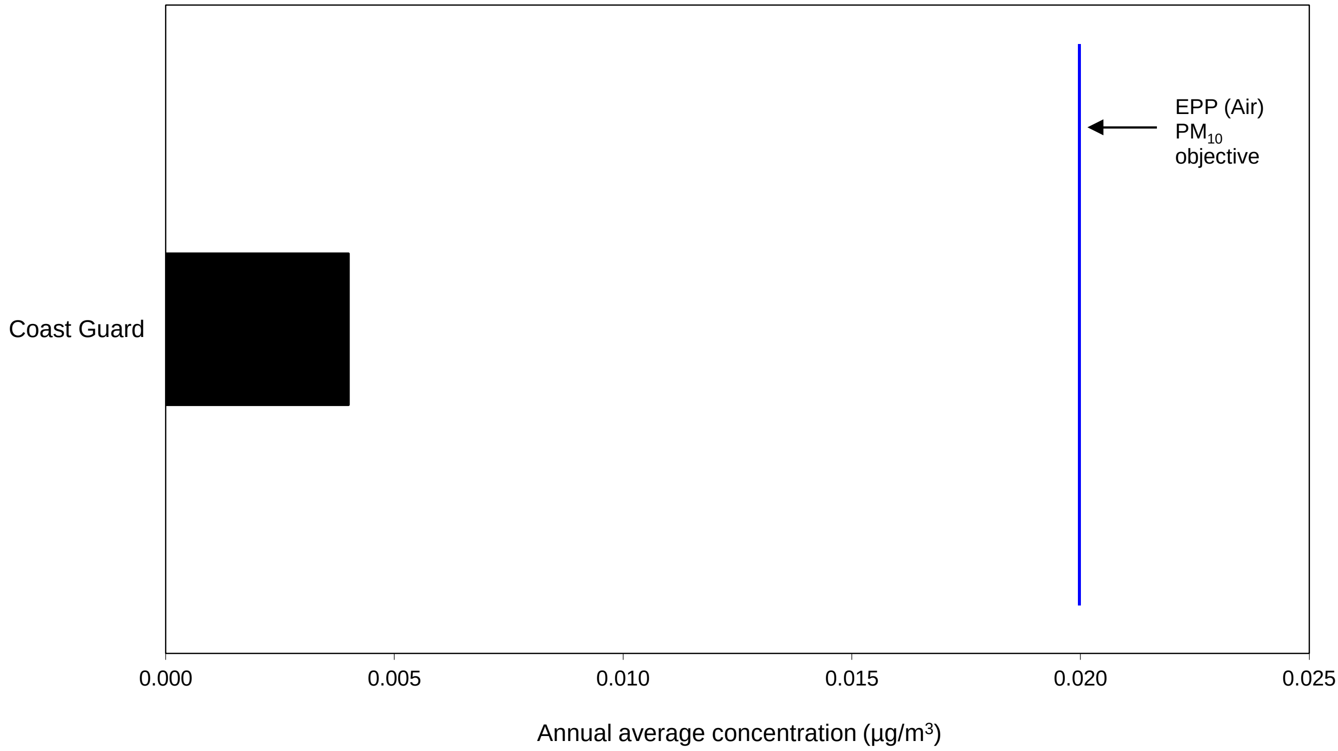


Table 11. Ambient concentrations of TSP nickel. Annual average and monthly maximum 24-hour average concentrations (µg/m^3) for one day in six monitoring, April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville													
Coast Guard													
Annual average:	0.004												
Maximum 24-hour		0.015	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.017	<0.003	<0.003	0.022
% I.A.		100	100	100	67	100	100	100	60	80	80	100	80

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for nickel is an annual average of 0.020 µg/m^3 (measured as the total metal content in PM_{10} particles).

Monitoring conducted by the Queensland Government measures the amount of nickel present in the TSP fraction. As PM_{10} is a subset of TSP, if the TSP nickel concentration is less than the EPP (Air) PM_{10} objective value, it follows that the PM_{10} nickel concentration complies with the EPP (Air) objective.

The limit of reporting is the minimum measured nickel concentration that can be determined with the sampling equipment and laboratory method used. Nickel concentrations below this limit are preceded by a "<" sign in the table. Annual average concentrations have been calculated using half the minimum measurable concentration value for samples where no nickel was detected.

TSP Arsenic

Figure 10. Ambient concentrations of TSP arsenic (one day in six monitoring) at the Coast Guard site. Annual average concentrations (µg/m^3), April 2016 to March 2017.

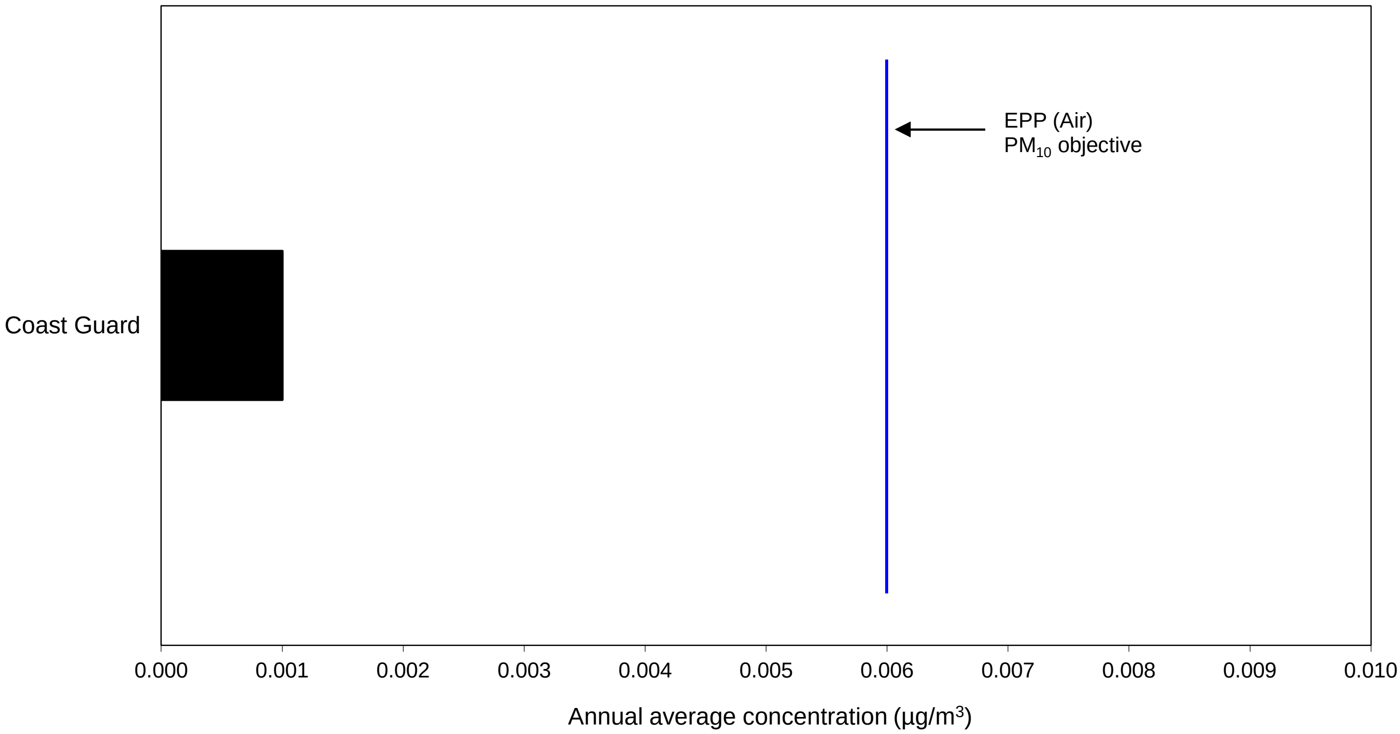


Table 12. Ambient concentrations of TSP arsenic. Annual average and monthly maximum 24-hour average concentrations (µg/m^3) for one day in six monitoring, April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville													
Coast Guard													
Annual average	0.001												
Maximum 24-hour		0.001	0.001	0.007	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
% I.A.		100	100	100	67	100	100	100	60	80	80	100	80

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for arsenic is an annual average of 0.006 µg/m^3 (measured as the total metal content in PM_{10} particles).

Monitoring conducted by the Queensland Government measures the amount of arsenic present in the TSP fraction. As PM_{10} is a subset of TSP, if the TSP arsenic concentration is less than the EPP (Air) PM_{10} objective value, it follows that the PM_{10} arsenic concentration complies with the EPP (Air) objective.

The limit of reporting is the minimum measured arsenic concentration that can be determined with the sampling equipment and laboratory method used. Arsenic concentrations below this limit are preceded by a "<" sign in the table. Annual average concentrations have been calculated using half the minimum measurable concentration value for samples where no arsenic was detected.

TSP Cadmium

Figure 11. Ambient concentrations of TSP cadmium (one day in six monitoring) at the Coast Guard site. Annual average concentrations (µg/m^3), April 2016 to March 2017.

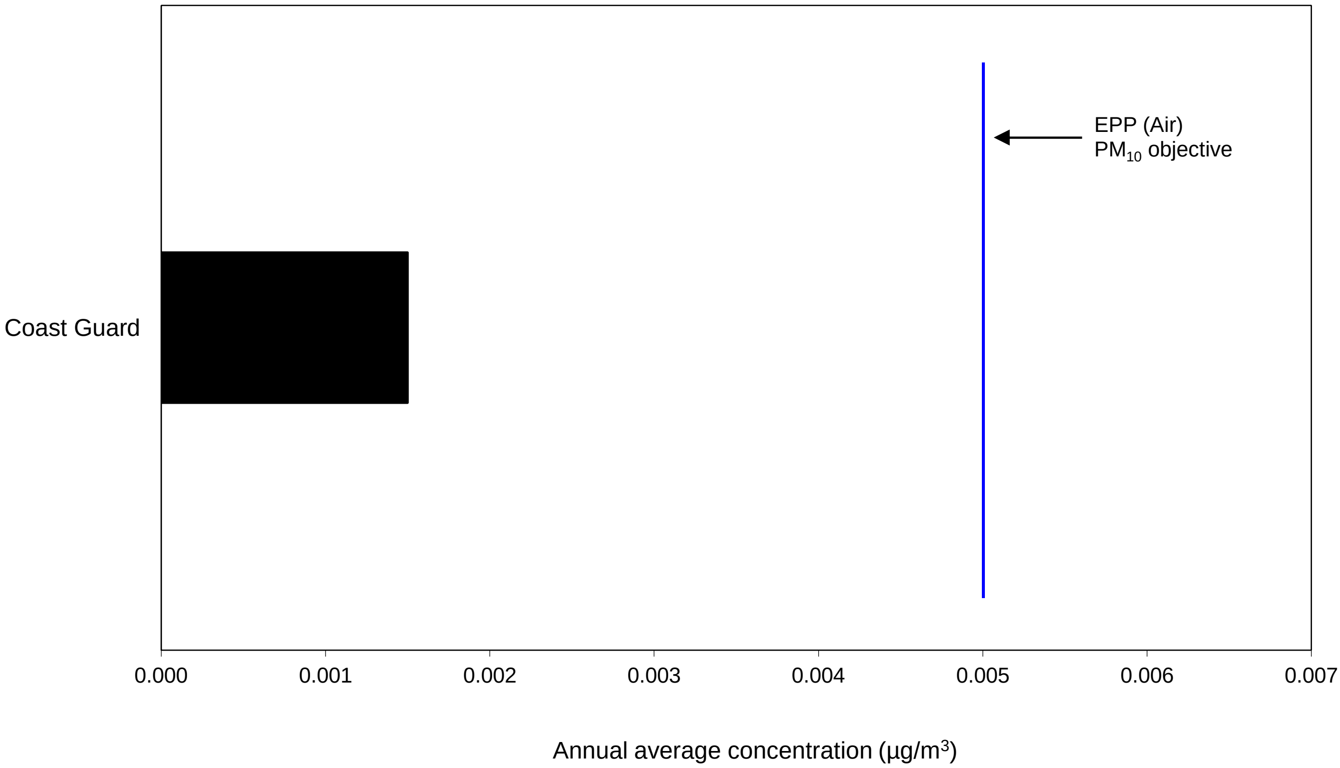


Table 13. Ambient concentrations of TSP cadmium. Annual average and monthly maximum 24-hour average concentrations (µg/m^3) for one day in six monitoring, April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville													
Coast Guard													
Annual Average	0.0015												
Maximum 24-hour		0.002	0.001	0.005	0.003	0.012	0.005	0.002	0.011	0.006	0.002	0.006	0.002
% I.A.		100	100	100	67	100	100	100	60	80	80	100	80

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for cadmium is an annual average of 0.005 µg/m^3 (measured as the total metal content in PM$_{10}$ particles).

Monitoring conducted by the Queensland Government measures the amount of cadmium present in the TSP fraction. As PM$_{10}$ is a subset of TSP, if the TSP cadmium concentration is less than the EPP (Air) PM$_{10}$ objective value, it follows that the PM$_{10}$ cadmium concentration complies with the EPP (Air) objective.

The limit of reporting is the minimum measured cadmium concentration that can be determined with the sampling equipment and laboratory method used. Cadmium concentrations below this limit are preceded by a "<" sign in the table. Annual average concentrations have been calculated using half the minimum measurable concentration value for samples where no cadmium was detected.

Dustfall

Figure 12. Dustfall monitoring at the Coast Guard and North Ward (Warburton Street) sites. Daily average dust (insoluble solids fraction) deposition rate ($mg/m^2/day$) for month of March 2017.

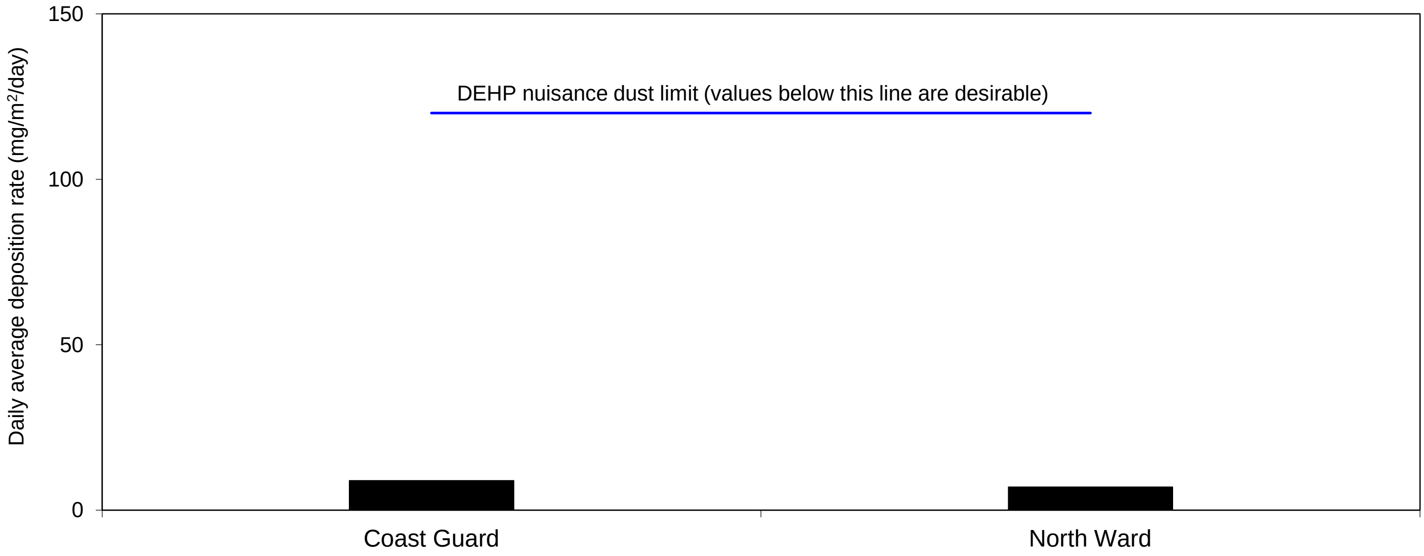


Table 14. Daily average dust (insoluble solids fraction) deposition rate ($mg/m^2/day$), April 2016 to March 2017.

Site	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville												
Coast Guard												
Daily average	44	23	59	24	45	32	37	33	24	19	33	9
North Ward (Warburton St)												
Daily average	172	77	165	30	n.d.	158	244	n.d.	53	15	13	7

n.d. indicates no data are available.

There is no national guideline for dust deposition.

The Department of Environment and Heritage Protection Air Impacts Guideline recommends a dust deposition limit of 120 $mg/m^2/day$, averaged over one month, be used to assess dust nuisance.

The limit of reporting is the minimum measured dust deposition rate that can be determined with the sampling equipment and laboratory method used. Dust deposition rates below this limit are preceded by a "<" sign in the table.

Dustfall lead

Figure 13. Dustfall lead monitoring at the Coast Guard and North Ward (Warburton Street) sites. Daily average lead deposition rate (µg/m^2/day) for month of March 2017.

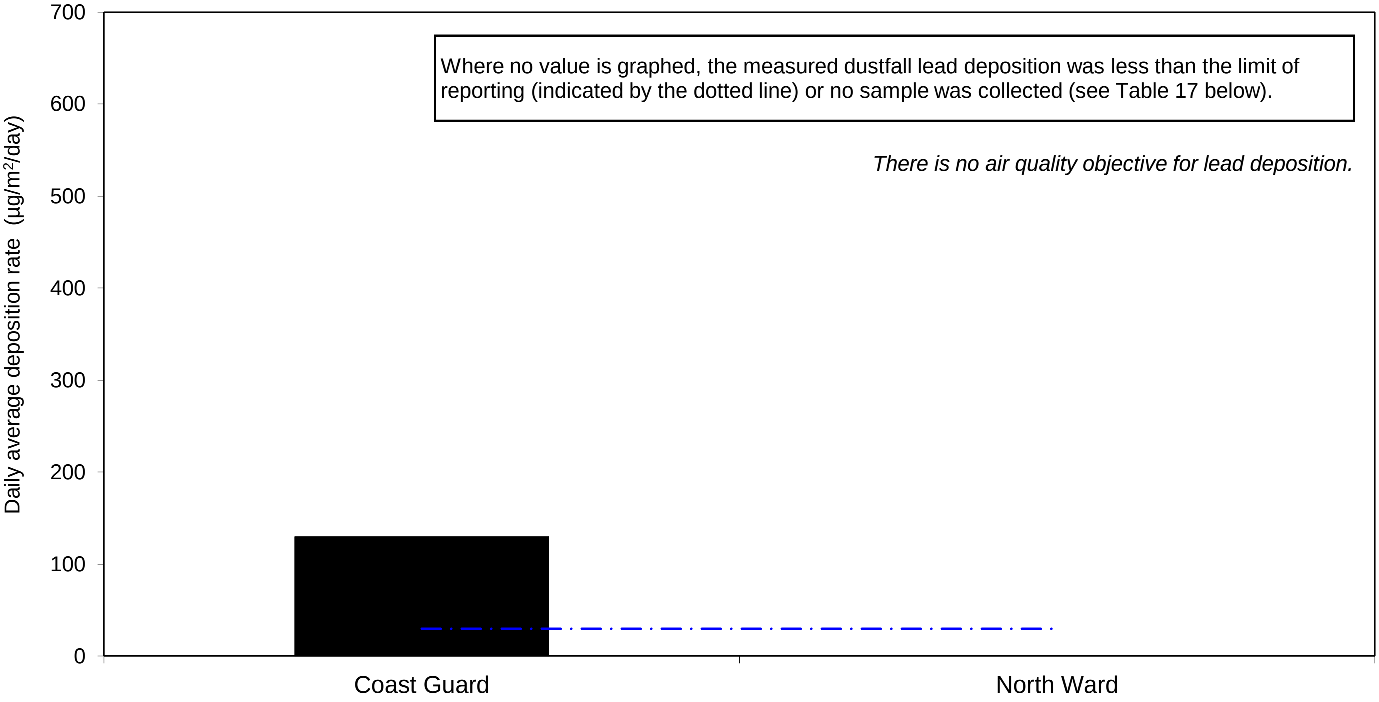


Table 15. Daily average lead deposition rate (µg/m^2/day), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Townsville													
Coast Guard													
Annual average:	206												
Daily average		94	57	118	61	310	235	222	300	500	269	133	130
North Ward (Warburton St)													
Annual average:	-												
Daily average		<31	<29	<59	<30	<30	<30	<37	n.d.	<29	<38	<33	<36

n.d. indicates no data are available.

There is no air quality objective for ambient lead deposition. Some data indicate that lead fallout levels between 250 and 750 µg/m^2/day (averaged over a 12-month period) are associated with a slight increase in blood lead levels (Air Quality Guidelines for Europe, Second Edition, World Health Organization, 2000).

The limit of reporting is the minimum measured lead deposition rate that can be determined with the sampling equipment and laboratory method used. Lead deposition rates below this limit are preceded by a "<" sign in the table.

Measured ambient concentrations - Mount Isa

Sulfur dioxide

Figure 14. Ambient concentrations of sulfur dioxide at the Menzies and The Gap sites. Daily 24-hour average concentrations (ppm), March 2017.

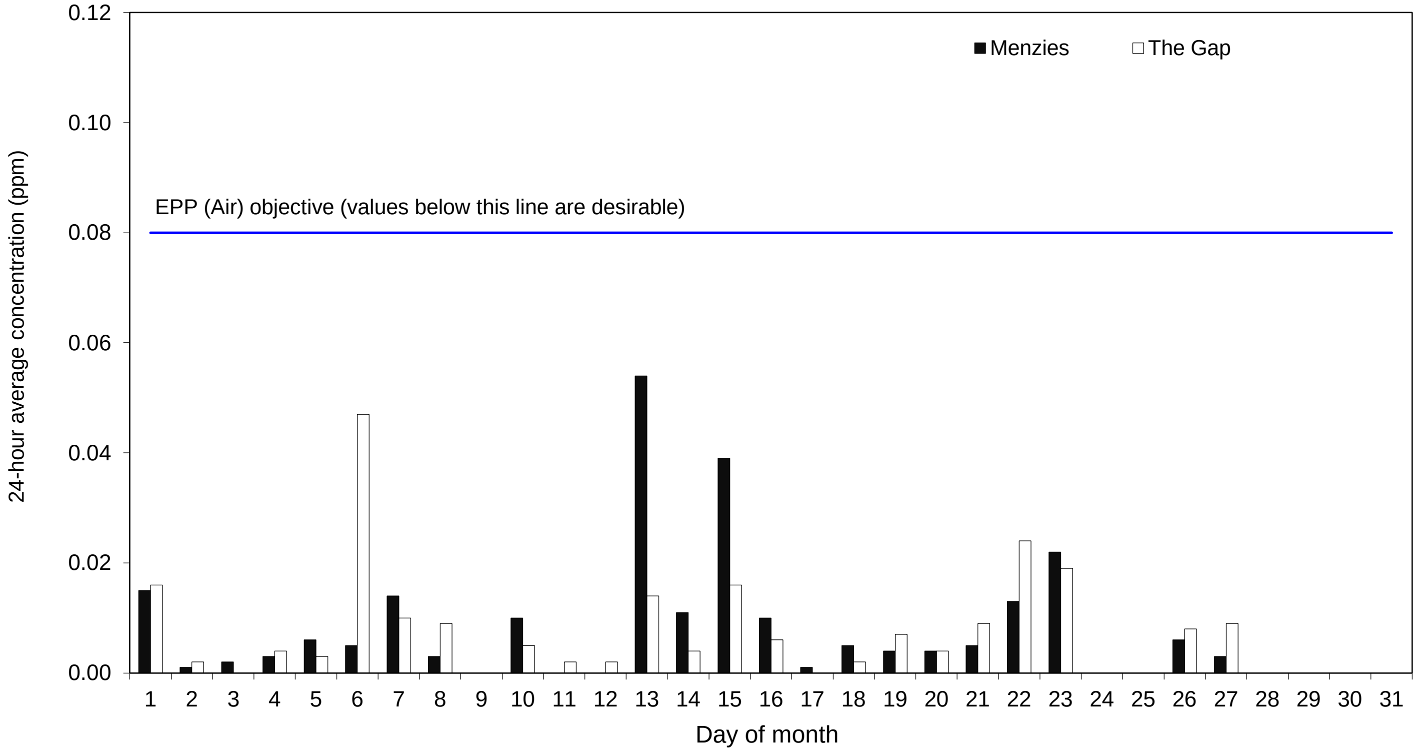


Figure 15. Ambient concentrations of sulfur dioxide at the Menzies and The Gap sites. Daily maximum 1-hour average concentrations (ppm), March 2017.

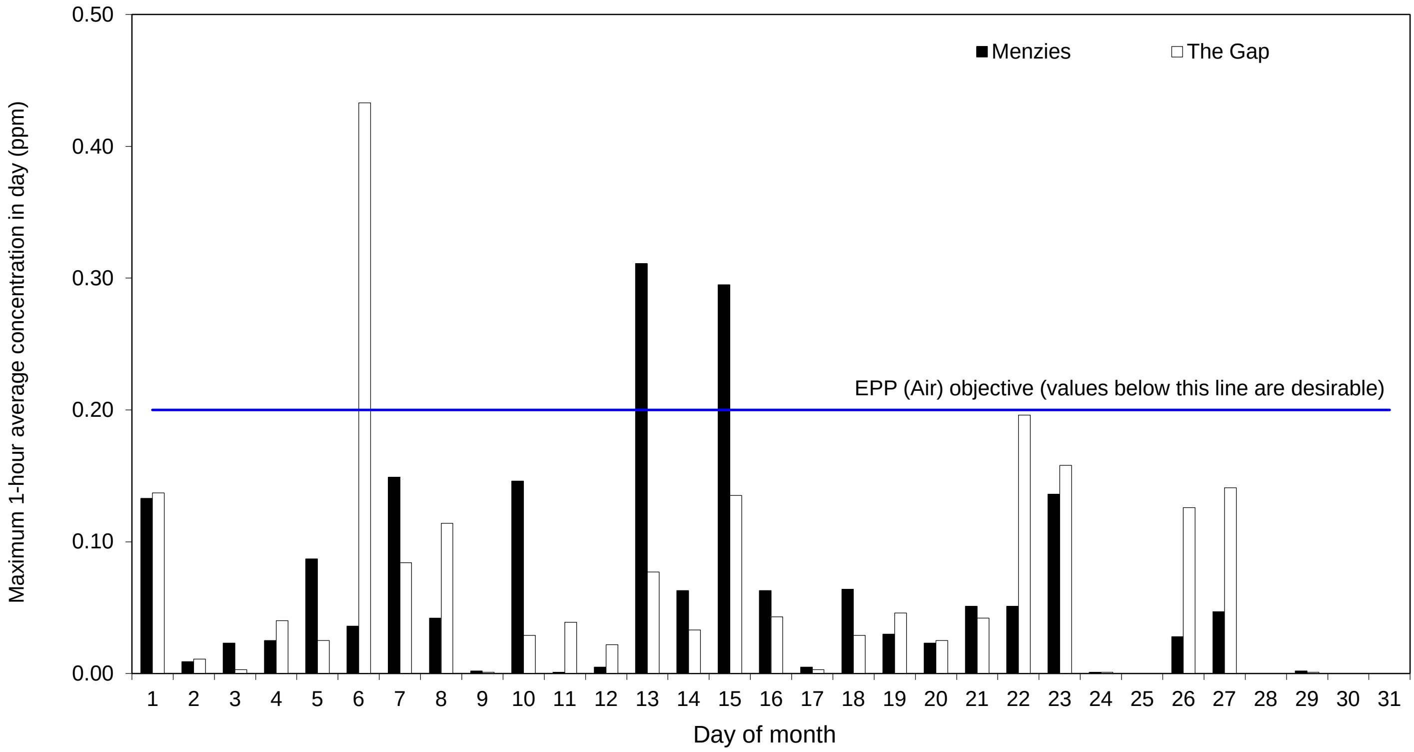


Table 16. Ambient concentrations of sulfur dioxide. Annual average and monthly maximum 24-hour and 1-hour average concentrations (ppm), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mount Isa													
Menzies													
Annual average:	0.006												
Maximum 24-hour		0.020	0.018	0.062	0.044	0.021	0.040	0.049	0.067	0.057	0.065	0.024	0.054
Maximum 1-hour		0.426	0.120	0.452	0.387	0.166	0.481	0.487	0.400	0.717	0.448	0.318	0.311
% I.A.		98	98	98	98	98	98	97	98	97	97	98	98
The Gap													
Annual average:	0.005												
Maximum 24-hour		0.027	0.033	0.041	0.058	0.030	0.031	0.039	0.051	0.031	0.047	0.034	0.047
Maximum 1-hour		0.366	0.275	0.284	0.504	0.292	0.222	0.271	0.232	0.260	0.465	0.314	0.433
% I.A.		91	98	98	98	98	98	94	74	97	96	98	98

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objectives for sulfur dioxide are an annual average of 0.020 ppm, a 24-hour average of 0.080 ppm (not to be exceeded on more than one day per year) and a 1-hour average of 0.200 ppm (not to be exceeded on more than one day per year).

PM_{10}

Figure 16. Ambient concentrations of PM_{10} at The Gap site. Daily 24-hour average concentrations (µg/m^3), March 2017.

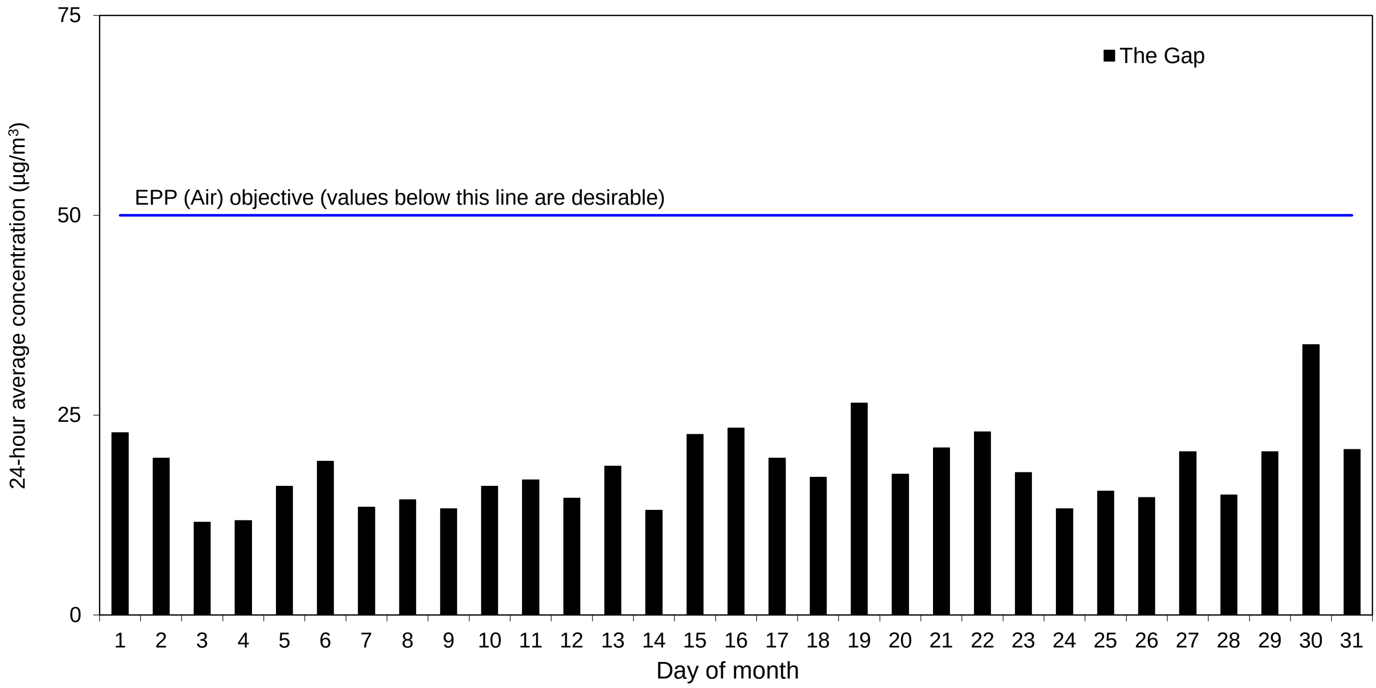


Table 17. Ambient concentrations of PM_{10}. Annual average and monthly maximum 24-hour average concentrations ($\mu g/m^3$), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mount Isa													
The Gap													
Annual average:	15.7												
Maximum 24-hour		24.9	25.0	31.5	30.5	36.9	33.2	38.0	36.3	43.3	23.1	23.3	33.8
% I.A.		89	98	95	99	98	96	94	98	94	90	95	94

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for PM_{10} is a 24-hour average of 50 $\mu g/m^3$ (not to be exceeded on more than five days per year).

The *National Environment Protection (Ambient Air Quality) Measure* standards for PM_{10} are an annual average of 25 $\mu g/m^3$ and a 24-hour average of 50 $\mu g/m^3$.

TSP Lead

Figure 17. Ambient concentrations of TSP lead at The Gap site. Annual average concentration ($\mu g/m^3$), April 2016 to March 2017.

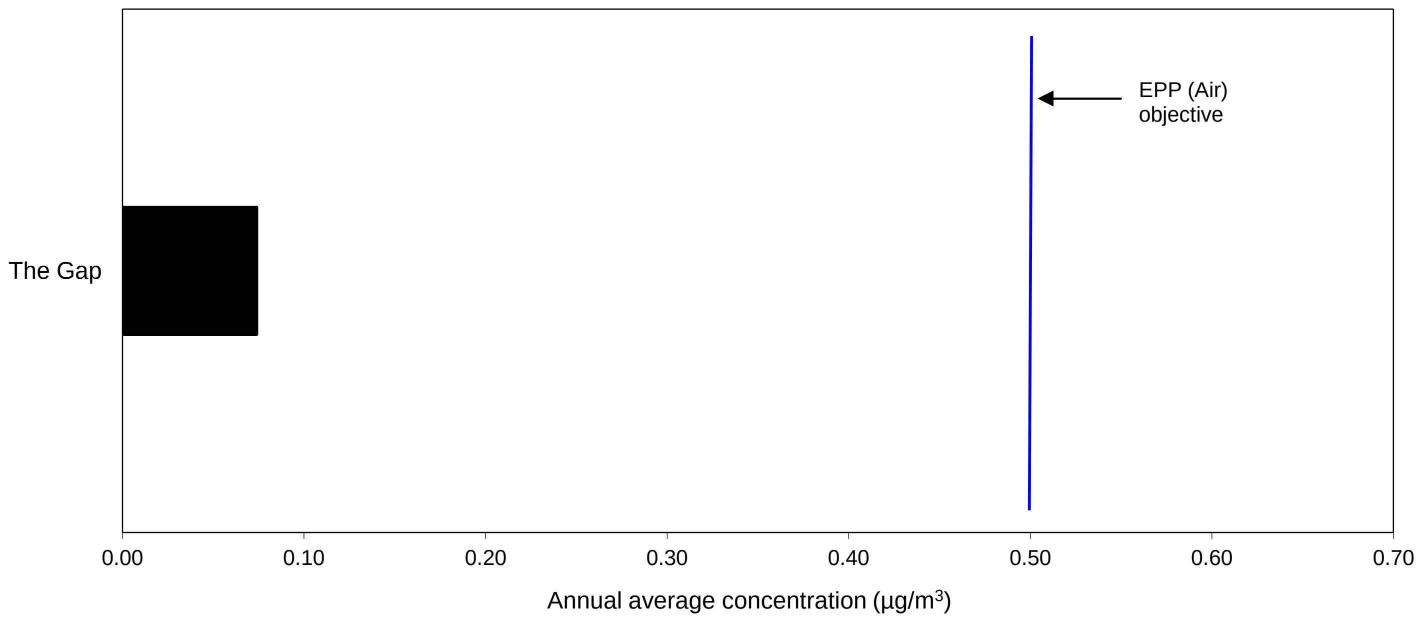


Table 18. Ambient concentrations of TSP lead. Annual average and monthly maximum 24-hour average concentrations ($\mu g/m^3$), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mount Isa													
The Gap													
Annual average:	0.07												
Maximum 24-hour		0.09	0.03	0.06	0.14	0.04	0.07	0.33	0.42	n.d.	0.28	0.24	0.61
% I.A.		100	100	100	100	100	100	100	100	n.d.	80	100	100

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for lead is an annual average of 0.5 $\mu g/m^3$.

The limit of reporting is the minimum measured lead concentration that can be determined with the sampling equipment and laboratory method used. Lead concentrations below this limit are preceded by a "<" sign in the table. The annual average concentration has been calculated using half the minimum measurable concentration value for samples where no lead was detected.

PM_{10} Arsenic

Figure 18. Ambient concentrations of PM_{10} arsenic at The Gap site. Annual average concentration (µg/m^3), April 2016 to March 2017.

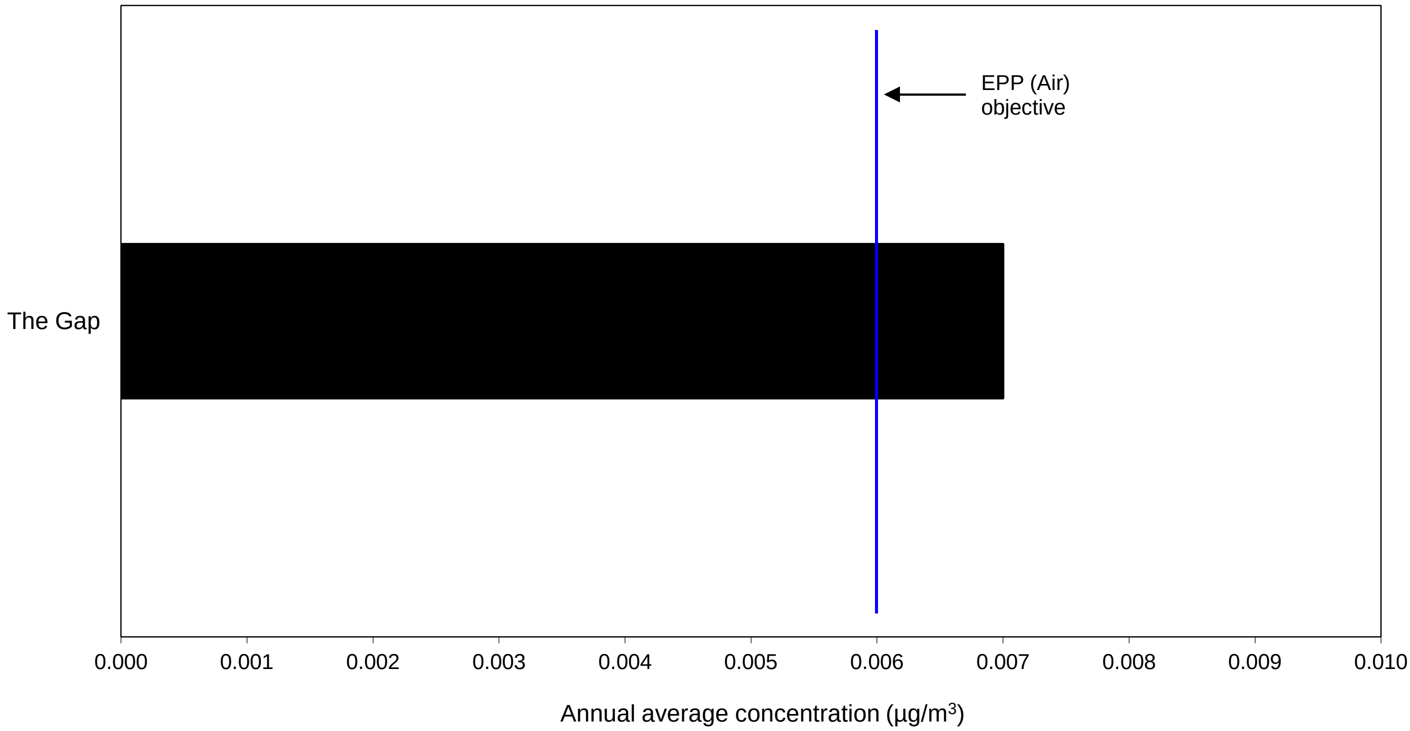


Table 19. Ambient concentrations of PM_{10} arsenic. Annual average and monthly maximum 24-hour average concentrations (µg/m^3), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mount Isa													
The Gap													
Annual average:	0.007												
Maximum 24-hour		<0.001	0.002	0.018	0.045	<0.001	0.031	0.016	0.047	n.d.	0.018	0.015	0.079
% I.A.		100	100	100	100	100	100	100	100	n.d.	80	100	100

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for arsenic is an annual average of 0.006 µg/m^3 (measured as the total metal content in PM_{10} particles).

Monitoring conducted by the Queensland Government measures the amount of arsenic present in the TSP fraction (the TSP fraction is collected so lead levels can be compared against the EPP (Air) objective). Monitoring using co-located TSP and PM_{10} high volume samplers has determined that the ratio of PM_{10} arsenic to TSP arsenic is 0.88:1 in Mount Isa. The PM_{10} arsenic values presented in this table have been generated by applying this factor to the measured TSP arsenic concentrations.

The limit of reporting is the minimum measured arsenic concentration that can be determined with the monitoring instrumentation used. Arsenic concentrations below this limit are preceded by a "<" sign in the table. The annual average concentration has been calculated using half the minimum measurable concentration value for samples where no arsenic was detected.

PM_{10} Cadmium

Figure 19. Ambient concentrations of PM_{10} cadmium at The Gap site. Annual average concentration (µg/m^3), April 2016 to March 2017.

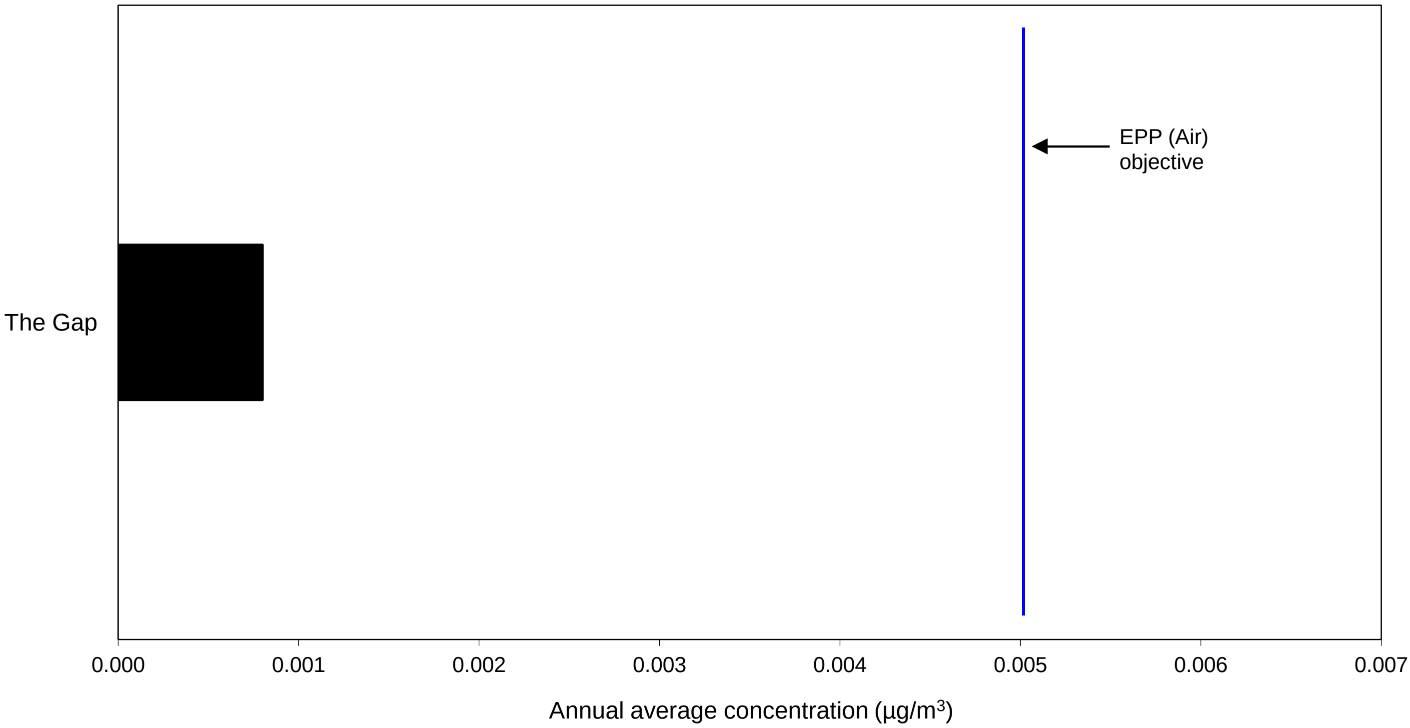


Table 20. Ambient concentrations of PM_{10} cadmium. Annual average and monthly maximum 24-hour average concentrations (µg/m^3), April 2016 to March 2017.

Site		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mount Isa													
The Gap													
Annual average:	0.001												
Maximum 24-hour		0.008	<0.001	0.002	0.004	<0.001	0.004	0.002	0.006	n.d.	0.003	0.002	0.006
% I.A.		100	100	100	100	100	100	100	100	n.d.	80	100	100

% I.A. indicates instrument availability. - indicates less than three-fifths of the data are available. n.d. indicates no data are available.

The *Environmental Protection (Air) Policy 2008* air quality objective for cadmium is an annual average of 0.005 µg/m^3 (measured as the total metal content in PM_{10} particles).

Monitoring conducted by the Queensland Government measures the amount of cadmium present in the TSP fraction (the TSP fraction is collected so lead levels can be compared against the EPP(Air) objective). Monitoring using co-located TSP and PM_{10} high volume samplers has determined that the ratio of PM_{10} cadmium to TSP cadmium is 0.76:1 in Mount Isa. The PM_{10} cadmium values presented in this table have been generated by applying this factor to the measured TSP cadmium concentrations.

The limit of reporting is the minimum measured cadmium concentration that can be determined with the monitoring instrumentation used. Cadmium concentrations below this limit are preceded by a "<" sign in the table. The annual average concentration has been calculated using half the minimum measurable concentration value for samples where no cadmium was detected.

Data Availability

When required, Table 21 summarises the reasons for data availability below the minimum criteria for reporting at North Queensland monitoring sites.

Table 21. Reasons for low data availability at North Queensland ambient air monitoring sites during March 2017.

Station	Air Pollutant	Cause
Townsville Coast Guard	TSP (1 day in 6 sampling)	Instrument fault

Related air quality information

Current hourly air quality data is available from the internet at www.ehp.qld.gov.au/air/data/search.php.

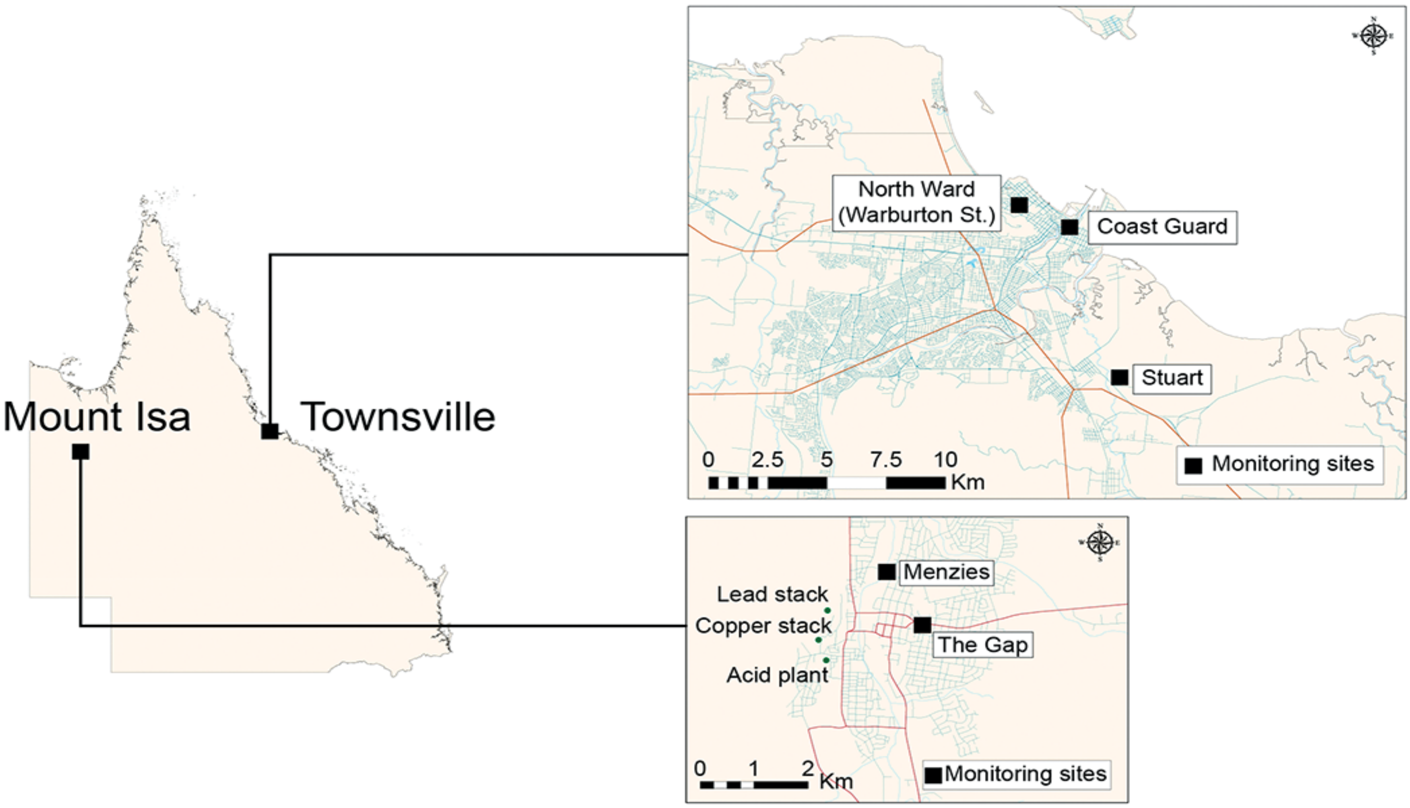
Additional information on air quality monitoring and related issues is also available from the above website.

Further information

For further information about the data presented in this bulletin or related publications, contact:

Air Quality Monitoring
Environmental Monitoring and Assessment Sciences
Science Division
Department of Science, Information Technology and Innovation
Ecosciences Precinct
41 Boggo Rd
DUTTON PARK QLD 4102
Telephone (07) 3170 5477
Email: air.sciences@dsiti.qld.gov.au

Figure 20. North Queensland ambient air quality monitoring station locations.



Department of Science, Information Technology and Innovation

Queensland air monitoring 2016

National Environment Protection (Ambient Air Quality) Measure

Queensland Government

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May 2017

Summary

This document fulfils annual reporting requirements for Queensland under clause 18 of the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM).

Ambient air quality monitoring at AAQ NEPM sites in Queensland from January to December 2016 showed no exceedances of the AAQ NEPM standards for carbon monoxide, nitrogen dioxide, ozone, $PM_{2.5}$ (particles less than 2.5 micrometres in diameter) and lead at any Queensland monitoring station. Exceedances of the AAQ NEPM standards occurred for:

- one-hour average sulfur dioxide concentrations at the Menzies and The Gap monitoring sites in Mount Isa due to industrial emissions;
- 24-hour average sulfur dioxide concentrations at the Menzies monitoring site in Mount Isa due to industrial emissions; and
- 24-hour average PM_{10} (particles less than 10 micrometres in diameter) concentrations at The Gap monitoring site in Mount Isa due to a dust storm.

AAQ NEPM goals were met in all regions except:

- one-hour average sulfur dioxide concentrations at the Menzies and The Gap monitoring sites in Mount Isa due to industrial emissions.

The Woolloongabba monitoring site in South East Queensland was temporarily closed on 17 June 2016 due to construction works at the monitoring site location. The Pimlico monitoring site in Townsville was decommissioned on 29 February 2016 at the request of the property owners due to planned redevelopment of the site. As a result, compliance with AAQ NEPM standards and goals was not demonstrated for carbon monoxide at Woolloongabba, and nitrogen dioxide, ozone, sulfur dioxide and PM_{10} at Pimlico because data availability was below the level required to make a valid assessment.

Low data availability in Quarter 4 as a result of equipment failure meant that a valid assessment of compliance with the AAQ NEPM annual standard for lead at The Gap monitoring site in Mount Isa could not be made, however it is considered highly probably that compliance with the annual standard would have been achieved.

Contents

List of tables

List of figures

Introduction

Clause 18 of the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) [1] requires all jurisdictions to submit an annual report on their compliance with the Measure. The required content of these reports are specified in the *National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 8, Annual Reports*[2] (AAQ NEPM Technical Paper No. 8).

The Department of Science, Information Technology and Innovation (DSITI) operates the Queensland ambient air quality monitoring network. This network includes air monitoring to assess compliance with the standards and goals of the AAQ NEPM, as detailed in the *Ambient air quality monitoring plan for Queensland*[3], together with additional ambient and investigative air monitoring for other purposes.

This report documents Queensland's compliance with the standards and goals of the AAQ NEPM in accordance with the AAQ NEPM Technical Paper No. 8.

[1] available from www.legislation.gov.au/Details/F2016C00215

[2] available from www.nepc.gov.au/resource/ephc-archive-ambient-air-quality-nepm

[3] available from www.qld.gov.au/environment/pollution/monitoring/air-reports/

Section A – Monitoring summary

Current AAQ NEPM monitoring stations

DSITI monitored air quality in 2016 in five of the ten regions identified in the Queensland monitoring plan:

- South East Queensland (made up of three sub-regions: North Coast, Brisbane and Ipswich)
- Gladstone
- Mackay
- Townsville
- Mount Isa.

Table 1 presents summary information for all AAQ NEPM compliance monitoring stations in Queensland in 2016. Each monitoring station is categorised as one of the following:

- performance monitoring station (PMS) – nominated to measure air quality to assess achievement of the AAQ NEPM goal
- trend station – nominated to measure air quality to identify long-term changes and assess achievement of the AAQ NEPM goal
- campaign station – short-term investigation station, operated for at least one calendar year, to assess the need for ongoing monitoring in the region to assess achievement of the AAQ NEPM goal.

The location category in Table 1 provides a qualitative description of the exposed population at each monitoring station.

Table 1 also describes monitoring stations using population coverage descriptors in the *National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 3, Monitoring Strategy*[4]:

- generally representative upper bound (GRUB) – indicative of pollutant concentrations in the upper range occurring in populated areas in the region
- population-average – indicative of air quality experienced by most of the population.

DSITI generally monitors air quality in compliance with the Australian Standards (AS) specified in the AAQ NEPM. Exceptions to these standards are:

- differential optical absorption spectroscopy (DOAS) technique used to measure ozone, nitrogen dioxide and sulfur dioxide at Springwood in South East Queensland
- tapered element oscillating microbalance (TEOM) instruments fitted with Filter Dynamics Measurement Systems (FDMS) to account for possible losses of semi-volatile compounds present in particles caused by heating the air stream, at Rocklea and Springwood in South East Queensland and at South Gladstone.

Monitoring techniques used at each AAQ NEPM compliance monitoring site are listed in Table 1.

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[4] available from www.nepc.gov.au/resource/ephc-archive-ambient-air-quality-nepm

Table 1. Summary information for 2016 Queensland AAQ NEPM monitoring sites

Site	Station type	Date established	Pollutants measured	Monitoring technique	Location category	Non-conformance with AS3580.1.1 siting criteria	Major pollutant sources
South East Queensland							
North Coast sub-region							
Mountain Creek	PMS – GRUB	July 2001	O_3 NO_2 PM_{10}	AS3580.6.1–2011 AS3580.5.1–2011 AS3580.9.8–2008	Residential	Nil	Major roads, forestry/ agricultural burning
Brisbane sub-region							
Deception Bay	Trend – GRUB	June 1994	O_3 NO_2	AS3580.6.1–2011 AS3580.5.1–2011	Residential	Trees within 20m west of site	Major roads
Woolloongabba	Trend – Peak	June 1998 (temporarily closed 17 June 2016)	CO	AS3580.7.1–2011	Inner city roadside	Building within 20m west of site	Major roads
Rocklea	Trend – GRUB	January 1978 (relocated March 1994 and June 2007)	O_3 NO_2 PM_{10} $PM_{2.5}$	AS3580.6.1–2011 AS3580.5.1–2011 FDMS TEOM, based on AS3580.9.13:2013 AS3580.9.13:2013 (FDMS TEOM)	Light industry/ residential	Nil	Major roads
Springwood	PMS – Population average	March 1999	O_3 NO_2 SO_2 PM_{10} $PM_{2.5}$	DOAS DOAS DOAS AS3580.9.8–2008 (to 25 Feb); FDMS TEOM, based on AS3580.9.13:2013 (from 25 Feb). TEOM, based on AS3580.9.8–2008 (to 25 Feb); AS3580.9.13:2013 (FDMS TEOM) (from 25 Feb).	Residential	Nil	Major roads
Ipswich sub-region							
Flinders View	Trend – GRUB	January 1993	O_3 NO_2 SO_2 PM_{10}	AS3580.6.1–2011 AS3580.5.1–2011 AS3580.4.1–2008 AS3580.9.8–2008	Industry/ residential	Trees within 20m of site	Major roads, industry (power station)

Table 1 (continued). Summary information for 2016 Queensland AAQ NEPM monitoring sites

Site	Station type	Date established	Pollutants measured	Monitoring technique	Location category	Non-conformance with AS3580.1.1 siting criteria	Major pollutant sources
Gladstone							
South Gladstone	Trend – GRUB	July 1992	NO_2 SO_2 PM_{10} $PM_{2.5}$	AS3580.5.1–2011 AS3580.4.1–2008 FDMS TEOM, based on AS3580.9.13:2013 AS3580.9.13:2013 (FDMS TEOM)	Industry/ residential	Nil	Major roads, industry (power station, metals processing)
Mackay							
West Mackay	PMS – GRUB	September 1997 (relocated June 2010)	PM_{10}	AS3580.9.8–2008	Residential/ rural	Nil	Agricultural burning
Townsville							
Coast Guard	Campaign – Peak	March 2008	Lead	AS3580.9.3–2003, with analysis by AS3580.9.15:2014 (ICP)	Industry	Trees within 20m of site	Port operations handling metal concentrates
Pimlico	Campaign – Population average	May 2004 (closed 29 February 2016)	O_3 NO_2 SO_2 PM_{10}	AS3580.6.1–2011 AS3580.5.1–2011 AS3580.4.1–2008 AS3580.9.8–2008	Residential	Trees within 20m of site	Major roads, industry (port operations, metals processing)
Stuart	Campaign – GRUB	September 2001	SO_2	AS3580.4.1–2008	Industry/ rural	Nil	Industry (metals processing)
Mount Isa							
Menzies	Trend – GRUB	January 1983	SO_2	AS3580.4.1–2008	Industry/ residential	Trees within 20m of site	Industry (metals smelting, sulfuric acid manufacture)
The Gap	PMS – Population average	January 2009	SO_2 PM_{10} Lead	AS3580.4.1–2008 AS3580.9.8–2008 AS3580.9.3–2003, with analysis by AS3580.9.15:2014 (ICP)	Industry/ residential	Building within 20m north-east of site	Industry (metals smelting, sulfuric acid manufacture)

PMS = performance monitoring station
GRUB = generally representative upper bound
PM_{10} = particles less than 10 micrometres in diameter
$PM_{2.5}$ = particles less than 2.5 micrometres in diameter

FDMS = Filter Dynamics Measurement System
TEOM = tapered element oscillating microbalance
DOAS = differential optical absorption spectroscopy
ICP = inductively coupled plasma

PM_{10} data collected using TEOM units not fitted with FDMS units were adjusted using a temperature-dependent factor described in Option 2 in the *National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 10, Collection and Reporting of TEOM PM_{10} data*[5]. These adjusted PM_{10} concentrations vary linearly from no change at daily average temperatures at or above 15 degrees Celsius to an increase of 40 per cent at or below a temperature of five degrees Celsius.

$PM_{2.5}$ data presented in this report was collected using TEOM $PM_{2.5}$ instruments that operated continuously. Where not fitted with FDMS units, the TEOM instruments were operated in accordance with the *National Environment Protection (Ambient Air Quality) Measure Technical Paper on Monitoring for Particles as $PM_{2.5}$*[6].

Figure 1 shows the location of all 2016 Queensland AAQ NEPM monitoring stations.

[5] available from www.nepc.gov.au/resource/ephc-archive-ambient-air-quality-nepm

[6] available from www.nepc.gov.au/resource/ephc-archive-ambient-air-quality-nepm

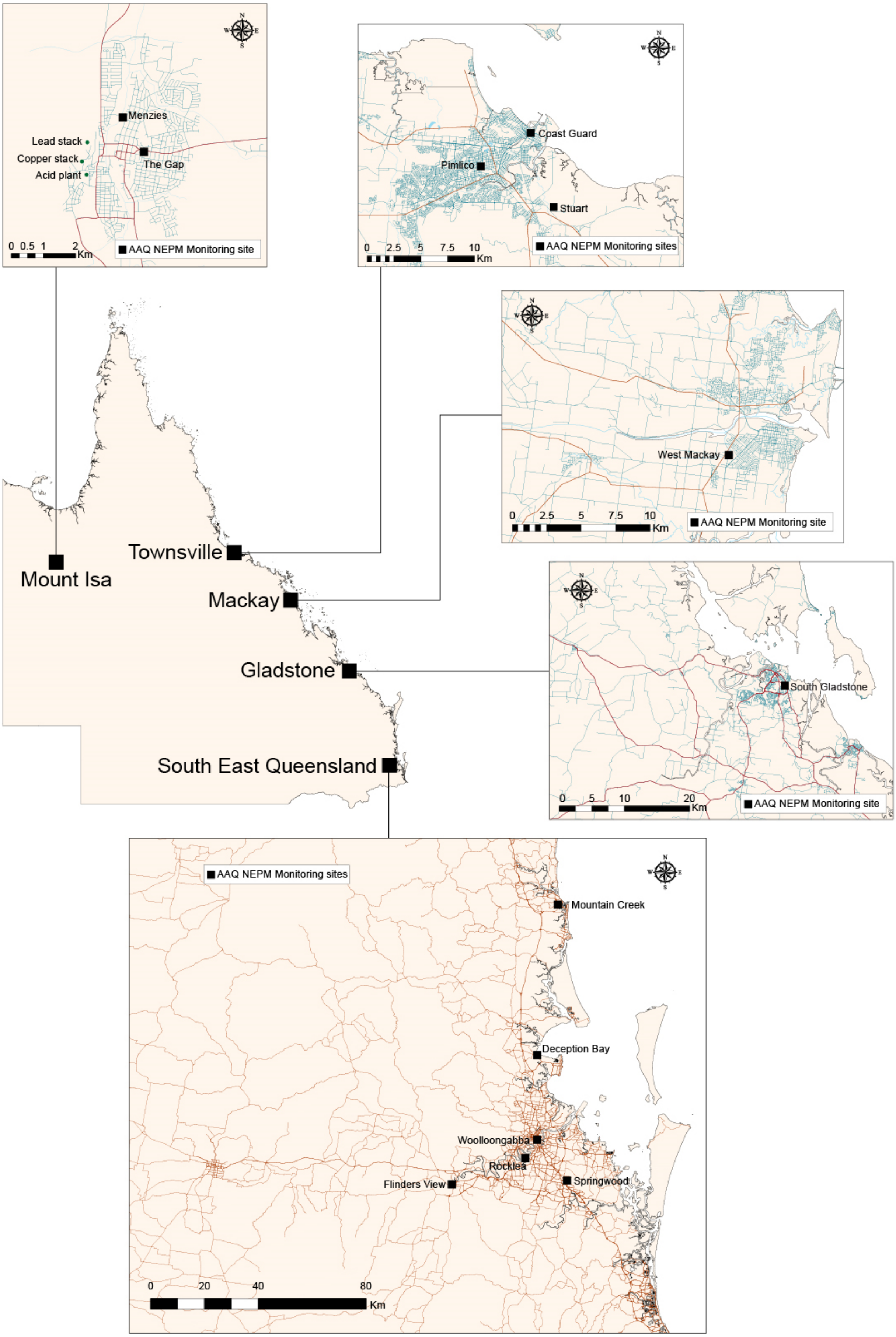

Figure 1. 2016 AAQ NEPM monitoring site locations

Variations to the approved monitoring plan for Queensland

Monitoring is not required if screening criteria specified in the *National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 4 – Screening Procedures*[7] (AAQ NEPM Technical Paper No. 4) are met.

Results of screening in Queensland showed that campaign monitoring of nitrogen dioxide in Bundaberg, Cairns, Mackay, Maryborough/Hervey Bay and Rockhampton, and campaign monitoring of ozone in Bundaberg, Mackay and Maryborough/Hervey Bay is not required. This was determined by the results of monitoring conducted in larger population centres and/or findings of generic modelling studies detailed in Appendix 1 of AAQ NEPM Technical Paper No. 4.

Table 2 shows the regions and pollutants that satisfied the screening procedures.

Table 2. Regions that satisfy screening procedures and do not require campaign monitoring

Region	CO	NO_2	Ozone	SO_2	PM_{10}	Lead
South East Queensland	–	–	–	–	–	A
Toowoomba	A	A	A	F	–	F
Maryborough/Hervey Bay	F	E & F	E & F	F	–	F
Bundaberg	F	E & F	E & F	F	–	F
Gladstone	F	–	A	–	–	F
Rockhampton	F	E & F	–	–	–	F
Mackay	F	E & F	E & F	F	–	F
Townsville	F	–	–	–	–	–
Cairns	F	E & F	–	F	–	F
Mount Isa	E	E	E	–	–	–

A = Screening by campaign monitoring at a generally representative upper bound (GRUB) monitoring location (with no significant deterioration expected over 5–10 years).
E = Screening by use of generic model results based on gross emission estimates, 'worst case' meteorology estimates and other conservative assumptions.
F = Screening by comparison with a National Environment Protection (Ambient Air Quality) Measure compliant region with greater population, emissions and pollution potential.
The '–' symbol indicates that monitoring is required to assess compliance.
For further information on the screening procedures, refer to *National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 4, Screening Procedures*, available from www.nepc.gov.au/resource/ephc-archive-ambient-air-quality-nepm.

[7] available from www.nepc.gov.au/resource/ephc-archive-ambient-air-quality-nepm

Section B – Assessment of compliance with standards and goals

This section presents details of the 2016 compliance assessment for Queensland. Compliance criteria are applied at each performance monitoring station in the state.

Compliance is achieved if approved screening procedures are satisfied or:

- the number of exceedances of the relevant standard was no more than the number specified in Schedule 2 of the AAQ NEPM, and
- data availability was at least 75 per cent in each calendar quarter.

In 2016 the AAQ NEPM was amended to include a PM_{10} annual average standard (25 µg/m^3) and replacement of the previous five-day exceedance form of the 24-hour particle standards with an exception event rule. Compliance with the AAQ NEPM goal for 24-hour $PM_{2.5}$ and PM_{10} concentrations now excludes exceptional events such as bushfires, hazard reduction burning and dust storms. These events are still included in determination of compliance with the AAQ NEPM goal for annual $PM_{2.5}$ and PM_{10} concentrations.

AAQ NEPM Technical Paper No. 8 states that a data availability rate of at least 75 per cent in each calendar quarter is required to make a valid assessment of compliance. Compliance with the relevant standards and goals could not be demonstrated for carbon monoxide at Woolloongabba in South East Queensland; nitrogen dioxide, ozone, sulfur dioxide and PM_{10} at Pimlico in Townsville; and lead at The Gap in Mount Isa for this reason.

Compliance summaries for AAQ NEPM pollutants in 2016 are presented from Table 3 to Table 9.

Carbon monoxide

Table 3. 2016 CO compliance summary

Region/performance monitoring station	Data availability rates (% of hours)					Number of exceedances (days)	Performance against the standard and goal
	Q1	Q2	Q3	Q4	Annual		
South East Queensland *Brisbane sub-region* Woolloongabba	95.8	80.4	0.0	0.0	43.8	0	ND

ND = “not demonstrated” due to insufficient data in one or more quarters.

AAQ NEPM standard for CO: 9.0 ppm (8-hour average).
AAQ NEPM goal for CO: standard exceeded on no more than 1 day per year.

Regions which do not require monitoring on the basis of screening arguments that carbon monoxide levels are reasonably expected to be consistently below the NEPM standard are:

- Bundaberg
- Cairns
- Gladstone
- Mackay
- Maryborough/Hervey Bay
- Mount Isa

- Rockhampton
- Toowoomba
- Townsville.

Motor vehicles are the main contributor to ambient carbon monoxide concentrations in urban areas. Combustion stoves and wood heaters can also contribute, but their use in most monitored areas in Queensland is minimal.

Carbon monoxide concentrations at performance monitoring stations in South East Queensland (at Brisbane CBD from 2000 to 2004 and Woolloongabba from 2007 to 2016) were consistently less than 40 per cent of the AAQ NEPM standard (see Section D – Pollutant distribution and trends). Therefore, under screening procedure F in Table 1 of the AAQ NEPM Technical Paper No. 4, carbon monoxide monitoring is not required in coastal Queensland population centres with lower traffic density and warmer winter temperatures than South East Queensland.

Carbon monoxide concentrations at North Toowoomba were consistently less than 30 per cent of the AAQ NEPM standard during campaign monitoring from July 2003 to December 2010. This satisfies the 60 per cent acceptance limit specified in screening procedure A in Table 1 of the AAQ NEPM Technical Paper No. 4.

Mount Isa satisfies screening criteria for carbon monoxide by generic modelling alone (screening procedure E in Table 1 of the AAQ NEPM Technical Paper No. 4) and therefore is considered to comply with the AAQ NEPM carbon monoxide standard.

Nitrogen dioxide

Table 4. 2016 NO_2 compliance summary

Region/performance monitoring station	Data availability rates (% of hours)					Number of exceedences (days)	Annual mean (ppm)	Performance against the standards and goals	
	Q1	Q2	Q3	Q4	Annual			1-hour	1-year
South East Queensland									
North Coast sub-region									
Mountain Creek	95.1	95.6	95.6	95.7	95.5	0	0.004	met	met
Brisbane sub-region									
Deception Bay	95.6	95.7	95.6	95.4	95.6	0	0.005	met	met
Rocklea	95.7	95.4	94.4	95.4	95.2	0	0.007	met	met
Springwood	99.7	100.0	94.9	99.0	98.4	0	0.006	met	met
Ipswich sub-region									
Flinders View	92.4	95.3	95.5	95.2	94.6	0	0.008	met	met
Gladstone									
South Gladstone	95.6	95.4	95.4	95.6	95.5	0	0.005	met	met
Townsville									
Pimlico	32.6	0.0	0.0	0.0	8.1	0	i.d.	ND	ND

i.d. = insufficient data to calculate value.
ND = “not demonstrated” due to insufficient data in one or more quarters.
AAQ NEPM standards for NO_2: 0.12 ppm (1-hour average); 0.03 ppm (1-year average).
AAQ NEPM goal for NO_2: one-hour standard exceeded on no more than one day per year.

Regions which do not require monitoring on the basis of screening arguments that nitrogen dioxide levels are reasonably expected to be consistently below the NEPM standards are:

- Bundaberg
- Cairns
- Mackay
- Maryborough/Hervey Bay
- Mount Isa
- Rockhampton
- Toowoomba
- Townsville.

Appendix 1 of the AAQ NEPM Technical Paper No. 4 states that nitrogen dioxide monitoring is not required in coastal and inland centres with populations below 250,000 on the bases of generic modelling conducted by CSIRO (screening procedure E in Table 1) and data from an AAQ NEPM compliant region with greater population, emissions and pollution potential showing nitrogen dioxide concentrations below 40 per cent of the NEPM standards (screening procedure F in Table 1).

Nitrogen dioxide monitoring at Pimlico in Townsville from 2004 to 2016 showed concentrations were consistently less than 40 per cent of the AAQ NEPM standards. The maximum one-hour average concentration during this period was 0.042 ppm (35 per cent of the standard). The highest annual average nitrogen dioxide concentration was 0.006 ppm (20 per cent of the standard). On this basis, nitrogen dioxide monitoring is not required at the coastal Queensland centres of Bundaberg, Cairns, Mackay, Maryborough/Hervey Bay and Rockhampton, which are considered to comply with the AAQ NEPM standards.

During campaign monitoring from July 2003 to December 2010, nitrogen dioxide concentrations at North Toowoomba were consistently less than 50 per cent of the AAQ NEPM standard. This satisfies the 60 per cent acceptance limit specified in screening procedure A in Table 1 of the AAQ NEPM Technical Paper No. 4.

Mount Isa satisfies screening criteria for nitrogen dioxide by generic modelling alone (screening procedure E in Table 1 of the AAQ NEPM Technical Paper No. 4) and therefore is considered to comply with the AAQ NEPM nitrogen dioxide standards.

Ozone

Table 5. 2016 O_3 compliance summary

Region/performance monitoring station	Data availability rates (% of hours)					Number of exceedances (days)		Performance against the standards and goals	
	Q1	Q2	Q3	Q4	Annual	1-hour	4-hour	1-hour	4-hour
South East Queensland									
North Coast sub-region									
Mountain Creek	89.0	95.6	95.6	95.7	94.0	0	0	met	met
Brisbane sub-region									
Deception Bay	94.5	95.7	95.6	95.3	95.2	0	0	met	met
Rocklea	95.6	95.5	89.1	95.6	93.9	0	0	met	met
Springwood	98.8	99.1	94.3	77.1	92.3	0	0	met	met
Ipswich sub-region									
Flinders View	95.3	95.2	94.6	95.0	95.0	0	0	met	met
Townsville									
Pimlico	65.5	0.0	0.0	0.0	16.3	0	0	ND	ND

ND = “not demonstrated” due to insufficient data in one or more quarters.

AAQ NEPM standards for O_3: 0.10 ppm (1-hour average); 0.08 ppm (4-hour average).
AAQ NEPM goal for O_3: standards exceeded on no more than one day per year.

Regions which do not require monitoring on the basis of screening arguments that ozone levels are reasonably expected to be consistently below the NEPM standards are:

- Bundaberg
- Cairns
- Gladstone
- Mackay
- Maryborough/Hervey Bay
- Mount Isa
- Rockhampton
- Toowoomba
- Townsville.

Appendix 1 of the AAQ NEPM Technical Paper No. 4 states that ozone monitoring is not required in coastal centres with a population below 25,000 on the basis of generic modelling conducted by CSIRO (screening procedure E in Table 2). Therefore, ozone monitoring is not required in the coastal Queensland centres of Bundaberg, Mackay, Maryborough/Hervey Bay and the inland centre of Mount Isa, which are considered to comply with the AAQ NEPM ozone standards.

Ozone concentrations monitored at North Toowoomba from July 2003 to December 2010 were consistently less than 75 per cent of the AAQ NEPM standards. This satisfied screening procedure A in Table 2 of the AAQ NEPM Technical Paper No. 4.

Ozone concentrations monitored at Targinie in the Gladstone region from 2001 to mid-2006 were consistently less than 60 per cent of the AAQ NEPM standards. The Targinie campaign GRUB monitoring station was located 20 kilometres north west of Gladstone and downwind of the region’s major industrial and transport sources. Ozone monitoring is not required in Gladstone on the basis of this campaign monitoring, as ozone concentrations satisfied screening procedure A in Table 2 of the AAQ NEPM Technical Paper No. 4.

Under screening procedure F in Table 2 of AAQ NEPM Technical Paper No. 4, ozone monitoring is not required in Rockhampton based on ozone concentrations measured in the Gladstone region meeting the 60 per cent acceptance limit and emissions of precursor ozone pollutants being lower in Rockhampton than in the Gladstone airshed[8].

Ozone concentrations at the Pimlico campaign monitoring site in Townsville, have been consistently less than 75 per cent of the AAQ NEPM 1-hour and 4-hour standards between 2004 and 2016. This indicates that, in the absence of a significant increase in ozone precursor pollutant emissions, ongoing ozone monitoring is not required in Townsville as ozone concentrations satisfy screening procedure A in Table 2 of the AAQ NEPM Technical Paper No. 4.

Under screening procedure F in Table 2 of the AAQ NEPM Technical Paper No. 4, ozone monitoring is not required in Cairns where population and emissions of precursor ozone pollutants are lower than in Townsville[9].

Sulfur dioxide

Table 6. 2016 SO_2 compliance summary

Region/ performance monitoring station	Data availability rates (% of hours)					Number of exceedances (days)		Annual mean (ppm)	Performance against the standards and goal		
	Q1	Q2	Q3	Q4	Annual	1-hour	24-hour		1-hour	24-hour	1-year
South East Queensland *Brisbane sub-region* Springwood	98.6	99.6	94.6	94.3	96.7	0	0	0.001	met	met	met
Ipswich sub-region Flinders View	95.3	95.3	95.2	95.1	95.2	0	0	0.001	met	met	met
Gladstone South Gladstone	87.7	95.2	95.4	95.4	93.5	0	0	0.002	met	met	met
Townsville Pimlico	62.6	0.0	0.0	0.0	15.6	0	0	i.d.	ND	ND	ND
Stuart	93.5	95.5	95.7	94.6	94.8	0	0	0.000	met	met	met
Mount Isa Menzies	95.8	95.7	95.8	95.2	95.6	32	1	0.007	not met	met	met
The Gap	94.6	93.5	95.8	83.1	91.8	24	0	0.005	not met	met	met

i.d. = insufficient data to calculate value.
ND = "not demonstrated" due to insufficient data in one or more quarters.

AAQ NEPM standards for SO_2: 0.20 ppm (1-hour average); 0.08 ppm (24-hour average); 0.02 ppm (1-year average).
AAQ NEPM goal for SO_2: 1-hour and 24-hour standards exceeded on no more than one day per year.

Regions which do not require monitoring on the basis of screening arguments that sulfur dioxide levels are reasonably expected to be consistently below the NEPM standards are:

- Bundaberg
- Cairns

[8] National Pollutant Inventory reporting for 2015–16 shows that industrial facilities in the Gladstone region emitted 46,000 tonnes of oxides of nitrogen and 570 tonnes of volatile organic compounds. Corresponding emissions from industrial facilities in the Rockhampton area (including the Stanwell Power Station) were 19,000 tonnes of oxides of nitrogen and 180 tonnes of volatile organic compounds (data obtained from www.npi.gov.au).

[9] National Pollutant Inventory reporting for 2015–16 shows that industrial facilities in the Townsville region emitted 3500 tonnes of oxides of nitrogen and 280 tonnes of volatile organic compounds. Corresponding emissions from industrial facilities in the Cairns area were 630 tonnes of oxides of nitrogen and 190 tonnes of volatile organic compounds (data obtained from www.npi.gov.au).

- Mackay
- Maryborough/Hervey Bay
- Rockhampton
- Toowoomba.

Concentrations of sulfur dioxide are typically low unless significant industrial sources of sulfur dioxide are present (e.g. coal-fired power stations or metals smelting). Peak sulfur dioxide concentrations in the Brisbane sub-region in South East Queensland are below 40 per cent of the AAQ NEPM standard (see Section D – Pollutant distribution and trends). On this basis, sulfur dioxide monitoring is not required in other Queensland centres with lower populations and no significant sulfur dioxide point sources under screening procedure F in Table 1 of the AAQ NEPM Technical Paper No. 4.

Sulfur dioxide concentrations at the South Gladstone monitoring site have been regularly below 40 per cent of the AAQ NEPM standards from 2009 to 2016. Therefore, under screening procedure F in Table 1 of the AAQ NEPM Technical Paper No. 4, sulfur dioxide monitoring is not required in Rockhampton based on the lower level of industrial emissions in Rockhampton[10].

[10] National Pollutant Inventory reporting for 2015–16 shows that sulfur dioxide emissions from industrial facilities in the Gladstone region totalled 42,000 tonnes, compared with 34,000 tonnes from industrial facilities (including the Stanwell Power Station) in Rockhampton over the same period (data obtained from www.npi.gov.au/).

PM_{10}

Table 7. 2016 PM_{10} compliance summary

Region/performance monitoring station	Data availability rates (% of days)					Number of exceedances (days)	Annual mean (µg/m³)	Performance against the standards and goals	
	Q1	Q2	Q3	Q4	Annual			24-hour	1-year
South East Queensland									
North Coast sub-region									
Mountain Creek	97.7	95.4	96.6	96.1	96.4	0	16.0	met	met
Brisbane sub-region									
Rocklea	95.8	86.3	90.9	90.4	90.9	0	15.1	met	met
Springwood	86.4	99.7	99.2	99.3	96.2	0	12.4	met	met
Ipswich sub-region									
Flinders View	96.8	98.3	98.2	97.3	97.6	0	13.1	met	met
Gladstone									
South Gladstone	98.7	94.5	98.6	95.9	96.9	0	14.5	met	met
Mackay									
West Mackay	92.0	91.3	96.3	95.6	93.8	0	19.8	met	met
Townsville									
Pimlico	52.3	0.0	0.0	0.0	13.0	0	i.d.	ND	ND
Mount Isa									
The Gap	96.7	92.9	97.0	94.3	95.2	1*	16.8	met	met

* Exceedance due to a dust storm. Excluded from determination of compliance with the 24-hour goal under the exceptional event rule.
i.d. = insufficient data to calculate value.
ND = “not demonstrated” due to insufficient data in one or more quarters.
AAQ NEPM standards for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average).
PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

PM_{10} monitoring is required in all regions because screening procedure arguments, that pollutant concentrations are reasonably expected to be consistently below the relevant AAQ NEPM standard, are not satisfied.

PM_{10} monitoring at North Toowoomba from July 2003 to December 2010 showed that bushfire smoke and widespread windblown dust events were associated with exceedances of the AAQ NEPM 24-hour PM_{10} standard. There was no evidence that domestic and commercial PM_{10} emissions were, on their own, sufficient to cause exceedances of the PM_{10} standard at the North Toowoomba station.

As no monitoring has been carried out to date, performance is ‘not demonstrated’ for the following regions:

- Bundaberg
- Cairns
- Maryborough/Hervey Bay
- Rockhampton.

$PM_{2.5}$

Table 8. 2016 $PM_{2.5}$ compliance summary

Region/performance monitoring station	Data availability rates (% of days)					Number of exceedances (days)	Annual mean (µg/m³)	Performance against the standards and goals	
	Q1	Q2	Q3	Q4	Annual			24-hour	1-year
South East Queensland *Brisbane sub-region*									
Rocklea+	95.8	86.3	90.9	90.4	90.9	0	6.5	met	met
Springwood‡	83.5	99.7	99.2	99.3	95.4	0	5.7	met	met
Gladstone									
South Gladstone+	98.7	94.5	98.6	95.9	96.9	0	5.7	met	met

+ Monitoring by TEOM Model 1405 instrumentation fitted with FDMS.
‡ Monitoring by TEOM Model 1400 instrumentation in accordance with Technical Paper on Monitoring for Particles as $PM_{2.5}$ (to 25 February 2016). From 25 February, monitoring by TEOM Model 1405 instrumentation fitted with FDMS.

AAQ NEPM standards for $PM_{2.5}$: 25 µg/m³ (24-hour average); 8 µg/m³ (1-year average).
$PM_{2.5}$ monitoring data determined as being directly associated with an exceptional event (e.g. bushfire) is excluded from reporting compliance with the $PM_{2.5}$ 24-hour goal.

$PM_{2.5}$ monitoring is required in all regions because screening procedure arguments, that pollutant concentrations are reasonably expected to be consistently below the relevant AAQ NEPM advisory standard, are not satisfied.

$PM_{2.5}$ monitoring at North Toowoomba from July 2003 to December 2010 showed that bushfire smoke and widespread windblown dust events were associated with exceedances of the (then advisory) AAQ NEPM 24-hour $PM_{2.5}$ standard. There was no evidence that domestic and commercial $PM_{2.5}$ emissions were, on their own, sufficient to cause exceedances of the $PM_{2.5}$ standard at the North Toowoomba station.

As no monitoring has been carried out to date, performance is ‘not demonstrated’ for the following regions:

- Bundaberg
- Cairns
- Mackay
- Maryborough/Hervey Bay
- Mount Isa
- Rockhampton
- Townsville.

Lead

Table 9. 2016 lead compliance summary

Region/ performance monitoring station	Data availability rates (% of days)					Annual mean (µg/m³)	Performance against the standards and goal
	Q1	Q2	Q3	Q4	Annual		
Townsville Coast Guard	100.0	100.0	100.0	100.0	100.0	0.05	met
Mount Isa The Gap	86.7	80.0	86.7	68.8	80.3	0.06	ND
ND = “not demonstrated” due to insufficient data in one or more quarters. AAQ NEPM standard for lead: 0.5 µg/m³ (1-year average).							

Regions which do not require monitoring on the basis of screening arguments that lead levels are reasonably expected to be consistently below the NEPM standard are:

- Bundaberg
- Cairns
- Gladstone
- Mackay
- Maryborough/Hervey Bay
- Rockhampton
- South East Queensland
- Toowoomba.

The phase-out of leaded motor vehicle fuel from March 2001 means that no significant sources of lead now exist in most Queensland regions. The exceptions to this are non-vehicle sources of lead such as metals smelting and handling of metal ore concentrates. Lead concentrations measured at the Woolloongabba performance monitoring station in South East Queensland were less than ten per cent of the AAQ NEPM standard for both 2001 (0.03 µg/m³) and 2002 (0.02 µg/m³). These measurements demonstrated that compliance with the AAQ NEPM standard and goal has been achieved in South East Queensland, in accordance with the *National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 9, Lead Monitoring*[11]. Lead monitoring in South East Queensland ceased in 2002.

Peak lead concentrations in South East Queensland were less than 40 per cent of the AAQ NEPM standard between 1999 and 2002 (see Section D – Pollutant distribution and trends). This means that, under screening procedure F in Table 1 of the AAQ NEPM Technical Paper No. 4, lead monitoring is not required in other Queensland centres with lower population and traffic density (except for Townsville and Mount Isa where other non-vehicle lead emission sources exist).

[11] available from www.nepc.gov.au/resource/ephc-archive-ambient-air-quality-nepm

Section C – Analysis of monitoring data against standards

This section presents time, date and location information for the following annual summary statistics for 2016:

- exceedances of AAQ NEPM standards and circumstances under which they occurred
- annual maximum and second-highest daily concentrations for carbon monoxide, nitrogen dioxide, ozone and sulfur dioxide, for which the AAQ NEPM allows one exceedance day per year.

Exceedance details are presented in Table 10 and Table 11, and summary statistics are presented from Table 12 to Table 19. Concentrations exceeding AAQ NEPM standards are shown in bold text in the summary tables.

Exceedance summary

In 2016, there were no exceedances of AAQ NEPM standards at compliance monitoring sites in Queensland, with the exception of sulfur dioxide and PM_{10} concentrations in Mount Isa.

Industrial operations (metals smelting and sulfuric acid manufacture) emit sulfur dioxide into the atmosphere in Mount Isa. Prior to April 2012 smelter operations were only controlled to meet Mount Isa Mines Agreement Act 1985 (MIM Act) air quality limits. From April 2012 to December 2016, smelter operations were under a Transitional Environmental Program (TEP) that set out a staged program of works to achieve compliance with the air quality objectives contained in the Queensland Environmental Protection (Air) Policy 2008 (equivalent to the AAQ NEPM standards for sulfur dioxide). From January 2016 smelter operations have been operating under an amended Environmental Authority (EA) which sets alternative air quality limits for some air pollutants as part of the Copper Smelter Extension Project. As smelter operations were only controlled to meet EA limits during 2016, sulfur dioxide concentrations exceeded the more stringent AAQ NEPM one-hour and 24-hour standards on numerous days. Details of these exceedances are shown in Table 10.

Mount Isa is situated in a low rainfall area where winds associated with the passage of low pressure troughs through the region can result in high levels of windblown dust during dry ground conditions. Windblown dust during a dust storm[12] was responsible for a single exceedance of the AAQ NEPM 24-hour PM_{10} standard in Mount Isa during 2016. Wind direction measurements during the exceedance period indicated that PM_{10} emissions from industrial activities would not have contributed to the exceedance of the 24-hour PM_{10} standard. Details of this exceedance are presented in Table 11.

[12] A report on the dust storm and associated images appeared on The North West Star newspaper website on 15 January 2016, see http://www.northweststar.com.au/story/3665864/flight-and-train-delayed-due-to-dust-storm/.

Table 10. 2016 SO_2 exceedances

Region/performance monitoring station	Standard	Concentration (ppm)	Date	Time	Circumstances
Mount Isa Menzies	1-hour	0.717	Dec 5	9	All exceedances at the Menzies monitoring site were due to industry emissions.
		0.576	Dec 5	10	
		0.487	Oct 25	18	
		0.481	Sep 23	15	
		0.478	Oct 21	22	
		0.465	Jan 10	12	
		0.452	Jun 5	14	
		0.438	Feb 29	19	
		0.432	Jun 21	15	
		0.426	Apr 2	16	
		0.400	Nov 29	17	
		0.396	Jun 5	17	
		0.392	Jan 2	16	
		0.387	Jul 3	16	
		0.377	Jun 21	16	
		0.366	Jun 3	15	
		0.356	Jul 4	12	
		0.347	Feb 29	18	
		0.345	Feb 5	22	
		0.327	Jun 6	16	
		0.323	Nov 29	16	
		0.291	Feb 9	18	
		0.286	Oct 3	9	
		0.277	Feb 5	21	
		0.277	Jun 18	14	
		0.270	Feb 18	14	
		0.264	Feb 25	14	
		0.263	Jul 22	17	
		0.251	Feb 29	24	
		0.251	Jun 30	15	
		0.249	Oct 26	16	
		0.247	Dec 31	10	
		0.230	Feb 29	14	
		0.226	Nov 22	20	
		0.224	Mar 1	14	
		0.219	Jan 6	17	
		0.216	Jun 6	11	
		0.214	Mar 29	17	
		0.213	Jan 2	17	
		0.210	Feb 29	20	
		0.209	Feb 19	18	
		0.208	Jan 5	18	
		0.207	Jan 10	17	
		0.206	Jun 6	12	
		0.205	Jul 22	15	
		0.205	Sep 23	16	
		0.204	Sep 9	17	
		0.203	Oct 26	12	
		0.201	Feb 29	17	

Table 10. 2016 SO2 exceedances (continued)

Region/performance monitoring station	Standard	Concentration (ppm)	Date	Time	Circumstances
Mount Isa The Gap	1-hour	0.504 0.366 0.328 0.292 0.284 0.284 0.278 0.275 0.274 0.272 0.271 0.260 0.244 0.237 0.234 0.232 0.231 0.228 0.228 0.222 0.221 0.220 0.218 0.216 0.215 0.213 0.210 0.206 0.206 0.202	Jul 4 Apr 5 Jan 10 Aug 1 Jun 23 Jan 1 Jun 6 May 27 Jul 4 Jul 3 Oct 25 Dec 8 Dec 5 Jun 21 Jun 30 Nov 11 Jan 2 Dec 31 May 27 Sep 24 Jan 22 Apr 5 Oct 2 Dec 17 Sep 24 Feb 3 Sep 23 Jun 5 Jun 5 Jul 4	12 10 10 15 15 21 11 14 17 16 18 14 10 15 12 14 16 10 13 20 10 11 15 23 15 13 15 17 16 16	All exceedances at The Gap monitoring site were due to industry emissions.
Mount Isa Menzies	24-hour	0.111	Feb 29	24	Exceedance due to industry emissions.
AAQ NEPM standards for SO_2: 0.20 ppm (1-hour average); 0.08 ppm (24-hour average); 0.02 ppm (1-year average). AAQ NEPM goals for SO_2: 1-hour average and 24-hour average standards exceeded on no more than one day per year.					

Table 11. 2016 PM_{10} exceedances

Region/performance monitoring station	Standard	Concentration (µg/m³)	Date	Time	Circumstances
Mount Isa The Gap	24-hour	350.8	Jan 15	24	Dust storm.
AAQ NEPM standard for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average). PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.					

Summaries of maximum and second-highest pollutant concentrations

Table 12 to Table 19 present daily peak concentrations, and the time and date on which these occurred, for all pollutants and monitoring sites for 2016. Second-highest daily concentrations are also shown for carbon monoxide, nitrogen dioxide, ozone and sulfur dioxide, for which the AAQ NEPM allows one exceedance day per year.

Table 12. 2016 summary statistics for daily peak 8-hour average CO concentrations

Region/performance monitoring station	Number of valid days	Highest (ppm)	Highest (date:hour)	2nd highest (ppm)	2nd highest (date:hour)
South East Queensland					
Woolloongabba	167	1.2	May 11:23 May 12:01 May 26:01		
AAQ NEPM standard for CO: 9.0 ppm (8-hour average). AAQ NEPM goal for CO: standard exceeded on no more than one day per year.					

Table 13. 2016 summary statistics for daily peak 1-hour average NO_2 concentrations

Region/performance monitoring station	Number of valid days	Highest (ppm)	Highest (date:hour)	2nd highest (ppm)	2nd highest (date:hour)
South East Queensland					
Mountain Creek	366	0.031	Jul 25:19	0.030	May 20:19 Jul 29:20
Deception Bay	366	0.037	May 20:20	0.036	May 25:20 Jul 30:20
Rocklea	364	0.057	May 19:19	0.047	May 25:19
Springwood	361	0.034	May 20:23 May 26:01		
Flinders View	361	0.046	Jul 28:19	0.044	Jun 9:18
Gladstone					
South Gladstone	366	0.037	Jun 10:19	0.035	Jun 22:19 Sep 7:14 Sep 9:11
Townsville					
Pimlico	31	0.022	Jan 06:22	0.020	Jan 5:21
AAQ NEPM standard for NO_2: 0.12 ppm (1-hour average). AAQ NEPM goal for NO_2: standard exceeded on no more than one day per year.					

Table 14. 2016 summary statistics for daily peak 1-hour average O_3 concentrations

Region/performance monitoring station	Number of valid days	Highest (ppm)	Highest (date:hour)	2nd highest (ppm)	2nd highest (date:hour)
South East Queensland					
Mountain Creek	359	0.054	Oct 7:13	0.049	Nov 24:10
Deception Bay	364	0.064	Mar 31:16	0.063	Oct 19:15
Rocklea	359	0.073	Nov 11:13	0.071	Feb 16:15
Springwood	337	0.058	Dec 21:13	0.051	Dec 7:14
Flinders View	363	0.082	Feb 16:17	0.074	Oct 7:15
Townsville					
Pimlico	59	0.054	Feb 17:15	0.048	Jan 6:11
AAQ NEPM standard for O_3: 0.10 ppm (1-hour average). AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.					

Table 15. 2016 summary statistics for daily peak 4-hour average O_3 concentrations

Region/performance monitoring station	Number of valid days	Highest (ppm)	Highest (date:hour)	2nd highest (ppm)	2nd highest (date:hour)
South East Queensland					
Mountain Creek	359	0.047	Oct 7:14	0.045	Sep 25:17
Deception Bay	364	0.059	Mar 31:17	0.057	Oct 7:16
Rocklea	359	0.062	Feb 16:16	0.061	Feb 26:16
Springwood	337	0.055	Dec 21:14	0.047	Dec 15:14
Flinders View	363	0.065	Feb 16:18	0.062	Oct 7:16
Townsville					
Pimlico	59	0.050	Feb 17:15	0.046	Jan 6:14
AAQ NEPM standard for O_3: 0.08 ppm (4-hour average). AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.					

Table 16. 2016 summary statistics for daily peak 1-hour average SO_2 concentrations

Region/performance monitoring station	Number of valid days	Highest (ppm)	Highest (date:hour)	2nd highest (ppm)	2nd highest (date:hour)
South East Queensland					
Springwood	352	0.017	Oct 8:20	0.012	Jul 22:19 Dec 8:18
Flinders View	365	0.007	Apr 8:20	0.006	May 16:17 Oct 6:20
Gladstone					
South Gladstone	358	0.061	Aug 17:15	0.059	Jun 22:12
Townsville					
Pimlico	59	0.007	Jan 19:03	0.006	Feb 26:09
Stuart	361	0.014	Nov 17:21	0.013	Aug 5:20
Mount Isa					
Menzies	366	**0.717**	Dec 5:09	**0.487**	Oct 25:18
The Gap	347	**0.504**	Jul 4:12	**0.366**	Apr 5:10
Bold text indicates a value greater than the AAQ NEPM standard. AAQ NEPM standard for SO_2: 0.20 ppm (1-hour average). AAQ NEPM goal for SO_2: standard exceeded on no more than one day per year.					

Table 17. 2016 summary statistics for daily 24-hour average SO_2 concentrations

Region/performance monitoring station	Number of valid days	Highest (ppm)	Highest (date)	2nd highest (ppm)	2nd highest (date)
South East Queensland					
Springwood	352	0.004	Jul 22 Dec 3 Dec 5 Dec 6 Dec 8 Dec 21		
Flinders View	365	0.002	May 16 May 26 Jul 4 Jul 12 Aug 1 Aug 3 Nov 11		
Gladstone					
South Gladstone	358	0.012	Sep 5 Nov 20		
Townsville					
Pimlico	59	0.001	Jan 7 Jan 18 Jan 19 Jan 20 Jan 21 Feb 13 Feb 14 Feb 26 Feb 27		
Stuart	361	0.004	Oct 30 Nov 17		
Mount Isa					
Menzies	366	**0.111**	Feb 29	0.067	Nov 30
The Gap	347	0.058	Jul 4	0.051	Nov 10

Bold text indicates a value greater than the AAQ NEPM standard.

AAQ NEPM standard for SO_2: 0.08 ppm (24-hour average).
AAQ NEPM goal for SO_2: standard exceeded on no more than one day per year.

Table 18. 2016 summary statistics for daily 24-hour average PM_{10} concentrations

Region/performance monitoring station	Number of valid days	Highest (µg/m³)	Highest (date)
South East Queensland			
Mountain Creek	357	38.8	Feb 27
Rocklea	332	31.2	May 26
Springwood	352	30.6	Nov 6
Flinders View	361	34.0	Jun 3
Gladstone			
South Gladstone	358	32.1	Feb 9
Mackay			
West Mackay	357	44.5	Oct 12
Townsville			
Pimlico	43	33.4	Jan 7
Mount Isa			
The Gap	350	**350.8**	Jan 15

Bold text indicates a value greater than the AAQ NEPM standard.

AAQ NEPM standard for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average).
PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

Table 19. 2016 summary statistics for daily 24-hour average $PM_{2.5}$ concentrations

Region/ performance monitoring station	Number of valid days	Highest (µg/m³)	Highest (date)
South East Queensland			
Rocklea⁺	332	19.9	Jul 31
Springwood‡	350	20.1	Jul 31
Gladstone			
South Gladstone⁺	358	15.9	Sep 27

⁺ Monitoring by TEOM Model 1405 instrumentation fitted with FDMS.
‡ Monitoring by TEOM Model 1400 instrumentation in accordance with Technical Paper on Monitoring for Particles as $PM_{2.5}$ to February 25. Monitoring by TEOM Model 1405 instrumentation fitted with FDMS from February 25.

AAQ NEPM standards for $PM_{2.5}$: 25 µg/m³ (24-hour average); 8 µg/m³ (1-year average).
$PM_{2.5}$ monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the $PM_{2.5}$ 24-hour goal.

Section D – Pollutant distribution and trends

This section presents results of further analysis of the monitoring data. Percentiles of 2016 daily peak concentrations are presented for each monitoring station and pollutant. Daily peak concentrations were only included in this analysis if at least 75 per cent of the daily data were valid. Percentiles for eight-hour average carbon monoxide and four-hour average ozone were calculated for daily peak concentrations. Daily peak concentrations were calculated from running hourly values, including those that overlap from one calendar day to the next. Concentrations exceeding the corresponding AAQ NEPM standard are shown in bold text.

The tables in this section also present annual statistics for all trend monitoring stations identified in the Queensland AAQ NEPM monitoring plan. For regions and sub regions where a pollutant is not monitored at a trend station, annual statistics are presented for performance monitoring stations. Concentrations where less than 75 per cent of the annual data were valid are shown in italics. Trend data for lead at Woolloongabba in South East Queensland is presented in Table 71 although monitoring ceased in 2002.

Carbon monoxide

Table 20. 2016 percentiles of daily peak 8-hour average CO concentrations

Region/performance monitoring station	Data availability (% of days)	Maximum (ppm)	Percentiles (ppm)					
			99th	98th	95th	90th	75th	50th
South East Queensland Woolloongabba	45.6	1.2	1.2	1.2	1.0	0.8	0.6	0.4
AAQ NEPM standard for CO: 9.0 ppm (8-hour average). AAQ NEPM goal for CO: standard exceeded on no more than one day per year.								

Table 21. Percentiles of daily peak 8-hour average CO concentrations at Woolloongabba (1998–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
1998	*57.0**	*0*	*5.1*	*5.0*	*4.4*	*4.1*	*3.4*
1999	92.3*	0	5.7	5.3	4.9	4.0	3.2
2000	92.9	0	5.0	4.7	4.2	3.4	2.9
2001	97.0	0	7.0	4.4	4.3	3.9	3.2
2002	97.0	0	4.7	4.7	4.1	3.6	3.0
2003	83.3*	0	5.4	4.4	4.2	3.5	2.7
2004	98.9	0	4.7	4.2	3.8	3.3	2.6
2005	95.1	0	4.0	3.5	3.3	2.6	2.1
2006	95.3	0	4.0	3.7	3.1	2.4	2.1
2007	*26.0**	*0*	*1.1*	*1.1*	*1.1*	*1.1*	*1.0*
2008	*66.9**	*0*	*2.9*	*2.7*	*2.5*	*2.2*	*1.8*
2009	100.0	0	2.4	2.3	2.1	1.8	1.5
2010	97.0	0	2.7	1.9	1.8	1.3	1.1
2011	99.5	0	1.9	1.7	1.6	1.3	1.0
2012	98.9	0	1.8	1.7	1.7	1.4	1.1
2013	99.7	0	1.6	1.4	1.3	1.1	0.9
2014	97.0	0	1.9	1.6	1.5	1.0	0.6
2015	98.1	0	1.6	1.4	1.3	1.0	0.8
2016	*45.8**	*0*	*1.2*	*1.2*	*1.2*	*1.0*	*0.8*

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.

AAQ NEPM standard for CO: 9.0 ppm (8-hour average).
AAQ NEPM goal for CO: standard exceeded on no more than one day per year.

Table 22. Percentiles of daily peak 8-hour average CO concentrations at North Toowoomba (2003–2010)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
2003	*42.4**	*0*	*2.6*	*2.5*	*2.3*	*2.2*	*1.9*
2004	97.0	0	3.4	2.8	2.5	2.0	1.5
2005	99.5	0	2.3	1.8	1.7	1.1	0.7
2006	95.3	0	1.9	1.8	1.7	1.3	1.1
2007	97.5	0	2.2	1.8	1.6	1.0	0.4
2008	98.4	0	1.9	1.7	1.5	1.1	0.8
2009	100.0	0	1.8	1.4	1.2	1.0	0.7
2010	92.6*	0	1.7	1.5	1.3	0.9	0.5

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.

AAQ NEPM standard for CO: 9.0 ppm (8-hour average).
AAQ NEPM goal for CO: standard exceeded on no more than one day per year.

Nitrogen dioxide

Table 23. 2016 percentiles of daily peak 1-hour average NO_2 concentrations

Region/performance monitoring station	Data availability (% of days)	Maximum (ppm)	Percentiles (ppm)					
			99th	98th	95th	90th	75th	50th
South East Queensland								
Mountain Creek	100.0	0.031	0.029	0.026	0.023	0.021	0.015	0.008
Deception Bay	100.0	0.037	0.035	0.034	0.030	0.026	0.019	0.013
Rocklea	99.5	0.057	0.037	0.034	0.028	0.025	0.019	0.014
Springwood	98.6	0.034	0.032	0.031	0.028	0.027	0.022	0.015
Flinders View	98.6	0.046	0.040	0.038	0.033	0.029	0.023	0.016
Gladstone								
South Gladstone	100.0	0.037	0.035	0.032	0.029	0.026	0.019	0.013
Townsville								
Pimlico	8.5	0.022	0.022	0.022	0.020	0.015	0.008	0.006

AAQ NEPM standard for NO_2: 0.12 ppm (1-hour average).
AAQ NEPM goal for NO_2: standard exceeded on no more than one day per year.

Table 24. Percentiles of daily peak 1-hour average NO_2 concentrations at Mountain Creek (2002–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
2002	91.5*	0	0.036	0.006	0.036	0.034	0.031	0.028
2003	91.4	0	0.033	0.005	0.029	0.028	0.026	0.023
2004	98.1	0	0.041	0.005	0.036	0.035	0.029	0.026
2005	100.0	0	0.032	0.005	0.031	0.028	0.025	0.022
2006	100.0	0	0.035	0.005	0.032	0.030	0.027	0.024
2007	100.0	0	0.034	0.004	0.030	0.028	0.026	0.022
2008	95.6	0	0.030	0.004	0.030	0.029	0.026	0.021
2009	99.7	0	0.030	0.004	0.029	0.027	0.024	0.021
2010	98.6	0	0.029	0.005	0.028	0.026	0.023	0.021
2011	97.8	0	0.032	0.004	0.027	0.027	0.023	0.021
2012	96.7	0	0.030	0.004	0.028	0.027	0.022	0.021
2013	99.7	0	0.031	0.004	0.029	0.026	0.023	0.020
2014	99.5	0	0.031	0.004	0.027	0.026	0.023	0.021
2015	100.0	0	0.030	0.003	0.027	0.024	0.021	0.019
2016	100.0	0	0.031	0.004	0.029	0.025	0.023	0.021

*Data availability less than 75 % for one or more quarters.

AAQ NEPM standards for NO_2: 0.12 ppm (1-hour average); 0.03 ppm (annual average).
AAQ NEPM goal for NO_2: 1-hour standard exceeded on no more than one day per year.

Table 25. Percentiles of daily peak 1-hour average NO_2 concentrations at Deception Bay (1995–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
1995	93.4	0	0.058	0.007	0.054	0.046	0.038	0.033
1996	*68.6**	*0*	*0.048*	*i.d.*	*0.043*	*0.042*	*0.034*	*0.030*
1997	95.6	0	0.043	0.007	0.038	0.036	0.032	0.028
1998	97.5	0	0.066	0.006	0.050	0.039	0.031	0.026
1999	96.4	0	0.058	0.006	0.039	0.030	0.028	0.024
2000	99.5	0	0.053	0.005	0.038	0.034	0.029	0.025
2001	95.1	0	0.047	0.006	0.040	0.039	0.034	0.030
2002	87.4*	0	0.065	0.006	0.044	0.042	0.036	0.030
2003	94.5	0	0.053	0.006	0.036	0.033	0.030	0.028
2004	97.8	0	0.045	0.006	0.036	0.036	0.030	0.027
2005	95.3	0	0.034	0.006	0.033	0.030	0.028	0.026
2006	99.5	0	0.044	0.008	0.035	0.033	0.028	0.027
2007	94.2*	0	0.063	0.006	0.035	0.033	0.030	0.027
2008	84.7*	0	0.037	0.008	0.034	0.031	0.029	0.027
2009	100.0	0	0.036	0.005	0.030	0.028	0.026	0.024
2010	98.9	0	0.037	0.005	0.033	0.033	0.028	0.024
2011	99.5	0	0.035	0.006	0.033	0.030	0.029	0.027
2012	97.8	0	0.040	0.006	0.034	0.033	0.030	0.027
2013	*67.9**	*0*	*0.033*	*i.d.*	*0.033*	*0.031*	*0.029*	*0.025*
2014	98.9	0	0.041	0.005	0.035	0.034	0.030	0.026
2015	100.0	0	0.048	0.005	0.033	0.032	0.029	0.025
2016	100.0	0	0.037	0.005	0.035	0.034	0.030	0.026

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for NO_2: 0.12 ppm (1-hour average); 0.03 ppm (annual average).
AAQ NEPM goal for NO_2: 1-hour standard exceeded on no more than one day per year.

Table 26. Percentiles of daily peak 1-hour average NO_2 concentrations at Rocklea (1982–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
1982	97.8	0	0.073	0.010	0.058	0.054	0.048	0.040
1983	95.6	0	0.056	0.006	0.050	0.042	0.033	0.030
1984	83.3*	0	0.076	0.007	0.061	0.056	0.048	0.041
1985	91.2	0	0.048	0.008	0.044	0.039	0.035	0.031
1986	83.6*	2	**0.160**	0.012	0.099	0.069	0.056	0.045
1987	92.1	0	0.089	0.015	0.078	0.067	0.060	0.052
1988	*60.1**	*0*	*0.114*	*i.d.*	*0.083*	*0.077*	*0.066*	*0.055*
1989	84.4*	0	0.073	0.016	0.069	0.061	0.054	0.047
1990	75.3*	0	0.079	0.016	0.070	0.064	0.053	0.046
1991	89.0	0	0.113	0.015	0.085	0.071	0.061	0.052
1992	77.9*	2	**0.157**	0.013	0.072	0.065	0.052	0.042
1993	89.6	0	0.086	0.013	0.066	0.058	0.047	0.040
1994	91.8	0	0.096	0.012	0.062	0.057	0.051	0.045
1995	79.5*	0	0.066	0.010	0.050	0.048	0.040	0.036
1996	90.4*	0	0.058	0.010	0.055	0.044	0.040	0.036
1997	95.6	0	0.061	0.010	0.043	0.042	0.039	0.033
1998	96.2	0	0.056	0.009	0.046	0.041	0.038	0.033
1999	91.2*	0	0.054	0.009	0.044	0.042	0.034	0.029
2000	96.7	0	0.059	0.009	0.046	0.043	0.037	0.032
2001	98.4	0	0.049	0.009	0.042	0.041	0.035	0.032
2002	98.4	0	0.051	0.009	0.046	0.041	0.037	0.033
2003	97.0	0	0.050	0.009	0.039	0.038	0.033	0.030
2004	95.6	0	0.049	0.009	0.047	0.043	0.037	0.033
2005	98.6	0	0.046	0.009	0.042	0.041	0.036	0.031
2006	96.4	0	0.046	0.011	0.039	0.035	0.031	0.027
2007	100.0	0	0.044	0.008	0.041	0.040	0.035	0.031
2008	79.3*	0	0.047	0.008	0.041	0.034	0.030	0.027
2009	98.4	0	0.039	0.007	0.035	0.034	0.031	0.027
2010	98.4	0	0.039	0.007	0.037	0.033	0.028	0.023
2011	*2.7**	*0*	*0.020*	*i.d.*	*0.020*	*0.020*	*0.020*	*0.020*
2012	*63.9**	*0*	*0.039*	*i.d.*	*0.035*	*0.032*	*0.030*	*0.027*
2013	98.6	0	0.037	0.007	0.034	0.032	0.030	0.025
2014	99.5	0	0.047	0.007	0.040	0.037	0.032	0.027
2015	100.0	0	0.041	0.006	0.036	0.033	0.027	0.024
2016	99.5	0	0.057	0.007	0.037	0.034	0.028	0.025

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for NO2: 0.12 ppm (1-hour average); 0.03 ppm (annual average).
AAQ NEPM goal for NO_2: 1-hour standard exceeded on no more than one day per year.

Table 27. Percentiles of daily peak 1-hour average NO_2 concentrations at Flinders View (1995–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
1995	91.2*	0	0.038	0.009	0.037	0.035	0.031	0.028
1996	98.4	0	0.055	0.009	0.050	0.044	0.037	0.033
1997	96.4	0	0.046	0.009	0.042	0.040	0.036	0.030
1998	96.4	0	0.048	0.009	0.041	0.039	0.034	0.030
1999	98.4	0	0.046	0.008	0.039	0.038	0.032	0.029
2000	99.2	0	0.042	0.008	0.040	0.038	0.034	0.031
2001	100.0	0	0.045	0.009	0.037	0.036	0.034	0.031
2002	88.8*	0	0.062	0.010	0.057	0.043	0.036	0.033
2003	94.0	0	0.046	0.009	0.039	0.037	0.033	0.029
2004	100.0	0	0.054	0.009	0.047	0.038	0.034	0.030
2005	100.0	0	0.055	0.008	0.046	0.038	0.032	0.028
2006	100.0	0	0.050	0.012	0.043	0.041	0.035	0.032
2007	96.2	0	0.039	0.008	0.036	0.035	0.031	0.029
2008	96.7	0	0.040	0.010	0.039	0.038	0.031	0.028
2009	99.5	0	0.042	0.008	0.038	0.036	0.034	0.030
2010	99.5	0	0.039	0.008	0.037	0.034	0.028	0.025
2011	99.5	0	0.040	0.008	0.036	0.034	0.031	0.028
2012	99.7	0	0.039	0.007	0.037	0.035	0.028	0.025
2013	100.0	0	0.043	0.008	0.038	0.037	0.032	0.029
2014	95.9	0	0.050	0.008	0.046	0.043	0.036	0.030
2015	100.0	0	0.041	0.006	0.038	0.036	0.031	0.026
2016	98.6	0	0.046	0.008	0.040	0.038	0.033	0.029

*Data availability less than 75 % for one or more quarters.

AAQ NEPM standards for NO_2: 0.12 ppm (1-hour average); 0.03 ppm (annual average).
AAQ NEPM goal for NO_2: 1-hour standard exceeded on no more than one day per year.

Table 28. Percentiles of daily peak 1-hour average NO_2 concentrations at North Toowoomba (2003–2010)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
2003	*43.7**	*0*	*0.057*	*i.d.*	*0.042*	*0.038*	*0.032*	*0.029*
2004	98.4	0	0.054	0.007	0.041	0.039	0.035	0.031
2005	99.2	0	0.057	0.006	0.038	0.036	0.033	0.030
2006	94.8	0	0.042	0.005	0.037	0.033	0.031	0.027
2007	96.4	0	0.043	0.005	0.039	0.038	0.034	0.029
2008	98.1	0	0.041	0.007	0.035	0.033	0.031	0.029
2009	100.0	0	0.044	0.006	0.040	0.038	0.033	0.029
2010	93.2*	0	0.042	0.005	0.036	0.033	0.030	0.026

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for NO_2: 0.12 ppm (1-hour average); 0.03 ppm (annual average).
AAQ NEPM goal for NO_2: 1-hour standard exceeded on no more than one day per year.

Table 29. Percentiles of daily peak 1-hour average NO_2 concentrations at South Gladstone (1994–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
1994	81.6*	0	0.049	0.005	0.047	0.044	0.038	0.028
1995	91.8	0	0.038	0.005	0.030	0.028	0.025	0.022
1996	84.2*	0	0.045	0.006	0.039	0.035	0.032	0.029
1997	*65.8**	*0*	*0.031*	*i.d.*	*0.030*	*0.029*	*0.022*	*0.017*
1998	*72.9**	*0*	*0.022*	*i.d.*	*0.020*	*0.018*	*0.015*	*0.012*
1999	88.8*	0	0.034	0.003	0.029	0.029	0.025	0.021
2000	97.8	0	0.031	0.003	0.025	0.024	0.022	0.019
2001	96.4	0	0.048	0.004	0.033	0.031	0.026	0.023
2002	98.4	0	0.036	0.004	0.031	0.029	0.026	0.021
2003	95.3	0	0.035	0.004	0.030	0.027	0.024	0.022
2004	100.0	0	0.042	0.004	0.030	0.029	0.026	0.023
2005	99.7	0	0.035	0.004	0.030	0.028	0.024	0.022
2006	100.0	0	0.034	0.003	0.027	0.027	0.024	0.021
2007	98.4	0	0.035	0.005	0.030	0.029	0.027	0.024
2008	98.6	0	0.033	0.003	0.030	0.026	0.023	0.020
2009	97.5	0	0.033	0.006	0.029	0.028	0.025	0.022
2010	98.4	0	0.033	0.006	0.031	0.029	0.026	0.023
2011	96.7	0	0.035	0.006	0.034	0.032	0.029	0.026
2012	94.0*	0	0.042	0.007	0.037	0.035	0.032	0.029
2013	95.3	0	0.042	0.007	0.037	0.035	0.032	0.027
2014	99.7	0	0.046	0.005	0.033	0.032	0.029	0.025
2015	99.7	0	0.043	0.005	0.036	0.032	0.028	0.025
2016	100.0	0	0.037	0.005	0.035	0.032	0.029	0.026

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for NO_2: 0.12 ppm (1-hour average); 0.03 ppm (annual average).
AAQ NEPM goal for NO_2: 1-hour standard exceeded on no more than one day per year.

Table 30. Percentiles of daily peak 1-hour average NO_2 concentrations at Pimlico (2004–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
2004	*59.0**	*0*	*0.034*	*i.d.*	*0.032*	*0.031*	*0.030*	*0.027*
2005	100.0	0	0.034	0.005	0.032	0.031	0.028	0.024
2006	98.6	0	0.034	0.006	0.032	0.029	0.025	0.022
2007	99.2	0	0.035	0.004	0.027	0.024	0.023	0.020
2008	100.0	0	0.030	0.006	0.028	0.027	0.025	0.023
2009	97.0	0	0.035	0.005	0.030	0.028	0.025	0.023
2010	99.5	0	0.032	0.005	0.028	0.026	0.023	0.020
2011	98.9	0	0.042	0.006	0.038	0.036	0.031	0.027
2012	99.5	0	0.034	0.005	0.031	0.028	0.026	0.022
2013	98.9	0	0.033	0.004	0.029	0.027	0.023	0.018
2014	99.7	0	0.031	0.004	0.030	0.029	0.026	0.020
2015	97.8	0	0.039	0.004	0.030	0.028	0.025	0.021
2016	*8.5**	*0*	*0.022*	*i.d.*	*0.022*	*0.022*	*0.020*	*0.015*

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for NO_2: 0.12 ppm (1-hour average); 0.03 ppm (annual average).
AAQ NEPM goal for NO_2: 1-hour standard exceeded on no more than one day per year.

Ozone

Table 31. 2016 percentiles of daily peak 1-hour average O_3 concentrations

Region/performance monitoring station	Data availability (% of days)	Maximum (ppm)	Percentiles (ppm)					
			99th	98th	95th	90th	75th	50th
South East Queensland								
Mountain Creek	98.1	0.054	0.045	0.042	0.040	0.036	0.032	0.028
Deception Bay	99.5	0.064	0.061	0.053	0.045	0.041	0.036	0.031
Rocklea	98.1	0.073	0.064	0.058	0.053	0.047	0.039	0.032
Springwood	92.1	0.058	0.049	0.043	0.041	0.037	0.030	0.026
Flinders View	99.2	0.082	0.066	0.062	0.056	0.050	0.042	0.034
Townsville								
Pimlico	16.1	0.054	0.054	0.054	0.045	0.040	0.029	0.021

AAQ NEPM standard for O_3: 0.10 ppm (1-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 32. 2016 percentiles of daily peak 4-hour average O_3 concentrations

Region/performance monitoring station	Data availability (% of days)	Maximum (ppm)	Percentiles (ppm)					
			99th	98th	95th	90th	75th	50th
South East Queensland								
Mountain Creek	98.1	0.047	0.042	0.040	0.038	0.034	0.031	0.027
Deception Bay	99.5	0.059	0.054	0.047	0.042	0.038	0.034	0.029
Rocklea	98.1	0.062	0.052	0.050	0.047	0.043	0.036	0.030
Springwood	92.1	0.055	0.046	0.039	0.037	0.033	0.028	0.024
Flinders View	99.2	0.065	0.059	0.054	0.050	0.046	0.040	0.033
Townsville								
Pimlico	16.1	0.050	0.050	0.050	0.042	0.038	0.028	0.020

AAQ NEPM standard for O_3: 0.08 ppm (4-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 33. Percentiles of daily peak 1-hour average O_3 concentrations at Mountain Creek (2002–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
2002	91.5*	0	0.064	0.060	0.050	0.043	0.040
2003	91.6	0	0.060	0.045	0.044	0.039	0.035
2004	100.0	0	0.060	0.050	0.045	0.041	0.037
2005	99.7	0	0.051	0.047	0.045	0.040	0.037
2006	100.0	0	0.053	0.047	0.043	0.038	0.035
2007	99.2	0	0.053	0.048	0.046	0.040	0.036
2008	95.6	0	0.055	0.047	0.045	0.038	0.036
2009	100.0	0	0.053	0.049	0.045	0.041	0.038
2010	98.4	0	0.065	0.044	0.043	0.039	0.036
2011	81.9*	0	0.077	0.061	0.052	0.043	0.037
2012	96.7	0	0.059	0.051	0.047	0.041	0.039
2013	98.9	0	0.057	0.049	0.045	0.042	0.039
2014	100.0	0	0.058	0.045	0.045	0.041	0.037
2015	95.6	0	0.051	0.045	0.043	0.040	0.036
2016	98.1	0	0.054	0.045	0.042	0.040	0.036

*Data availability less than 75 % for one or more quarters.

AAQ NEPM standard for O_3: 0.10 ppm (1-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 34. Percentiles of daily peak 1-hour average O_3 concentrations at Deception Bay (1995–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
1995	95.9	0	0.083	0.075	0.070	0.052	0.047
1996	95.9	0	0.091	0.073	0.064	0.055	0.048
1997	100.0	0	0.079	0.065	0.057	0.048	0.043
1998	94.2	0	0.069	0.060	0.053	0.048	0.044
1999	99.2	0	0.092	0.062	0.057	0.048	0.043
2000	99.7	0	0.070	0.058	0.054	0.046	0.041
2001	86.6*	0	0.079	0.058	0.054	0.048	0.044
2002	89.6*	0	0.071	0.063	0.061	0.048	0.044
2003	97.0	0	0.095	0.063	0.057	0.047	0.043
2004	96.7	0	0.070	0.058	0.055	0.048	0.045
2005	98.4	0	0.079	0.065	0.056	0.050	0.044
2006	99.5	0	0.064	0.056	0.052	0.047	0.042
2007	99.5	0	0.086	0.056	0.054	0.047	0.042
2008	99.7	0	0.082	0.069	0.064	0.047	0.042
2009	100.0	0	0.069	0.057	0.054	0.048	0.045
2010	98.6	0	0.058	0.050	0.046	0.044	0.039
2011	98.9	0	0.099	0.069	0.059	0.046	0.041
2012	98.9	0	0.059	0.056	0.053	0.048	0.044
2013	*68.2**	*0*	*0.068*	*0.064*	*0.052*	*0.049*	*0.047*
2014	98.4	0	0.065	0.057	0.052	0.046	0.042
2015	99.7	0	0.063	0.055	0.051	0.044	0.040
2016	99.5	0	0.064	0.061	0.053	0.045	0.041

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.

AAQ NEPM standard for O_3: 0.10 ppm (1-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 35. Percentiles of daily peak 1-hour average O_3 concentrations at Rocklea (1982–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
1982	97.8	1	**0.102**	0.070	0.065	0.057	0.047
1983	97.5	0	0.099	0.071	0.068	0.059	0.041
1984	95.1	1	**0.102**	0.070	0.064	0.055	0.046
1985	91.0	1	**0.105**	0.079	0.056	0.047	0.036
1986	84.1*	0	0.074	0.073	0.063	0.057	0.050
1987	*72.1**	*4*	***0.125***	***0.106***	*0.100*	*0.078*	*0.055*
1988	*67.5**	*1*	***0.101***	*0.085*	*0.069*	*0.047*	*0.039*
1989	82.5*	0	0.071	0.058	0.051	0.042	0.036
1990	76.2*	0	0.061	0.051	0.042	0.036	0.031
1991	91.2	0	0.061	0.053	0.045	0.039	0.031
1992	94.0	0	0.069	0.059	0.049	0.039	0.035
1993	94.8	0	0.096	0.063	0.059	0.054	0.050
1994	95.1	1	**0.127**	0.083	0.073	0.059	0.050
1995	78.6*	0	0.098	0.086	0.070	0.061	0.053
1996	97.0	2	**0.135**	0.090	0.085	0.071	0.060
1997	97.0	0	0.093	0.085	0.077	0.065	0.053
1998	95.1	1	**0.103**	0.080	0.078	0.064	0.053
1999	94.2	1	**0.135**	0.093	0.066	0.057	0.047
2000	96.2	0	0.088	0.076	0.066	0.057	0.049
2001	99.2	0	0.093	0.072	0.063	0.055	0.047
2002	98.6	2	**0.118**	0.075	0.073	0.060	0.054
2003	97.8	0	0.065	0.063	0.059	0.052	0.046
2004	95.9	0	0.088	0.080	0.076	0.064	0.055
2005	100.0	0	0.081	0.074	0.070	0.061	0.053
2006	97.5	0	0.079	0.066	0.063	0.055	0.048
2007	95.6	0	0.076	0.070	0.059	0.052	0.049
2008	85.0*	0	0.079	0.067	0.065	0.050	0.043
2009	98.4	0	0.077	0.073	0.067	0.055	0.048
2010	98.4	0	0.085	0.072	0.068	0.048	0.043
2011	*2.7**	*0*	*0.036*	*0.036*	*0.036*	*0.036*	*0.036*
2012	*62.6**	*0*	*0.081*	*0.073*	*0.062*	*0.058*	*0.050*
2013	100.0	0	0.070	0.066	0.063	0.053	0.048
2014	99.5	0	0.076	0.072	0.068	0.057	0.049
2015	98.6	1	**0.101**	0.076	0.062	0.055	0.046
2016	98.1	0	0.073	0.064	0.058	0.053	0.047

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.

AAQ NEPM standard for O_3: 0.10 ppm (1-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 36. Percentiles of daily peak 1-hour average O_3 concentrations at Flinders View (1994–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
1994	97.5	0	0.076	0.069	0.062	0.056	0.048
1995	95.1	0	0.079	0.071	0.065	0.056	0.051
1996	98.6	2	**0.125**	0.082	0.075	0.063	0.055
1997	97.5	2	**0.106**	0.094	0.078	0.066	0.056
1998	95.1	0	0.100	0.085	0.076	0.066	0.056
1999	98.6	1	**0.127**	0.082	0.077	0.055	0.048
2000	99.2	1	**0.116**	0.073	0.070	0.060	0.054
2001	99.5	0	0.079	0.074	0.070	0.059	0.051
2002	95.3	0	0.098	0.080	0.078	0.070	0.062
2003	96.7	0	0.087	0.073	0.068	0.056	0.048
2004	100.0	2	**0.114**	0.079	0.077	0.066	0.058
2005	100.0	0	0.085	0.075	0.073	0.063	0.056
2006	100.0	0	0.077	0.069	0.065	0.057	0.050
2007	100.0	0	0.069	0.062	0.060	0.055	0.050
2008	99.5	0	0.067	0.062	0.056	0.049	0.045
2009	99.7	0	0.075	0.070	0.064	0.058	0.052
2010	97.5	0	0.089	0.063	0.055	0.048	0.043
2011	95.8	1	**0.103**	0.071	0.065	0.054	0.048
2012	94.3	0	0.090	0.086	0.067	0.056	0.051
2013	99.2	0	0.082	0.063	0.061	0.056	0.050
2014	96.4	0	0.075	0.069	0.068	0.061	0.055
2015	99.5	1	**0.101**	0.080	0.065	0.057	0.049
2016	99.2	0	0.082	0.066	0.062	0.056	0.050

Bold text indicates a value greater than the AAQ NEPM standard.

AAQ NEPM standard for O_3: 0.10 ppm (1-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 37. Percentiles of daily peak 1-hour average O_3 concentrations at North Toowoomba (2003–2010)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
2003	*43.7**	*0*	*0.066*	*0.061*	*0.061*	*0.051*	*0.046*
2004	99.2	0	0.084	0.064	0.058	0.052	0.048
2005	99.2	0	0.064	0.061	0.055	0.051	0.045
2006	96.2	0	0.063	0.059	0.058	0.052	0.046
2007	99.7	0	0.062	0.057	0.056	0.050	0.046
2008	98.4	0	0.063	0.051	0.048	0.043	0.040
2009	100.0	0	0.062	0.058	0.058	0.052	0.048
2010	93.2*	0	0.061	0.055	0.050	0.042	0.039

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.

AAQ NEPM standard for O_3: 0.10 ppm (1-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 38. Percentiles of daily peak 1-hour average O_3 concentrations at Targinie (2001–2006)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
2001	79.2*	0	0.026	0.026	0.025	0.023	0.022
2002	93.7	0	0.046	0.044	0.042	0.038	0.034
2003	97.4	0	0.045	0.035	0.034	0.032	0.031
2004	84.7	0	0.040	0.034	0.032	0.030	0.027
2005	95.9	0	0.038	0.033	0.032	0.028	0.027
2006	*34.0**	*0*	*0.035*	*0.035*	*0.035*	*0.028*	*0.025*

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.

AAQ NEPM standard for O_3: 0.10 ppm (1-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 39. Percentiles of daily peak 1-hour average O_3 concentrations at Pimlico (2004–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
2004	*58.7**	*0*	*0.047*	*0.047*	*0.045*	*0.041*	*0.039*
2005	100.0	0	0.054	0.043	0.043	0.040	0.035
2006	98.6	0	0.048	0.042	0.040	0.037	0.035
2007	100.0	0	0.049	0.043	0.040	0.038	0.036
2008	100.0	0	0.059	0.045	0.043	0.038	0.036
2009	93.4	0	0.060	0.056	0.051	0.043	0.040
2010	94.5	0	0.055	0.042	0.040	0.038	0.036
2011	94.5	0	0.073	0.064	0.055	0.046	0.040
2012	98.1	0	0.051	0.043	0.042	0.040	0.038
2013	84.7*	0	0.053	0.043	0.042	0.040	0.037
2014	99.2	0	0.051	0.047	0.043	0.040	0.037
2015	99.2	0	0.051	0.046	0.043	0.038	0.037
2016	*16.1**	*0*	*0.054*	*0.054*	*0.054*	*0.045*	*0.040*

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
AAQ NEPM standard for O_3: 0.10 ppm (1-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 40. Percentiles of daily peak 4-hour average O_3 concentrations at Mountain Creek (2002–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
2002	91.8*	0	0.059	0.051	0.045	0.040	0.037
2003	91.6	0	0.057	0.043	0.041	0.036	0.033
2004	100.0	0	0.047	0.044	0.042	0.038	0.035
2005	100.0	0	0.049	0.044	0.042	0.038	0.035
2006	100.0	0	0.048	0.041	0.039	0.035	0.033
2007	99.2	0	0.049	0.044	0.042	0.038	0.034
2008	95.9	0	0.049	0.043	0.041	0.036	0.034
2009	100.0	0	0.049	0.045	0.044	0.037	0.033
2010	98.4	0	0.062	0.041	0.040	0.036	0.034
2011	81.9*	0	0.068	0.058	0.049	0.039	0.035
2012	97.0	0	0.056	0.046	0.044	0.040	0.037
2013	98.9	0	0.050	0.046	0.044	0.040	0.037
2014	100.0	0	0.047	0.044	0.043	0.039	0.036
2015	95.6	0	0.050	0.042	0.040	0.038	0.035
2016	98.1	0	0.047	0.042	0.040	0.038	0.034

*Data availability less than 75 % for one or more quarters.
AAQ NEPM standard for O_3: 0.08 ppm (4-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 41. Percentiles of daily peak 4-hour average O_3 concentrations at Deception Bay (1995–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
1995	95.9	0	0.077	0.061	0.057	0.047	0.043
1996	95.9	0	0.076	0.065	0.059	0.049	0.045
1997	100.0	0	0.066	0.053	0.050	0.044	0.040
1998	94.2	0	0.059	0.054	0.049	0.043	0.040
1999	99.2	1	**0.083**	0.055	0.052	0.043	0.039
2000	99.7	0	0.063	0.050	0.049	0.042	0.038
2001	86.6*	0	0.075	0.056	0.050	0.044	0.040
2002	89.6*	0	0.067	0.060	0.053	0.044	0.041
2003	97.0	0	0.076	0.060	0.052	0.044	0.040
2004	96.7	0	0.062	0.053	0.049	0.044	0.042
2005	98.6	0	0.063	0.061	0.049	0.046	0.041
2006	99.5	0	0.060	0.055	0.048	0.044	0.039
2007	99.7	0	0.070	0.052	0.050	0.044	0.040
2008	99.7	0	0.073	0.062	0.054	0.043	0.039
2009	100.0	0	0.061	0.053	0.050	0.045	0.042
2010	98.4	0	0.051	0.046	0.044	0.040	0.037
2011	98.9	2	**0.086**	0.063	0.051	0.043	0.039
2012	98.9	0	0.057	0.051	0.050	0.044	0.041
2013	*68.2**	*0*	*0.060*	*0.057*	*0.049*	*0.047*	*0.044*
2014	98.4	0	0.053	0.050	0.047	0.043	0.040
2015	99.7	0	0.054	0.050	0.047	0.041	0.038
2016	99.5	0	0.059	0.054	0.047	0.042	0.038

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.

AAQ NEPM standard for O_3: 0.08 ppm (4-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 42. Percentiles of daily peak 4-hour average O_3 concentrations at Rocklea (1982–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
1982	97.8	0	0.076	0.058	0.053	0.048	0.040
1983	97.5	0	0.078	0.058	0.054	0.047	0.036
1984	95.1	0	0.080	0.059	0.054	0.047	0.041
1985	91.0	1	**0.090**	0.069	0.051	0.039	0.031
1986	84.1*	0	0.063	0.059	0.052	0.049	0.041
1987	*72.1**	*8*	***0.110***	***0.094***	***0.093***	*0.066*	*0.049*
1988	*67.5**	*1*	***0.081***	*0.065*	*0.050*	*0.041*	*0.035*
1989	82.5*	0	0.060	0.048	0.042	0.037	0.032
1990	76.2*	0	0.053	0.042	0.037	0.030	0.028
1991	91.2	0	0.054	0.043	0.039	0.032	0.026
1992	94.0	0	0.058	0.052	0.042	0.034	0.031
1993	94.8	0	0.074	0.054	0.053	0.048	0.043
1994	95.1	1	**0.101**	0.075	0.063	0.051	0.043
1995	78.6*	0	0.080	0.070	0.058	0.054	0.047
1996	97.0	1	**0.111**	0.076	0.070	0.061	0.051
1997	97.0	0	0.080	0.069	0.064	0.056	0.045
1998	95.1	1	**0.091**	0.068	0.064	0.057	0.049
1999	94.2	1	**0.102**	0.066	0.058	0.049	0.042
2000	96.2	0	0.072	0.063	0.054	0.049	0.044
2001	99.2	0	0.071	0.063	0.056	0.048	0.043
2002	98.6	1	**0.105**	0.068	0.061	0.054	0.047
2003	97.8	0	0.059	0.053	0.051	0.047	0.042
2004	95.9	0	0.077	0.069	0.064	0.057	0.050
2005	100.0	0	0.067	0.064	0.059	0.052	0.047
2006	97.5	0	0.068	0.056	0.055	0.049	0.043
2007	95.9	0	0.067	0.058	0.053	0.048	0.043
2008	85.0*	0	0.064	0.057	0.053	0.044	0.039
2009	98.4	0	0.068	0.061	0.056	0.050	0.043
2010	98.4	0	0.076	0.063	0.056	0.045	0.040
2011	*2.7**	*0*	*0.033*	*0.033*	*0.033*	*0.033*	*0.033*
2012	*62.6**	*0*	*0.066*	*0.064*	*0.054*	*0.051*	*0.046*
2013	100.0	0	0.063	0.057	0.055	0.049	0.044
2014	99.5	0	0.069	0.062	0.058	0.051	0.046
2015	98.6	1	**0.083**	0.064	0.055	0.048	0.042
2016	98.1	0	0.062	0.052	0.050	0.047	0.043

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.

AAQ NEPM standard for O_3: 0.08 ppm (4-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 43. Percentiles of daily peak 4-hour average O_3 concentrations at Flinders View (1994–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
1994	97.5	0	0.072	0.058	0.056	0.047	0.043
1995	95.1	0	0.066	0.062	0.060	0.050	0.044
1996	98.6	2	**0.091**	0.068	0.065	0.058	0.049
1997	97.5	2	**0.090**	0.073	0.067	0.056	0.049
1998	95.1	0	0.069	0.065	0.064	0.057	0.049
1999	98.6	1	**0.101**	0.067	0.064	0.049	0.043
2000	99.2	1	**0.089**	0.064	0.061	0.052	0.048
2001	99.5	0	0.072	0.066	0.058	0.052	0.047
2002	95.3	1	**0.083**	0.070	0.066	0.061	0.055
2003	96.7	0	0.080	0.067	0.059	0.049	0.044
2004	100.0	1	**0.100**	0.071	0.067	0.057	0.050
2005	100.0	0	0.067	0.066	0.062	0.057	0.050
2006	100.0	0	0.070	0.059	0.056	0.050	0.044
2007	100.0	0	0.062	0.056	0.054	0.049	0.045
2008	99.5	0	0.058	0.055	0.052	0.045	0.041
2009	99.7	0	0.066	0.062	0.059	0.051	0.046
2010	97.5	0	0.072	0.055	0.050	0.043	0.040
2011	96.2	1	**0.088**	0.061	0.059	0.049	0.045
2012	94.3	0	0.080	0.079	0.062	0.052	0.046
2013	99.2	0	0.070	0.057	0.054	0.051	0.047
2014	96.4	0	0.067	0.063	0.062	0.055	0.049
2015	99.5	1	**0.081**	0.067	0.058	0.052	0.046
2016	99.2	0	0.065	0.059	0.054	0.050	0.046

Bold text indicates a value greater than the AAQ NEPM standard.

AAQ NEPM standard for O_3: 0.08 ppm (4-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 44. Percentiles of daily peak 4-hour average O_3 concentrations at North Toowoomba (2003–2010)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
2003	*43.7**	*0*	*0.062*	*0.055*	*0.053*	*0.046*	*0.043*
2004	99.2	0	0.070	0.058	0.053	0.048	0.044
2005	99.5	0	0.057	0.053	0.052	0.047	0.042
2006	96.2	0	0.057	0.055	0.053	0.047	0.042
2007	99.7	0	0.056	0.054	0.051	0.046	0.043
2008	98.4	0	0.056	0.046	0.045	0.040	0.037
2009	100.0	0	0.057	0.054	0.053	0.049	0.045
2010	93.2”	0	0.056	0.050	0.046	0.041	0.037

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
AAQ NEPM standard for O_3: 0.08 ppm (4-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 45. Percentiles of daily peak 4-hour average O_3 concentrations at Targinie (2001–2006)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
2001	75.1*	0	0.026	0.026	0.025	0.023	0.022
2002	94.2	0	0.044	0.042	0.038	0.035	0.031
2003	97.4	0	0.041	0.033	0.032	0.030	0.028
2004	84.7	0	0.030	0.028	0.027	0.026	0.024
2005	95.9	0	0.031	0.030	0.027	0.026	0.024
2006	*34.0**	*0*	*0.030*	*0.030*	*0.028*	*0.023*	*0.020*

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
AAQ NEPM standard for O_3: 0.08 ppm (4-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Table 46. Percentiles of daily peak 4-hour average O_3 concentrations at Pimlico (2004–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Percentiles (ppm)			
				99th	98th	95th	90th
2004	*58.7**	*0*	*0.045*	*0.045*	*0.042*	*0.040*	*0.037*
2005	100.0	0	0.049	0.041	0.040	0.038	0.034
2006	98.6	0	0.045	0.039	0.038	0.035	0.034
2007	100.0	0	0.046	0.042	0.038	0.036	0.034
2008	100.0	0	0.054	0.043	0.040	0.037	0.034
2009	94.0	0	0.057	0.051	0.048	0.041	0.038
2010	94.5	0	0.045	0.041	0.038	0.036	0.034
2011	94.5	0	0.062	0.061	0.049	0.044	0.039
2012	98.1	0	0.045	0.041	0.041	0.038	0.036
2013	84.7*	0	0.045	0.042	0.041	0.039	0.036
2014	99.2	0	0.047	0.044	0.042	0.038	0.036
2015	99.2	0	0.049	0.043	0.040	0.037	0.035
2016	*16.1**	*0*	*0.050*	*0.050*	*0.046*	*0.042*	*0.038*

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
AAQ NEPM standard for O_3: 0.08 ppm (4-hour average).
AAQ NEPM goal for O_3: standard exceeded on no more than one day per year.

Sulfur dioxide

Table 47. 2016 percentiles of daily peak 1-hour average SO_2 concentrations

Region/performance monitoring station	Data availability (% of days)	Maximum (ppm)	Percentiles (ppm)					
			99th	98th	95th	90th	75th	50th
South East Queensland								
Springwood	96.2	0.017	0.011	0.009	0.007	0.005	0.003	0.002
Flinders View	99.7	0.007	0.005	0.004	0.003	0.003	0.002	0.001
Gladstone								
South Gladstone	97.8	0.061	0.053	0.051	0.038	0.030	0.016	0.008
Townsville								
Pimlico	16.1	0.007	0.007	0.007	0.005	0.004	0.002	0.001
Stuart	98.6	0.014	0.012	0.009	0.007	0.004	0.002	0.001
Mount Isa								
Menzies	100.0	**0.717**	**0.478**	**0.438**	**0.286**	0.180	0.055	0.005
The Gap	94.8	**0.504**	**0.328**	**0.278**	**0.228**	0.138	0.033	0.002

Bold text indicates a value greater than the AAQ NEPM standard.
AAQ NEPM standard for SO_2: 0.20 ppm (1-hour average).
AAQ NEPM goal for SO_2: standard exceeded on no more than one day per year.

Table 48. 2016 percentiles of daily 24-hour average SO_2 concentrations

Region/performance monitoring station	Data availability (% of days)	Maximum (ppm)	Percentiles (ppm)					
			99th	98th	95th	90th	75th	50th
South East Queensland								
Springwood	96.2	0.004	0.004	0.003	0.003	0.002	0.002	0.001
Flinders View	99.7	0.002	0.002	0.002	0.001	0.001	0.001	0.001
Gladstone								
South Gladstone	97.8	0.012	0.011	0.010	0.007	0.005	0.003	0.002
Townsville								
Pimlico	16.1	0.001	0.001	0.001	0.001	0.001	0.000	0.000
Stuart	98.6	0.004	0.003	0.003	0.002	0.002	0.001	0.000
Mount Isa								
Menzies	100.0	**0.111**	0.062	0.056	0.038	0.025	0.006	0.001
The Gap	94.8	0.058	0.046	0.036	0.027	0.015	0.004	0.001

Bold text indicates a value greater than the AAQ NEPM standard.
AAQ NEPM standard for SO_2: 0.08 ppm (24-hour average).
AAQ NEPM goal for SO_2: standard exceeded on no more than one day per year.

Table 49. Percentiles of daily peak 1-hour average SO_2 concentrations at Flinders View (1993–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
1993	88.2*	0	0.049	0.002	0.030	0.024	0.018	0.014
1994	98.9	0	0.033	0.003	0.027	0.025	0.021	0.017
1995	*59.5**	*0*	*0.041*	*i.d.*	*0.029*	*0.027*	*0.020*	*0.014*
1996	88.3*	0	0.047	0.002	0.037	0.027	0.023	0.017
1997	97.0	0	0.047	0.002	0.040	0.035	0.023	0.019
1998	95.9	0	0.090	0.002	0.037	0.033	0.024	0.019
1999	96.4	0	0.070	0.002	0.035	0.033	0.028	0.021
2000	89.9	0	0.081	0.002	0.049	0.036	0.027	0.022
2001	99.5	0	0.053	0.001	0.048	0.043	0.029	0.023
2002	97.0	0	0.057	0.001	0.035	0.033	0.025	0.018
2003	96.4	0	0.046	0.001	0.031	0.030	0.023	0.017
2004	99.5	0	0.063	0.001	0.036	0.031	0.021	0.016
2005	100.0	0	0.034	0.001	0.028	0.024	0.020	0.014
2006	100.0	0	0.040	0.001	0.037	0.027	0.023	0.018
2007	100.0	0	0.026	0.001	0.024	0.022	0.018	0.014
2008	100.0	0	0.042	0.001	0.030	0.028	0.019	0.016
2009	99.5	0	0.046	0.001	0.030	0.027	0.018	0.014
2010	99.4	0	0.034	0.001	0.022	0.018	0.015	0.012
2011	95.6	0	0.028	0.001	0.022	0.017	0.014	0.009
2012	100.0	0	0.015	0.001	0.014	0.012	0.009	0.007
2013	100.0	0	0.013	0.001	0.005	0.005	0.004	0.004
2014	96.4	0	0.008	0.000	0.005	0.004	0.003	0.003
2015	100.0	0	0.010	0.000	0.005	0.004	0.003	0.003
2016	99.7	0	0.007	0.001	0.005	0.004	0.003	0.003

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for SO_2: 0.20 ppm (1-hour average); 0.02 ppm (annual average).
AAQ NEPM goal for SO_2: 1-hour standard exceeded on no more than one day per year.

Table 50. Percentiles of daily peak 1-hour average SO_2 concentrations at South Gladstone (1991–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
1991	92.6	0	0.011	0.002	0.011	0.009	0.008	0.006
1992	94.3	0	0.052	0.003	0.039	0.029	0.020	0.015
1993	98.3	0	0.075	0.004	0.059	0.050	0.039	0.032
1994	97.0	0	0.070	0.003	0.042	0.040	0.031	0.024
1995	96.7	0	0.168	0.004	0.083	0.065	0.047	0.035
1996	99.2	0	0.083	0.002	0.053	0.042	0.026	0.018
1997	98.9	0	0.049	0.001	0.029	0.023	0.014	0.010
1998	97.5	0	0.076	0.001	0.050	0.042	0.027	0.020
1999	94.2	0	0.051	0.002	0.042	0.039	0.027	0.022
2000	84.7*	0	0.092	0.001	0.071	0.045	0.034	0.024
2001	98.1	0	0.068	0.001	0.046	0.035	0.023	0.018
2002	94.5	0	0.123	0.001	0.040	0.031	0.025	0.020
2003	93.2	0	0.112	0.001	0.058	0.041	0.025	0.019
2004	96.4	0	0.064	0.001	0.040	0.032	0.022	0.017
2005	99.7	0	0.084	0.002	0.063	0.053	0.032	0.027
2006	100.0	0	0.093	0.002	0.071	0.064	0.049	0.034
2007	98.4	0	0.075	0.002	0.069	0.061	0.044	0.035
2008	98.6	0	0.140	0.002	0.065	0.056	0.042	0.026
2009	97.5	0	0.053	0.002	0.040	0.035	0.028	0.021
2010	98.4	0	0.052	0.002	0.038	0.035	0.028	0.022
2011	97.3	0	0.091	0.003	0.049	0.045	0.033	0.026
2012	99.5	0	0.059	0.002	0.050	0.045	0.030	0.024
2013	95.3	0	0.067	0.002	0.053	0.042	0.033	0.028
2014	99.7	0	0.068	0.002	0.060	0.059	0.040	0.033
2015	95.1	0	0.077	0.002	0.057	0.052	0.039	0.025
2016	97.8	0	0.061	0.002	0.053	0.051	0.038	0.030

*Data availability less than 75 % for one or more quarters.

AAQ NEPM standards for SO_2: 0.20 ppm (1-hour average); 0.02 ppm (annual average).
AAQ NEPM goal for SO_2: 1-hour standard exceeded on no more than one day per year.

Table 51. Percentiles of daily peak 1-hour average SO_2 concentrations at Pimlico (2005–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
2005	*18.6**	*0*	*0.003*	*i.d.*	*0.003*	*0.003*	*0.002*	*0.002*
2006	98.6	0	0.006	0.000	0.005	0.004	0.003	0.002
2007	98.1	0	0.005	0.001	0.005	0.004	0.003	0.003
2008	100.0	0	0.006	0.000	0.005	0.003	0.002	0.002
2009	97.0	0	0.006	0.000	0.005	0.004	0.003	0.002
2010	90.1*	0	0.007	0.000	0.006	0.004	0.003	0.002
2011	94.2	0	0.009	0.001	0.007	0.006	0.005	0.005
2012	99.5	0	0.006	0.001	0.004	0.004	0.003	0.003
2013	94.8	0	0.004	0.000	0.003	0.003	0.002	0.002
2014	99.7	0	0.005	0.001	0.004	0.003	0.003	0.002
2015	99.5	0	0.004	0.001	0.004	0.004	0.003	0.003
2016	*16.1**	*0*	*0.007*	*i.d.*	*0.007*	*0.007*	*0.005*	*0.004*

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for SO_2: 0.20 ppm (1-hour average); 0.02 ppm (annual average).
AAQ NEPM goal for SO_2: 1-hour standard exceeded on no more than one day per year.

Table 52. Percentiles of daily peak 1-hour average SO_2 concentrations at Menzies (1983–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
1983	*67.4**	*25*	***0.725***	*i.d.*	***0.515***	***0.430***	***0.270***	*0.200*
1984	93.7	31	**1.155**	0.017	**0.555**	**0.515**	**0.330**	0.185
1985	97.3	7	**1.080**	0.016	**0.325**	**0.210**	0.100	0.055
1986	88.5	50	**1.406**	**0.031**	**1.255**	**0.788**	**0.577**	**0.296**
1987	98.9	51	**1.755**	**0.022**	**1.016**	**0.853**	**0.546**	**0.324**
1988	91.0*	31	**0.798**	0.017	**0.682**	**0.562**	**0.342**	0.159
1989	85.2	41	**0.957**	0.020	**0.585**	**0.503**	**0.348**	**0.241**
1990	*44.7**	*6*	***0.577***	*i.d.*	***0.493***	***0.222***	*0.145*	*0.091*
1991	*54.8**	*28*	***0.673***	*i.d.*	***0.638***	***0.440***	***0.294***	***0.215***
1992	88.5*	25	**0.540**	0.012	**0.457**	**0.406**	**0.286**	0.170
1993	95.6	24	**0.718**	0.015	**0.434**	**0.403**	**0.282**	0.134
1994	91.5	20	**0.688**	0.019	**0.483**	**0.343**	**0.250**	0.135
1995	98.9	11	**0.443**	0.005	**0.254**	**0.239**	0.184	0.109
1996	98.6	16	**0.598**	0.005	**0.409**	**0.285**	0.198	0.131
1997	98.9	7	**0.300**	0.003	**0.256**	**0.216**	0.128	0.083
1998	*48.8**	*16*	***0.693***	*i.d.*	***0.548***	***0.368***	***0.265***	*0.190*
1999	90.4*	17	**0.675**	0.004	**0.366**	**0.269**	**0.202**	0.141
2000	96.4	31	**0.584**	0.006	**0.373**	**0.357**	**0.250**	0.191
2001	98.9	41	**0.581**	0.006	**0.438**	**0.422**	**0.295**	**0.222**
2002	91.2	49	**1.254**	0.009	**0.551**	**0.526**	**0.385**	**0.272**
2003	98.9	42	**0.658**	0.007	**0.503**	**0.493**	**0.312**	**0.217**
2004	97.5	36	**0.888**	0.007	**0.665**	**0.444**	**0.302**	**0.207**
2005	93.7*	49	**0.964**	0.009	**0.663**	**0.512**	**0.395**	**0.271**
2006	97.0	25	**0.567**	0.005	**0.398**	**0.356**	**0.246**	0.176
2007	96.7	31	**0.608**	0.007	**0.408**	**0.375**	**0.282**	0.185
2008	97.0	38	**0.751**	0.007	**0.528**	**0.482**	**0.289**	**0.203**
2009	96.7	25	**1.013**	0.006	**0.582**	**0.481**	**0.286**	0.126
2010	97.0	19	**0.669**	0.005	**0.413**	**0.392**	**0.248**	0.146
2011	84.1*	22	**0.502**	0.006	**0.426**	**0.348**	**0.236**	0.173
2012	99.5	30	**0.670**	0.005	**0.434**	**0.410**	**0.274**	0.165
2013	96.7	34	**0.594**	0.006	**0.398**	**0.375**	**0.311**	0.191
2014	97.0	20	**0.622**	0.005	**0.429**	**0.352**	**0.206**	0.131
2015	100.0	30	**0.577**	0.006	**0.466**	**0.371**	**0.260**	0.164
2016	100.0	32	**0.717**	0.007	**0.478**	**0.438**	**0.286**	0.180

Bold text indicates a value greater than the AAQ NEPM standards.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for SO_2: 0.20 ppm (1-hour average); 0.02 ppm (annual average).
AAQ NEPM goal for SO_2: 1-hour standard exceeded on no more than one day per year.

Table 53. Percentiles of daily 24-hour average SO_2 concentrations at Flinders View (1993–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
1993	88.2*	0	0.006	0.002	0.005	0.005	0.004	0.003
1994	98.9	0	0.008	0.003	0.007	0.006	0.006	0.005
1995	*59.5**	*0*	*0.009*	*i.d.*	*0.008*	*0.006*	*0.005*	*0.004*
1996	88.3*	0	0.010	0.002	0.005	0.005	0.004	0.004
1997	97.0	0	0.009	0.002	0.006	0.005	0.004	0.003
1998	95.9	0	0.011	0.002	0.007	0.006	0.004	0.004
1999	96.4	0	0.009	0.002	0.007	0.007	0.005	0.004
2000	89.9	0	0.013	0.002	0.012	0.008	0.006	0.005
2001	99.5	0	0.014	0.001	0.007	0.006	0.004	0.003
2002	97.0	0	0.006	0.001	0.006	0.005	0.003	0.003
2003	96.4	0	0.006	0.001	0.005	0.004	0.003	0.002
2004	99.5	0	0.007	0.001	0.006	0.005	0.003	0.003
2005	100.0	0	0.006	0.001	0.004	0.004	0.002	0.002
2006	99.7	0	0.007	0.001	0.006	0.004	0.004	0.003
2007	99.5	0	0.006	0.001	0.004	0.004	0.003	0.002
2008	98.6	0	0.006	0.001	0.005	0.004	0.003	0.002
2009	97.5	0	0.007	0.001	0.005	0.004	0.003	0.002
2010	99.5	0	0.008	0.001	0.004	0.003	0.003	0.002
2011	95.6	0	0.005	0.001	0.004	0.003	0.002	0.002
2012	100.0	0	0.004	0.001	0.003	0.003	0.002	0.002
2013	100.0	0	0.003	0.001	0.002	0.002	0.002	0.002
2014	96.4	0	0.002	0.000	0.001	0.001	0.001	0.001
2015	100.0	0	0.002	0.000	0.001	0.001	0.001	0.001
2016	99.7	0	0.002	0.001	0.002	0.002	0.001	0.001

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for SO_2: 0.08 ppm (24-hour average); 0.02 ppm (annual average).
AAQ NEPM goal for SO_2: 24-hour standard exceeded on no more than one day per year.

Table 54. Percentiles of daily 24-hour average SO_2 concentrations at South Gladstone (1991–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
1991	92.6	0	0.007	0.002	0.006	0.006	0.004	0.004
1992	94.3	0	0.012	0.003	0.011	0.010	0.009	0.008
1993	98.3	0	0.014	0.004	0.010	0.010	0.008	0.007
1994	97.0	0	0.013	0.003	0.007	0.007	0.006	0.005
1995	96.7	0	0.017	0.004	0.014	0.012	0.008	0.007
1996	99.2	0	0.010	0.002	0.007	0.006	0.005	0.004
1997	98.9	0	0.007	0.001	0.004	0.003	0.002	0.002
1998	97.5	0	0.012	0.001	0.010	0.007	0.005	0.003
1999	94.2	0	0.009	0.002	0.008	0.006	0.005	0.004
2000	84.7*	0	0.022	0.001	0.008	0.006	0.004	0.003
2001	98.1	0	0.006	0.001	0.005	0.004	0.003	0.002
2002	94.5	0	0.029	0.001	0.029	0.006	0.004	0.003
2003	93.2	0	0.013	0.001	0.011	0.007	0.005	0.003
2004	96.4	0	0.007	0.001	0.006	0.006	0.004	0.003
2005	98.9	0	0.011	0.002	0.009	0.006	0.004	0.004
2006	97.5	0	0.019	0.003	0.014	0.011	0.008	0.006
2007	97.5	0	0.021	0.002	0.012	0.010	0.007	0.005
2008	97.0	0	0.018	0.002	0.010	0.009	0.006	0.005
2009	93.7	0	0.009	0.002	0.008	0.007	0.006	0.004
2010	98.4	0	0.010	0.002	0.009	0.007	0.005	0.004
2011	97.3	0	0.011	0.003	0.011	0.009	0.008	0.005
2012	99.5	0	0.010	0.002	0.009	0.008	0.006	0.005
2013	95.3	0	0.013	0.002	0.010	0.008	0.006	0.004
2014	99.7	0	0.014	0.002	0.013	0.011	0.008	0.005
2015	95.1	0	0.013	0.002	0.012	0.010	0.008	0.005
2016	97.8	0	0.012	0.002	0.011	0.010	0.007	0.005

*Data availability less than 75 % for one or more quarters.

AAQ NEPM standards for SO_2: 0.08 ppm (24-hour average); 0.02 ppm (annual average).
AAQ NEPM goal for SO_2: 24-hour standard exceeded on no more than one day per year.

Table 55. Percentiles of daily 24-hour average SO_2 concentrations at Pimlico (2005–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
2005	*18.1**	*0*	*0.001*	*i.d.*	*0.001*	*0.001*	*0.001*	*0.000*
2006	96.2	0	0.003	0.000	0.002	0.002	0.002	0.001
2007	97.0	0	0.003	0.001	0.003	0.002	0.002	0.001
2008	98.9	0	0.001	0.000	0.001	0.001	0.001	0.000
2009	95.1	0	0.003	0.000	0.002	0.001	0.001	0.001
2010	90.1*	0	0.003	0.000	0.003	0.003	0.002	0.001
2011	94.2	0	0.006	0.001	0.006	0.005	0.004	0.003
2012	99.5	0	0.003	0.001	0.002	0.002	0.002	0.001
2013	94.8	0	0.002	0.000	0.001	0.001	0.001	0.001
2014	99.7	0	0.002	0.001	0.002	0.002	0.001	0.001
2015	99.5	0	0.003	0.001	0.003	0.002	0.001	0.001
2016	*16.1*	*0*	*0.001*	*i.d.*	*0.001*	*0.001*	*0.001*	*0.001*

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for SO_2: 0.08 ppm (24-hour average); 0.02 ppm (annual average).
AAQ NEPM goal for SO_2: 1-hour standard exceeded on no more than one day per year.

Table 56. Percentiles of daily 24-hour average SO_2 concentrations at Menzies (1984–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (ppm)	Annual average (ppm)	Percentiles (ppm)			
					99th	98th	95th	90th
1984	93.7	3	0.094	0.017	0.087	0.071	0.053	0.033
1985	97.3	1	0.111	0.016	0.050	0.042	0.030	0.024
1986	88.5	11	0.145	0.031	0.123	0.101	0.071	0.052
1987	98.9	12	0.158	0.022	0.110	0.099	0.060	0.044
1988	91.0*	3	0.123	0.017	0.091	0.064	0.041	0.032
1989	85.2	1	0.100	0.020	0.066	0.062	0.048	0.035
1990	44.7*	1	0.088	i.d.	0.078	0.072	0.052	0.046
1991	54.8*	3	0.117	i.d.	0.100	0.073	0.053	0.038
1992	88.5*	0	0.064	0.012	0.056	0.052	0.033	0.025
1993	95.6	0	0.064	0.015	0.052	0.046	0.040	0.027
1994	91.5	2	0.085	0.019	0.059	0.054	0.045	0.040
1995	98.9	0	0.049	0.005	0.036	0.028	0.018	0.012
1996	98.6	0	0.049	0.005	0.043	0.040	0.024	0.015
1997	98.9	0	0.034	0.003	0.028	0.022	0.016	0.010
1998	48.8*	0	0.055	i.d.	0.041	0.037	0.029	0.019
1999	90.4*	0	0.049	0.004	0.036	0.032	0.024	0.015
2000	96.4	0	0.078	0.006	0.070	0.055	0.032	0.019
2001	98.9	0	0.075	0.006	0.052	0.045	0.033	0.021
2002	91.2	1	0.081	0.009	0.057	0.055	0.043	0.033
2003	98.9	2	0.093	0.007	0.067	0.057	0.036	0.022
2004	97.5	1	0.100	0.007	0.069	0.050	0.034	0.017
2005	91.8*	2	0.091	0.009	0.069	0.060	0.044	0.032
2006	93.7	0	0.065	0.005	0.054	0.045	0.032	0.018
2007	94.5	1	0.199	0.007	0.060	0.046	0.036	0.023
2008	96.2	1	0.089	0.007	0.064	0.056	0.037	0.025
2009	95.1	2	0.088	0.006	0.056	0.051	0.032	0.015
2010	97.0	1	0.094	0.005	0.058	0.043	0.028	0.015
2011	84.1*	0	0.060	0.006	0.053	0.047	0.029	0.016
2012	99.5	0	0.063	0.005	0.056	0.055	0.031	0.016
2013	96.7	1	0.091	0.006	0.063	0.057	0.037	0.021
2014	97.0	1	0.096	0.005	0.048	0.039	0.030	0.017
2015	100.0	2	0.106	0.006	0.047	0.044	0.034	0.019
2016	100.0	1	0.111	0.007	0.062	0.056	0.038	0.025

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for SO_2: 0.08 ppm (24-hour average); 0.02 ppm (annual average).
AAQ NEPM goal for SO_2: 24-hour standard exceeded on no more than one day per year.

PM_{10}

Table 57. 2016 percentiles of daily 24-hour average PM_{10} concentrations

Region/performance monitoring station	Data availability (% of days)	Maximum (µg/m³)	Percentiles (µg/m³)					
			99th	98th	95th	90th	75th	50th
South East Queensland								
Mountain Creek	97.5	38.8	31.7	28.3	25.6	23.0	19.1	15.4
Rocklea	90.7	31.2	29.5	27.1	24.4	21.7	17.8	14.6
Springwood	96.2	30.6	26.0	25.5	22.2	19.0	15.2	11.7
Flinders View	98.6	34.0	31.4	28.1	24.2	20.2	16.0	12.7
Gladstone								
South Gladstone	97.8	32.1	27.6	25.8	23.3	21.9	17.7	13.7
Mackay								
West Mackay	97.5	44.5	34.4	33.1	28.4	27.0	22.7	19.2
Townsville								
Pimlico	11.7	33.4	33.4	33.4	32.5	24.5	22.0	18.6
Mount Isa								
The Gap	95.6	**350.8**	43.3	41.1	31.5	26.5	19.5	14.6

Bold text indicates a value greater than the AAQ NEPM standard.

AAQ NEPM standards for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average).
PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

Table 58. Percentiles of daily 24-hour average PM_{10} concentrations at Mountain Creek (2001–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m³)	Annual average (µg/m³)	Percentiles (µg/m³)			
					99th	98th	95th	90th
2001	*47.9**	*1*	***50.8***	*i.d.*	*39.9*	*38.1*	*27.2*	*23.8*
2002	88.2*	8	**146.9**	19.1	**76.0**	**56.3**	36.6	28.1
2003	99.5	1	**69.0**	15.1	37.0	32.4	27.4	22.4
2004	96.7	1	**66.6**	15.4	39.2	34.6	29.1	23.3
2005	95.9	2	**62.9**	14.5	37.6	29.7	24.4	20.3
2006	98.9	0	39.8	14.6	33.3	28.4	23.9	20.9
2007	98.9	0	41.9	14.6	34.4	31.1	24.0	21.1
2008	93.4	1	**53.3**	15.8	42.4	35.3	27.6	23.4
2009	97.5	8	**863.8**	20.2	**116.25**	**63.0**	35.6	24.7
2010	97.0	0	33.7	13.1	25.2	23.8	21.3	18.9
2011	97.0	0	49.5	13.2	29.5	28.3	21.7	19.3
2012	95.1	1	**57.1**	13.7	37.8	31.1	24.7	20.9
2013	98.6	1	**78.1**	15.8	38.7	30.6	26.6	24.0
2014	97.8	1	**59.5**	14.5	32.8	28.4	25.1	21.2
2015	98.4	0	44.8	13.8	29.6	26.6	21.8	19.5
2016	97.5	0	38.8	16.0	31.7	28.3	25.6	23.0

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average).
Prior to January 2016, the AAQ NEPM goal for PM_{10} was that the standard was exceeded on no more than five days per year.
From January 2016, PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

Table 59. Percentiles of daily 24-hour average PM_{10} concentrations at Rocklea (1996–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m³)	Annual average (µg/m³)	Percentiles (µg/m³)			
					99th	98th	95th	90th
1996	*62.0**	*2*	***59.5***	*i.d.*	*44.8*	*42.0*	*35.7*	*31.2*
1997	92.1	0	41.3	18.1	37.4	31.3	27.6	25.9
1998	91.2	0	32.8	17.0	30.6	28.1	25.4	23.3
1999	96.4	1	**56.7**	15.7	31.4	27.9	25.4	22.2
2000	92.6	0	47.5	17.8	40.5	37.1	31.4	26.5
2001	97.3	1	**70.8**	16.8	34.8	32.1	26.5	24.2
2002	99.2	8	**177.3**	20.2	**82.2**	49.0	32.9	29.6
2003	98.1	2	**119.9**	16.4	40.4	33.4	28.3	24.2
2004	92.6	0	47.3	19.1	40.8	38.1	33.3	28.2
2005	89.9	2	**52.6**	16.9	39.8	36.2	27.0	23.3
2006	96.2	0	39.5	16.1	31.5	29.4	26.8	23.8
2007	99.2	1	**53.4**	17.5	39.1	36.6	31.7	26.3
2008	95.1	1	**86.8**	16.7	39.6	36.4	28.9	24.8
2009	97.3	9	**1033.4**	**25.2**	**109.2**	**64.6**	40.3	35.1
2010	96.7	0	38.0	16.7	30.5	27.8	25.3	22.6
2011	*2.7**	*0*	*20.4*	*i.d.*	*20.3*	*20.2*	*19.9*	*19.3*
2012	*56.3**	*0*	*41.0*	*i.d.*	*34.8*	*34.6*	*26.7*	*22.8*
2013	85.8	0	32.2	14.2	29.8	27.3	24.0	21.0
2014	94.8	0	31.6	14.0	30.4	29.7	23.4	21.1
2015	96.2	0	44.0	14.9	31.1	27.4	24.2	21.5
2016	90.7	0	31.2	15.1	29.5	27.1	24.4	21.7

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average).
Prior to January 2016, the AAQ NEPM goal for PM_{10} was that the standard was exceeded on no more than five days per year. From January 2016, PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

Table 60. Percentiles of daily 24-hour average PM_{10} concentrations at Flinders View (1998–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m³)	Annual average (µg/m³)	Percentiles (µg/m³)			
					99th	98th	95th	90th
1998	*68.2**	*0*	*26.6*	*i.d.*	*24.6*	*22.2*	*20.8*	*19.0*
1999	95.3	0	44.2	12.3	27.4	25.1	19.7	17.5
2000	97.3	1	**62.8**	16.6	39.2	36.2	31.3	26.0
2001	99.7	0	42.5	15.1	36.5	32.9	25.4	22.4
2002	97.3	7	**197.2**	19.8	**92.1**	47.0	36.2	30.3
2003	94.8	1	**119.1**	15.7	35.3	30.6	26.1	23.1
2004	99.2	3	**64.1**	18.5	39.1	37.4	32.2	28.5
2005	97.0	3	**64.3**	16.1	43.5	40.1	26.8	23.6
2006	100.0	0	35.7	14.7	29.4	28.5	25.3	22.4
2007	99.2	0	44.6	15.7	38.4	34.3	27.5	23.3
2008	99.2	2	**68.5**	14.6	44.7	36.0	26.3	21.1
2009	98.6	8	**1001.8**	21.2	**100.7**	**54.0**	32.1	26.9
2010	99.2	0	33.9	12.2	25.5	24.2	20.2	18.3
2011	99.2	2	**67.0**	14.1	32.8	29.7	22.2	19.9
2012	98.4	2	**73.8**	15.0	42.2	35.3	27.2	23.1
2013	99.2	0	42.2	15.0	32.3	29.8	24.9	22.0
2014	94.8	0	38.8	15.9	35.7	33.3	28.9	24.6
2015	99.7	0	44.5	14.6	34.5	31.4	24.5	21.8
2016	98.6	0	34.0	13.1	31.4	28.1	24.2	20.2

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average).
Prior to January 2016, the AAQ NEPM goal for PM_{10} was that the standard was exceeded on no more than five days per year.
From January 2016, PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

Table 61. Percentiles of daily 24-hour average PM_{10} concentrations at North Toowoomba (2003–2010)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m³)	Annual average (µg/m³)	Percentiles (µg/m³)			
					99th	98th	95th	90th
2003	*41.1**	*1*	***139.8***	*i.d.*	*42.0*	*35.2*	*33.2*	*30.1*
2004	98.9	1	**54.5**	17.0	47.8	42.1	35.4	29.7
2005	95.9	3	**111.7**	15.3	43.1	34.6	28.5	24.6
2006	92.9	1	**55.6**	15.8	39.3	33.2	30.0	25.9
2007	97.5	1	**51.5**	13.8	43.0	36.6	27.2	24.0
2008	95.9	4	**105.2**	14.7	**51.9**	46.5	30.2	25.8
2009	97.5	11	**1131.0**	23.3	**127.8**	**87.8**	41.7	32.2
2010	90.7*	0	35.1	12.6	31.8	27.1	23.1	20.9

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average).
Prior to January 2016, the AAQ NEPM goal for PM_{10} was that the standard was exceeded on no more than five days per year.
From January 2016, PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

Table 62. Percentiles of daily 24-hour average PM_{10} concentrations at South Gladstone (2000–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m³)	Annual average (µg/m³)	Percentiles (µg/m³)			
					99th	98th	95th	90th
2000	*63.1**	*4*	***65.2***	*i.d.*	***54.8***	*44.5*	*32.0*	*28.2*
2001	95.6	4	**66.7**	17.7	47.4	35.9	30.4	25.8
2002	98.1	5	**197.1**	18.2	**75.1**	46.0	33.6	25.8
2003	96.4	0	41.3	15.5	36.1	33.4	26.2	23.6
2004	99.7	0	42.7	16.3	34.5	29.1	25.3	22.4
2005	97.8	4	**196.7**	16.9	48.5	32.7	26.4	22.8
2006	98.4	1	**54.6**	16.7	37.0	34.1	27.9	23.1
2007	96.7	0	38.8	15.7	29.5	28.3	25.1	22.7
2008	93.7	2	**65.6**	17.0	42.3	36.8	29.5	25.5
2009	83.0*	7	**252.3**	23.2	**80.8**	**54.1**	38.1	29.9
2010	78.4*	0	35.6	16.5	32.1	30.3	26.5	23.5
2011	76.7*	3	**136.7**	14.0	40.7	32.1	27.6	23.2
2012	88.5*	1	**63.0**	14.6	31.8	28.4	25.1	21.9
2013	95.3	0	37.6	16.8	30.3	28.8	25.5	23.0
2014	95.1	0	49.3	16.2	34.4	30.3	27.9	23.5
2015	93.4	0	31.5	12.9	26.6	25.9	22.0	19.8
2016	97.8	0	32.1	14.5	27.6	25.8	23.3	21.9

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average).
Prior to January 2016, the AAQ NEPM goal for PM_{10} was that the standard was exceeded on no more than five days per year.
From January 2016, PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

Table 63. Percentiles of daily 24-hour average PM_{10} concentrations at West Mackay (1998–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m^3)	Annual average (µg/m^3)	Percentiles (µg/m^3)			
					99th	98th	95th	90th
1998	*39.5**	*0*	*28.9*	*i.d.*	*28.8*	*28.7*	*22.3*	*20.7*
1999	93.2	1	**50.4**	17.3	37.6	32.2	27.7	25.6
2000	98.9	2	**51.6**	18.9	48.4	43.0	34.0	29.9
2001	98.6	2	**52.6**	22.0	48.5	42.8	37.9	33.5
2002	98.6	5	**475.4**	24.6	**51.2**	46.4	37.4	33.1
2003	92.3	7	**85.0**	21.5	**53.2**	49.1	38.9	32.2
2004	97.3	0	45.3	20.7	39.6	37.7	33.6	29.6
2005	97.0	7	**146.0**	22.0	**105.1**	**52.6**	36.3	31.1
2006	95.6	1	**106.0**	19.8	41.5	36.2	31.7	28.4
2007	95.6	2	**61.1**	21.6	49.1	46.1	38.5	33.1
2008	98.4	9	**94.0**	23.6	**61.4**	**53.1**	43.9	36.4
2009	97.5	18	**514.8**	**28.6**	**202.6**	**89.8**	**50.9**	40.8
2010	83.0*	0	44.0	18.5	41.4	35.8	30.7	27.1
2011	92.9	1	**65.8**	19.9	41.8	39.4	36.2	30.2
2012	98.9	1	**64.9**	17.8	40.0	37.4	27.6	24.3
2013	96.4	0	42.4	18.5	36.4	30.1	26.4	24.5
2014	91.2	0	34.3	18.2	29.0	27.9	25.2	24.0
2015	91.8	0	46.5	22.0	41.9	37.8	34.1	29.5
2016	97.5	0	44.5	19.8	34.4	33.1	28.4	27.0

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for PM_{10}: 50 µg/m^3 (24-hour average); 25 µg/m^3 (1-year average).
Prior to January 2016, the AAQ NEPM goal for PM_{10} was that the standard was exceeded on no more than five days per year.
From January 2016, PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

Table 64. Percentiles of daily 24-hour average PM_{10} concentrations at Pimlico (2004–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m³)	Annual average (µg/m³)	Percentiles (µg/m³)			
					99th	98th	95th	90th
2004	*52.2**	*0*	*28.1*	*i.d.*	*27.0*	*25.9*	*23.2*	*21.4*
2005	91.8	5	**141.9**	16.1	**113.0**	31.7	23.4	20.5
2006	89.6*	2	**61.5**	14.6	28.3	24.0	22.2	20.1
2007	94.0	0	29.1	12.9	26.9	24.2	20.5	18.3
2008	97.0	1	**50.6**	16.4	36.1	32.6	29.3	23.9
2009	93.4	9	**460.4**	21.2	**302.2**	**121.5**	33.9	23.6
2010	80.3*	0	31.5	13.9	29.3	25.6	22.8	19.4
2011	93.7	1	**64.9**	15.4	33.9	31.8	27.7	22.3
2012	92.1	0	30.0	12.9	26.3	23.6	21.5	18.8
2013	95.1	0	27.6	15.1	27.0	26.1	24.4	22.5
2014	98.4	0	29.4	15.1	27.7	26.2	23.1	20.6
2015	91.2	0	42.0	17.6	36.6	32.6	26.7	24.1
2016	*11.7**	*0*	*33.4*	*i.d.*	*33.4*	*33.4*	*32.5*	*24.5*

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average).
Prior to January 2016, the AAQ NEPM goal for PM_{10} was that the standard was exceeded on no more than five days per year.
From January 2016, PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

Table 65. Percentiles of daily 24-hour average PM_{10} concentrations at The Gap (2009–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m³)	Annual average (µg/m³)	Percentiles (µg/m³)			
					99th	98th	95th	90th
2009	*63.3**	*19*	***508.5***	*i.d.*	***283.6***	***135.6***	***67.8***	*45.8*
2010	75.1*	0	32.1	8.9	25.7	23.9	18.8	15.8
2011	87.4*	13	**124.0**	17.3	**91.2**	**71.5**	42.6	32.4
2012	99.2	16	**74.5**	19.5	**59.3**	**56.7**	49.2	38.8
2013	79.7*	13	**154.1**	23.1	**137.0**	**67.7**	45.9	37.5
2014	96.7	12	**153.7**	20.4	**80.0**	**57.7**	43.4	33.6
2015	98.1	6	**153.3**	19.5	**56.9**	50.0	39.5	31.5
2016	95.6	1	**350.8**	16.8	43.3	41.1	31.5	26.5

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.

AAQ NEPM standards for PM_{10}: 50 µg/m³ (24-hour average); 25 µg/m³ (1-year average).
Prior to January 2016, the AAQ NEPM goal for PM_{10} was that the standard was exceeded on no more than five days per year.
From January 2016, PM_{10} monitoring data determined as being directly associated with an exceptional event (e.g. dust storm) is excluded from reporting compliance with the PM_{10} 24-hour goal.

$PM_{2.5}$

Table 66. 2016 percentiles of daily 24-hour average $PM_{2.5}$ concentrations

Region/performance monitoring station	Data availability (% of days)	Maximum (µg/m³)	Percentiles (µg/m³)					
			99th	98th	95th	90th	75th	50th
South East Queensland								
Rocklea+	90.7	19.9	16.7	15.2	13.4	10.7	8.5	6.0
Springwood‡	95.6	20.1	16.0	13.6	10.9	9.3	7.0	5.2
Gladstone								
South Gladstone+	97.8	15.9	14.8	13.2	10.3	8.4	6.7	5.3

+ Monitoring by TEOM Model 1405 instrumentation fitted with FDMS.
‡ Monitoring by TEOM Model 1400 instrumentation in accordance with Technical Paper on Monitoring for Particles as $PM_{2.5}$ (to 25 February 2016). From 25 February, monitoring by TEOM Model 1405 instrumentation fitted with FDMS.

AAQ NEPM standards for $PM_{2.5}$: 25 µg/m³ (24-hour average); 8 µg/m³ (1-year average).
$PM_{2.5}$ monitoring data determined as being directly associated with an exceptional event (e.g. bushfire) is excluded from reporting compliance with the $PM_{2.5}$ 24-hour goal.

Table 67. Percentiles of daily 24-hour average $PM_{2.5}$ concentrations at Rocklea (1998–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m^3)	Annual average (µg/m^3)	Percentiles (µg/m^3)			
					99th	98th	95th	90th
1998	80.8*	0	16.1	3.5	11.1	9.2	7.7	6.0
1999	88.8*	0	14.5	5.0	13.3	12.4	10.3	8.3
2000	95.6	3	**37.4**	5.8	20.2	17.7	13.3	10.9
2001	98.6	3	**95.4**	5.5	18.4	17.1	12.3	9.2
2002	96.4	3	**45.3**	6.1	22.0	17.1	12.8	10.9
2003	87.7*	1	**34.7**	5.1	23.3	13.9	10.6	8.6
2004	93.7	5	**32.9**	6.5	**28.7**	24.4	17.9	11.6
2005	90.1*	0	15.3	4.6	13.0	12.2	9.6	8.1
2006	95.3	0	14.2	4.1	13.7	11.1	8.6	7.1
2007	99.7	0	20.5	4.4	17.6	13.5	10.6	8.5
2008	95.3	0	11.6	3.8	9.8	9.5	7.8	6.9
2009	92.6	7	**163.6**	**10.9**	**34.3**	**25.7**	21.5	18.0
2010	96.7	0	23.2	**8.2**	17.4	15.3	13.6	12.0
2011	*2.7**	*0*	*8.8*	*i.d.*	*8.8*	*8.8*	*8.8*	*8.8*
2012	*56.3**	*0*	*23.7*	*i.d.*	*22.8*	*16.7*	*13.9*	*11.3*
2013	85.8	0	17.2	6.6	16.4	14.7	12.0	10.3
2014	94.8	0	21.9	5.8	19.1	15.5	13.0	9.6
2015	96.2	0	20.3	7.3	16.6	15.8	13.5	11.5
2016	90.7	0	19.9	6.5	16.7	15.2	13.4	10.7

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.
Monitoring by TEOM Model 1400 instrumentation in accordance with Technical Paper on Monitoring for Particles as $PM_{2.5}$ from 1998 to 2008. Monitoring by TEOM Model 1405 instrumentation fitted with FDMS since 2009.

AAQ NEPM standards for $PM_{2.5}$: 25 µg/m^3 (24-hour average); 8 µg/m^3 (1-year average).
$PM_{2.5}$ monitoring data determined as being directly associated with an exceptional event (e.g. bushfire) is excluded from reporting compliance with the $PM_{2.5}$ 24-hour goal.

Table 68. Percentiles of daily 24-hour average $PM_{2.5}$ concentrations at Springwood (1999–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m³)	Annual average (µg/m³)	Percentiles (µg/m³)			
					99th	98th	95th	90th
1999	82.7*	0	22.3	4.3	12.9	11.8	8.7	7.1
2000	96.7	6	**35.4**	6.4	**28.9**	23.6	17.3	13.2
2001	97.0	0	19.4	5.3	18.0	16.2	11.8	9.1
2002	95.9	5	**38.9**	6.2	**28.4**	20.1	14.9	11.7
2003	96.2	0	20.5	5.5	16.6	15.4	10.9	9.2
2004	98.4	0	21.7	5.5	16.9	15.4	11.7	9.5
2005	96.4	0	15.2	4.7	14.9	13.3	10.3	8.6
2006	94.0	1	**25.5**	4.8	20.1	15.3	9.3	7.9
2007	98.4	0	17.8	4.3	14.0	12.0	9.4	7.8
2008	96.7	0	10.9	4.1	9.9	8.8	7.9	6.7
2009	91.5	3	**150.6**	5.5	**25.3**	18.0	11.4	9.0
2010	83.3	0	19.4	4.4	12.8	10.7	8.4	7.4
2011	92.9	3	**51.2**	4.6	**29.3**	11.5	8.7	6.8
2012	98.1	0	23.7	4.4	15.6	13.3	10.2	7.5
2013	96.7	0	14.2	4.5	11.9	11.6	10.1	8.6
2014	97.3	0	17.6	4.9	14.8	13.1	10.0	8.0
2015	*71.0**	*0*	*12.6*	*i.d.*	*10.9*	*9.8*	*7.5*	*6.5*
2016	95.6	0	20.1	5.7	16.0	13.6	10.9	9.3

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.
Monitoring by TEOM Model 1400 instrumentation in accordance with Technical Paper on Monitoring for Particles as $PM_{2.5}$ (to 25 February 2016). From 25 February, monitoring by TEOM Model 1405 instrumentation fitted with FDMS.

AAQ NEPM standards for $PM_{2.5}$: 25 µg/m³ (24-hour average); 8 µg/m³ (1-year average).
$PM_{2.5}$ monitoring data determined as being directly associated with an exceptional event (e.g. bushfire) is excluded from reporting compliance with the $PM_{2.5}$ 24-hour goal.

Table 69. Percentiles of daily 24-hour average $PM_{2.5}$ concentrations at North Toowoomba (2003–2007)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m^3)	Annual average (µg/m^3)	Percentiles (µg/m^3)			
					99th	98th	95th	90th
2003	*34.8**	*1*	***28.1***	*i.d.*	*19.0*	*17.1*	*15.3*	*12.1*
2004	98.6	1	**33.2**	5.1	19.1	17.3	14.6	11.7
2005	97.3	0	24.8	4.7	14.7	13.6	10.9	8.6
2006	93.2	0	16.0	4.1	15.3	12.0	9.6	7.9
2007	92.9	0	17.8	3.6	11.9	10.8	8.7	6.8

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.
Monitoring by TEOM Model 1400 instrumentation in accordance with Technical Paper on Monitoring for Particles as $PM_{2.5}$.
AAQ NEPM standards for $PM_{2.5}$: 25 µg/m^3 (24-hour average); 8 µg/m^3 (1-year average).
$PM_{2.5}$ monitoring data determined as being directly associated with an exceptional event (e.g. bushfire) is excluded from reporting compliance with the $PM_{2.5}$ 24-hour goal.

Table 70. Percentiles of daily 24-hour average $PM_{2.5}$ concentrations at South Gladstone (2008–2016)

Year	Data availability (% of days)	No. of exceedances (days)	Maximum (µg/m^3)	Annual average (µg/m^3)	Percentiles (µg/m^3)			
					99th	98th	95th	90th
2008	*13.9**	*0*	*15.2*	*i.d.*	*12.6*	*12.6*	*12.3*	*11.1*
2009	83.0*	7	**50.8**	**9.2**	**29.8**	**26.9**	17.7	13.8
2010	78.4*	0	17.5	6.2	16.3	14.8	12.9	9.9
2011	90.4*	9	**126.7**	7.6	**62.2**	**33.5**	16.4	12.0
2012	88.5*	1	**49.6**	5.2	21.4	12.1	9.5	7.5
2013	95.3	0	18.3	5.6	16.9	12.1	10.3	8.6
2014	95.1	1	**44.0**	6.0	14.6	12.8	10.9	9.4
2015	93.4	0	13.8	4.3	10.1	9.4	8.0	6.7
2016	97.8	0	15.9	5.7	14.8	13.2	10.3	8.4

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.
Monitoring by TEOM Model 1405 instrumentation fitted with FDMS.
AAQ NEPM standards for $PM_{2.5}$: 25 µg/m^3 (24-hour average); 8 µg/m^3 (1-year average).
$PM_{2.5}$ monitoring data determined as being directly associated with an exceptional event (e.g. bushfire) is excluded from reporting compliance with the $PM_{2.5}$ 24-hour goal.

Lead

Table 71. Annual average lead concentrations at Woolloongabba (1980–2002)

Year	Data availability (% of days)	Annual average (µg/m^3)
1980	91.8	**2.21**
1981	85.2*	**2.69**
1982	96.7	**2.34**
1983	96.7	**2.21**
1984	93.4	**2.56**
1985	86.9*	**2.40**
1986	100.0	**1.90**
1987	96.7	**1.91**
1988	98.4	**2.13**
1989	98.4	**1.64**
1990	98.4	**1.47**
1991	100.0	**0.97**
1992	90.2	**0.63**
1993	93.4	**0.57**
1994	96.7	0.48
1995	100.0	0.38
1996	98.4	0.25
1997	100.0	0.27
1998	*65.6**	*i.d.*
1999	98.3	0.19
2000	88.5	0.14
2001	93.4	0.03
2002	96.7	0.02

Bold text indicates a value greater than the AAQ NEPM standard.
*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.
AAQ NEPM standard for lead: 0.5 µg/m^3 (annual average).

Table 72. Annual average lead concentrations at Townsville Coast Guard (2011–2016)

Year	Data availability (% of days)	Annual average (µg/m^3)
2011	85.0*	0.14
2012	96.7	0.12
2013	88.5	0.24
2014	96.7	0.29
2015	91.8	0.16
2016	100.0	0.05

*Data availability less than 75 % for one or more quarters.
AAQ NEPM standard for lead: 0.5 µg/m^3 (annual average).

Table 73. Annual average lead concentrations at The Gap (2009–2016)

Year	Data availability (% of days)	Annual average (µg/m^3)
2009	77.0*	0.13
2010	95.0	0.13
2011	96.7	0.14
2012	91.8	0.10
2013	*73.8**	*i.d.*
2014	91.8*	0.11
2015	100.0	0.09
2016	80.3*	0.06

*Data availability less than 75 % for one or more quarters.
Years shown in italics have less than 75 % annual data availability.
i.d. = insufficient data to calculate value.
AAQ NEPM standard for lead: 0.5 µg/m^3 (annual average).

National Environment Protection (Ambient Air Quality) Measure

as amended

made under section 20 of the

National Environment Protection Council Act 1994 (Cwlth), *National Environment Protection Council (New South Wales) Act 1995* (NSW), *National Environment Protection Council (Victoria) Act 1995* (Vic), *National Environment Protection Council (Queensland) Act 1994* (Qld), *National Environment Protection Council (Western Australia) Act 1996* (WA), *National Environment Protection Council (South Australia) Act 1995* (SA), *National Environment Protection Council (Tasmania) Act 1995* (Tas), *National Environment Protection Council Act 1994* (ACT) and the *National Environment Protection Council (Northern Territory) Act 1994* (NT)

This compilation was prepared on 25 February 2016
taking into account amendments up to Variation 2015

Prepared by the Department of the Environment.

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Contents

Introductory Note

Section 14 of the *National Environment Protection Council Act 1994* and the equivalent provision of the corresponding Act of each participating State and Territory provides for the making of measures by the National Environment Protection Council and the matters to which they may relate. This Measure relates to ambient air quality (section 14 (1) (a)).

The Measure is to be implemented by the laws and other arrangements participating jurisdictions consider necessary: see section 7 of the Commonwealth Act and the equivalent provision of the corresponding Act of each participating State and Territory.

Part 1 Preliminary

1 Citation [*see* Note 1]

This Measure may be cited as the National Environment Protection (Ambient Air Quality) Measure.

2 Definitions

(1) This clause defines particular words and expressions used in this Measure.

(2) The words and expressions indicated by an asterisk are defined in the Commonwealth Act and are included for information only to assist readers of the Measure. Minor changes from the definitions in the Commonwealth Act are indicated by square brackets ([ ]).

(3) In this Measure:

****Agreement*** means the agreement made on 1 May 1992 between the Commonwealth, the States, the Australian Capital Territory, the Northern Territory and the Australian Local Government Association, a copy of which is set out in the Schedule [to the Commonwealth Act].

ambient air means the external air environment, it does not include the air environment inside buildings or structures.

Commonwealth Act means the *National Environment Protection Council Act 1994* of the Commonwealth.

Continuous direct mass measurement technique means a method for continuously monitoring suspended particulate matter changes of particles in ambient air, providing near real time measurement of mean particle concentration.

Council means the National Environment Protection Council established by section 8 of the Commonwealth Act and the equivalent provision of the corresponding Act of each participating State and Territory.

Exceptional event means a fire or dust occurrence that adversely affects air quality at a particular location, and causes an exceedance of 1 day average standards in excess of normal historical fluctuations and background levels, and is directly related to: bushfire; jurisdiction authorised hazard reduction burning; or continental scale windblown dust.

Fire management means all activities associated with the management of fire prone land, including the use of fire to meet land management goals and objectives.

Manual gravimetric method means a manual method for sampling particles by drawing air through a filter and determining the mass by weighing the filters.

monitoring station means a facility for measuring the concentration of one or more pollutants in the ambient air in a region or sub-region.

national environment protection goal means a goal:

(a) that relates to desired environmental outcomes; and

(b) that guides the formulation of strategies for the management of human activities that may affect the environment.

national environment protection protocol means a protocol that relates to the process to be followed in measuring environmental characteristics to determine:

(a) whether a particular standard or goal is being met or achieved; or

(b) the extent of the difference between the measured characteristic of the environment and a particular standard or a particular goal.

national environment protection standard means a standard that consists of quantifiable characteristics of the environment against which environmental quality can be assessed.

participating jurisdiction means the Commonwealth, a participating State or a participating Territory.

participating State means a State:

(a) that is a party to the Agreement; and

(b) in which an Act that corresponds to [the Commonwealth] Act is in force in accordance with the Agreement.

participating Territory means a Territory:

(a) that is a party to the Agreement; and

(b) in which an Act that corresponds to [the Commonwealth] Act is in force in accordance with the Agreement.

particles as PM_{10} means particulate matter with an equivalent aerodynamic diameter of 10 micrometres or less.

Particles as $PM_{2.5}$ means particulate matter with an equivalent aerodynamic diameter of 2.5 micrometres or less.

performance monitoring station means a monitoring station used to measure achievement against the goal.

pollutant means a pollutant mentioned in Schedule 1.

ppm means parts per million by volume.

principal Measure means the National Environment Protection (Ambient Air Quality) Measure.

Reference method means the monitoring method used for collection of data that can be compared to the Advisory Reporting Standards.

region means an area within a boundary surrounding population centres as determined by the relevant participating jurisdiction.

sub-region means a populated area within a region whose air quality differs from other areas in the region due to the topography, meteorology and sources of pollutants.

TEOM means tapered element oscillating microbalance.

$\mu g/m^3$ means microgram per cubic metre referenced to a temperature of 0 degrees Celsius and an absolute pressure of 101.325 kilopascals.

3 Application

Participating jurisdictions must:

(a) for carbon monoxide, nitrogen dioxide, photochemical oxidants (as ozone), sulfur dioxide, lead, particles as $PM_{2.5}$ and particles as PM_{10}, monitor, assess and report in accordance with the protocol in this Measure.

Part 2 National environment protection goal

4 Purpose of Part

The purpose of this Part is to set out a goal:

(a) that relates to the desired environmental outcomes; and

(b) that guides the formulation of strategies for the management of human activities that may affect the environment.

5 Desired environmental outcome

The desired environmental outcome of this Measure is ambient air quality that allows for the adequate protection of human health and well-being.

6 National Environment Protection Goal

The national environment protection goals of this Measure are:

(a) for carbon monoxide, nitrogen dioxide, photochemical oxidants (as ozone), sulfur dioxide, lead and particles (as PM_{10} and $PM_{2.5}$) to achieve the National Environment Protection Standards as assessed in accordance with the monitoring protocol (Part 4) to the extent specified in Schedule 2 table 1; and

(b) for particles as $PM_{2.5}$, to achieve by 2025 further reductions in maximum concentrations to the extent specified in Schedule 2 table 2 .

Part 3 National environment protection standards

7 Purpose of Part

The purpose of this Part is to set standards that consist of quantifiable characteristics of the air against which ambient air quality can be assessed.

8 National environment protection standards

(1) The national environment protection standards of this Measure are the standards set out in Schedule 2.

(2) For each pollutant mentioned in table 1 of Schedule 2, the standard for an averaging period mentioned in the Schedule is the concentration in column 4 of table 1 of Schedule 2.

Federal Register of Legislative Instruments F2016C00215

Part 4 National environment protection protocol

9 Purpose of Part

The purpose of this Part is to set out the processes to be followed in measuring the concentration of pollutants in the air to determine:

(a) whether the standards of this Measure are being met; or

(b) the extent of the difference between the measured concentration of pollutants in the air and the standards.

10 Monitoring plans

(1) Each participating jurisdiction must ensure that a monitoring plan consistent with this Part is prepared setting out how the jurisdiction proposes to monitor air quality for the purposes of this Measure.

(2) Each monitoring plan must be submitted to Council.

11 Methods of measuring and assessing concentration of pollutants

For the purpose of evaluating performance against the standards the concentration of pollutants in the air:

(a) is to be measured at performance monitoring stations; or

Note Because the concentrations of different pollutants vary across a region, it would not be necessary or appropriate to co-locate the measuring instrumentation for all pollutants at each performance monitoring station.

(b) is to be assessed by other means that provide information equivalent to measurements which would otherwise occur at a performance monitoring station.

Note These methods could include, for example, the use of emission inventories, windfield and dispersion modelling, and comparisons with other regions.

12 Accreditation of performance monitoring

(1) Subject to subclause (2) the operator of a performance monitoring station must be accredited by the National Association of Testing Authorities.

(2) The operator may apply an equivalent system for ensuring adequate monitoring, quality assurance, and validation procedures.

13 Location of performance monitoring stations

(1) To the extent practicable, performance monitoring stations should be sited in accordance with the requirements for Australian Standard AS/NZS 3580.1.1:2007 (Methods for sampling and analysis of ambient air – Guide

to siting air monitoring equipment). Any variations from AS/NZS 3580.1.1:2007 must be notified to Council for use in assessing reports.

(2) Performance monitoring station(s) must be located in a manner such that they contribute to obtaining a representative measure of the air quality likely to be experienced by the general population in the region or sub-region.

(3) A performance monitoring station should be operated in the same location for at least 5 years unless the integrity of the measurements is affected by unforeseen circumstances.

14 Number of performance monitoring stations

(1) Subject to subclauses (2) and (3) below, the number of performance monitoring stations for a region with a population of 25,000 people or more must be the next whole number above the number calculated in accordance with the formula:

$$1.5P + 0.5$$

where ***P*** is the population of the region (in millions).

(2) Additional performance monitoring stations may be needed where pollutant levels are influenced by local characteristics such as topography, weather or emission sources.

(3) Fewer performance monitoring stations may be needed where it can be demonstrated that pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure.

15 Trend stations

(1) A number of performance monitoring stations in each participating State and participating Territory must be nominated as trend stations.

(2) The number of performance monitoring stations to be nominated as trend stations must be sufficient to monitor and assess long term changes in ambient air quality in different parts of the jurisdiction.

(3) A trend station must be operated in the same location for one or more decades.

16 Monitoring methods

(1) Subject to subclauses (2) and (3) the Australian Standard Methods set out in Schedule 3 should be used for monitoring pollutants in the air.

(2) Where an Australian Standard Method has not yet been developed for a monitoring method, appropriate internationally recognised methods or standards may be used that provide equivalent information for assessment purposes.

(3) Other monitoring methods may be used if:

(a) calibration and validation studies show:
  (i) the accuracy and precision of the other method; and
  (ii) the method can be compared with the relevant Australian Standard Method; and
(b) the equipment used is calibrated to the standard required by the equipment manufacturer; and
(c) the equipment provides equivalent information for assessment purposes.

17 Evaluation of performance against standards and goal

(1) Each participating jurisdiction must evaluate its annual performance as set out in this clause.

(2) For each performance monitoring station in the jurisdiction or assessment in accordance with subclause 11(b) there must be:
  (a) a determination of the exposed population in the region or sub-region represented by the station; and
  (b) an evaluation of performance against the standards and goal of this Measure, other than in relation to table 2 of Schedule 2, as:
    (i) meeting; or
    (ii) not meeting; or
    (iii) not demonstrated.

(2A) Each participating jurisdiction must evaluate and report population exposures to particles as $PM_{2.5}$ annually from June 2018.

Note To ensure national consistency, evaluation and reporting shall be undertaken in accordance with any procedures or methods agreed by participating jurisdictions.

(3) Jurisdictions may provide an evaluation of a region as a whole against the standards using appropriate methodologies that provide equivalent information for assessment purposes.

(4) Performance must be evaluated as ‘not demonstrated’ if there has been no monitoring or no assessment by an approved alternative method as provided in clause (11).

18 Reporting

(1) Each participating jurisdiction must submit a report on its compliance with the Measure, other than in relation to table 2 of Schedule 2, in an approved form to Council by the 30 June next following each reporting year.

(2) In this clause ***reporting year*** means a year ending on 31 December.

The report must include:
(a) the evaluations and assessments mentioned in clause 17; and

(b) an analysis of the extent to which the standards of this Measure are, or are not, met in the jurisdiction; and

(c) a statement of the progress made towards achieving the goal.

(3) The description of the circumstances which led to exceedences, including the influence of natural events and fire management, must be reported to the extent that such information can be determined.

(3A) When reporting against PM_{10} and $PM_{2.5}$ 1 day average standards jurisdictions will report all measured data, including monitoring data that is directly associated with an exceptional event, and identify and describe any exceptional event.

(3B) Jurisdictions are to maintain and make available records relating to the determination of exceptional events.

(3C) For the purpose of reporting compliance against PM_{10} and $PM_{2.5}$ 1 day average standards, jurisdictions shall exclude monitoring data that has been determined as being directly associated with an exceptional event.

(3D) For the purpose of reporting compliance against PM_{10} and $PM_{2.5}$ 1 year average standards, jurisdictions shall include all measured data, including monitoring data that is directly associated with an exceptional event.

Note To ensure national consistency, all reporting or record-keeping referred to in subclauses 18(3A), (3B), (3C) or (3D) shall be undertaken in accordance with any procedures or methods agreed by participating jurisdictions.

(4) A report for a pollutant must include the percentage of data available in the reporting period.

Schedule 1 Pollutants

Carbon monoxide

Nitrogen dioxide

Photochemical Oxidants (as Ozone)

Sulfur dioxide

Lead

Particles (as PM_{10} and $PM_{2.5}$)

Schedule 2 Standards and Goal

Table 1: Standards for Pollutants

Column 1 Item	Column 2 Pollutant	Column 3 Averaging period	Column 4 Maximum concentration standard	Column 5 Maximum allowable exceedances
1	Carbon monoxide	8 hours	9.0 ppm	1 day a year
2	Nitrogen dioxide	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year None
3	Photochemical oxidants (as ozone)	1 hour 4 hours	0.10 ppm 0.08 ppm	1 day a year 1 day a year
4	Sulfur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year None
5	Lead	1 year	0.50 $\mu g/m^3$	None
6	Particles as PM_{10}	1 day 1 year	50 $\mu g/m^3$ 25 $\mu g/m^3$	None None
7	Particles as $PM_{2.5}$	1 day 1 year	25 $\mu g/m^3$ 8 $\mu g/m^3$	None None

Table 2: Goal for Particles as $PM_{2.5}$ by 2025

Column 1 Pollutant	Column 2 Averaging period	Column 3 Maximum concentration
Particles as $PM_{2.5}$	1 day 1 year	20 µg/m^3 by 2025 7 µg/m^3 by 2025

For the purposes of this Measure the following definitions shall apply:

(1) Lead sampling must be carried out for a period of 24 hours at least every sixth day.

(2) Measurement of lead must be carried out on Total Suspended Particles (TSP) or its equivalent.

(3) In Column 3 of table 1 and Column 2 of table 2 of Schedule 2, the averaging periods are defined as follows:

- 1 hour clock hour average
- 4 hour rolling 4 hour average based on 1 hour averages
- 8 hour rolling 8 hour average based on 1 hour averages
- 1 day calendar day average
- 1 year calendar year average

(4) In Column 5 of table 1 of Schedule 2, the time periods are defined as follows:

- day calendar day during which the associated standard is exceeded
- year calendar year.

(5) All averaging periods of 8 hours or less must be referenced by the end time of the averaging period. This determines the calendar day to which the averaging periods are assigned.

(6) For the purposes of calculating and reporting 4 and 8 hour averages, the first rolling average in a calendar day ends at 1.00 am, and includes hours from the previous calendar day.

(7) The concentrations in Column 4 of table 1 and Column 3 of table 2 of Schedule 2 are the arithmetic mean concentrations.

Schedule 3 Australian Standards Methods for Pollutant Monitoring

Pollutant	Method title	Method number
Carbon monoxide	Determination of Carbon Monoxide-Direct Reading Instrumental Method	AS/NZS 3580.7.1-2011/Amdt 1-2012
Nitrogen dioxide	Determination of Oxides of Nitrogen-Chemiluminescence Method	AS/NZS 3580.5.1-2011
Photochemical oxidants (as ozone)	Determination of Ozone-Direct Reading Instrumental Method	AS/NZS 3580.6.1-2011
Sulfur dioxide	Determination of Sulfur Dioxide-Direct Reading Instrumental Method	AS/NZS 3580.4.1-2008
Lead	Determination of Suspended Particulate Matter – Particulate metals high or low volume sampler gravimetric collection – Inductively coupled plasma (ICP) spectrometric method	AS/NZS 3580.9.15:2014
	Determination of Suspended Particulate Matter – Total suspended particulate matter (TSP) - High volume sampler gravimetric method	AS/NZS 3580.9.3:2015
Particles as PM_{10}	Determination of Suspended Particulate Matter-PM_{10} High Volume Sampler with Size Selective Inlet-Gravimetric Method	AS/NZS 3580.9.6:2003
	Determination of Suspended Particulate Matter-Dichotomous sampler ($PM_{10,}$ coarse PM and $PM_{2.5)}$ – Gravimetric method	AS/NZS 3580.9.7:2009
	Determination of Suspended Particulate Matter-PM_{10} continuous direct mass method using tapered element oscillating microbalance analyser.	AS/NZS 3580.9.8-2008
	Determination of Suspended Particulate Matter-PM_{10} Low Volume Sampler-Gravimetric Method	AS/NZS 3580.9.9:2006
	Determination of Suspended Particulate Matter-PM_{10} beta attenuation monitors	AS/NZS 3580.9.11:2008/Amdt 1 :2009
Particles as $PM_{2.5}$	Determination of Suspended Particulate Matter-$PM_{2.5}$ low volume sampler-Gravimetric Method	AS/NZS 3580.9.10:2008
	Determination of Suspended Particulate Matter-$PM_{2.5}$ beta attenuation monitors	AS/NZS 3580.9.12:2013
	Determination of Suspended Particulate Matter-$PM_{2.5}$ continuous direct mass method using a tapered element oscillating microbalance monitor	AS/NZS 3580.9.13:2013
	Determination of Suspended Particulate Matter-$PM_{2.5}$ high volume sampler with size selective inlet – Gravimetric Method	AS/NZS 3580.9.14:2013

Notes to the National Environment Protection (Ambient Air Quality) Measure

Note 1

The National Environment Protection (Ambient Air Quality) Measure (in force under section 20 of the *National Environment Protection Council Act 1994* (Cwlth), *National Environment Protection Council (New South Wales) Act 1995* (NSW), *National Environment Protection Council (Victoria) Act 1995* (Vic), *National Environment Protection Council (Queensland) Act 1994* (Qld), *National Environment Protection Council (Western Australia) Act 1996* (WA), *National Environment Protection Council (South Australia) Act 1995* (SA), *National Environment Protection Council (Tasmania) Act 1995* (Tas), *National Environment Protection Council Act 1994* (ACT) and the *National Environment Protection Council (Northern Territory) Act 1994* (NT)) as shown in this compilation is amended as indicated in the Tables below.

Table of Instruments

Title	Date of notification in *Gazette*/registration	Date of commencement	Application, saving or transitional provisions
National Environment Protection (Ambient Air Quality) Measure	8 July 1998 (*see* c. 1 and *Gazette* 1998, No. GN27)	8 July 1998	
National Environment Protection (Ambient Air Quality) Measure Variation, 2003	2 June2003 (*see* c. 1 and *Gazette* 2003, No. S190)	2 June 2003	—
National Environment Protection (Ambient Air Quality) Measure Variation, 2015	3 February 2016	3 February 2016	

Table of Amendments

ad. = added or inserted   am. = amended   rep. = repealed   rs. = repealed and substituted

Provision affected	How affected
s. 2	am. Variation 2003; am. Variation 2015
s. 3	am. Variation 2003; rs. Variation 2015
s. 6	am. Variation 2003; rs. Variation 2015
s. 8	am. Variation 2003; am. Variation 2015
s.13	am. Variation 2015
s.17	am. Variation 2015
s.18	am. Variation 2015
Schedule 1	rs. Variation 2015
Schedule 2	am. Variation 2003; rs. Variation 2015
Schedule 3	rs. Variation 2015
Schedule 4	ad. Variation 2003; rep. Variation 2015
Schedule 5	ad. Variation 2003; rep. Variation 2015

Question 8:

Details of monitoring devices - What types of monitoring devices are located where?

PM_{10} Monitoring

		Active	NEPM Performance Monitoring Station	Monitoring Technique	AS/NZS 3580.1.1:2007 site classification	Sources
South East Queensland	**Springwood**	**Y**	Y	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Road
	Rocklea	**Y**	Y	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Road
	Brisbane CBD	**Y**	N	TEOM 1405 AS3580.9.8:2008	Neighbourhood	CBD
	Mountain Creek	**Y**	Y	TEOM 1405 AS3580.9.8:2008	Neighbourhood	Road
	Wynnum	**Y**	N	TEOM 1405D AS3580.9.8:2008	Neighbourhood	Oil Refinery
	Flinders View	**Y**	Y	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Road
	Wynnum West	**Y**	N	TEOM 1405D AS3580.9.8:2008	Neighbourhood	Oil Refinery
	South Brisbane	**Y**	N	FDMS TEOM 1405DF AS3580.9.13:2013	Peak	Freeway Corridor
	Cannon Hill	**Y**	N	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Roadway/local industries
	Lytton	**Y**	N	TEOM 1405D AS3580.9.8:2008	Peak	Port Operations/Oil Refinery
	Woolloongabba	**Y**	N	FDMS TEOM 1405DF AS3580.9.13:2013	Peak	Road Corridor
	Jondaryan	**N**	N	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Coal Load-out Facility
	Pinkenba	**N**	N	TEOM 1405 AS3580.9.8:2008	Neighbourhood	Port Operations/Oil Refinery/Development
Gladstone	**Boyne Island**	**Y**	N	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Aluminium Smelter
	Clinton	**Y**	N	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Airport/Coal-fired Power Station
	Boat Creek	**Y**	N	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Aluminium Refinery
	Auckland Point	**Y**	N	TEOM 1405 AS3580.9.8:2008	Neighbourhood	Port Operations
	South Gladstone	**Y**	Y	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Road/Industry
	Targinie	**Y**	N	FDMS TEOM 1405DF AS3580.9.13:2013	Background	Rural
Other	**West Mackay**	**Y**	Y	TEOM 1405 AS3580.9.8:2008	Neighbourhood	Road
	Moranbah	**Y**	N	TEOM 1405 AS3580.9.8:2008	Neighbourhood	Central Queensland coal fields
	Ayr	**N**	N	TEOM 1405 AS3580.9.8:2008	Neighbourhood	Sugar Cane Burning
Townsville	**Pimlico**	**N**	Y	TEOM 1405 AS3580.9.8:2008	Neighbourhood	Road
	Townsville Port	**Y**	N	TEOM 1405 AS3580.9.8:2008	Peak	Port Operations Mineral concentrate/ore
Mt Isa	**The Gap**	**Y**	Y	TEOM 1405 AS3580.9.8:2008	Neighbourhood	Mining/Smelter

Annual PM2.5 Monitoring		Active	NEPM Performance Monitoring Station	Monitoring Technique	AS/NZS 3580.1.1:2007 site classification	Sources
South East Queensland	Wynnum West	Y	N	TEOM 1405D AS3580.9.8:2008	Neighbourhood	Oil Refinery
	Springwood	Y	Y	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Road
	Jondaryan	N	N	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Coal Load-out Facility
	Wynnum	Y	N	TEOM 1405D AS3580.9.8:2008	Neighbourhood	Oil Refinery
	Lytton	Y	N	TEOM 1405D AS3580.9.8:2008	Peak	Port Operations/Oil Refinery
	Rocklea	Y	Y	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Road
	South Brisbane	Y	N	FDMS TEOM 1405DF AS3580.9.13:2013	Peak	Freeway Corridor
	Woolloongabba	Y	N	FDMS TEOM 1405DF AS3580.9.13:2013	Peak	Road Corridor
	Cannon Hill	Y	N	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Rail/Roadway/local industries
Gladstone	Boat Creek	Y	N	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Aluminium Refinery
	Targinie	Y	N	FDMS TEOM 1405DF AS3580.9.13:2013	Background	Rural
	Boyne Island	N	N	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Aluminium Smelter
	Clinton	N	N	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Airport/Coal-fired Power Station
	South Gladstone	Y	Y	FDMS TEOM 1405DF AS3580.9.13:2013	Neighbourhood	Road/Industry

The FDMS 1405-DF TEOM Monitor simultaneously measures PM Fine (PM-2.5), PM Coarse and PM-10 mass concentrations. Consisting of two Filter Dynamics Measurement Systems (FDMS) and two TEOM mass sensors housed in a single-cabinet, network-ready configuration that includes control system with touch-screen user interface. The TEOM 1405-DF distinguishes itself from other PM measurement methods by utilizing a direct mass measurement that is not subject to measurement uncertainties found in surrogate techniques. It provides a self-referencing, NIST-traceable true mass measurement.

The 1405-D TEOM Monitor is the same as the FDMS 1405-DF TEOM Monitor but does not have the FDMS option. The FDMS option provides a measure of the volatile component of the particle.

The TEOM 1405 Monitor is the same as the 1405-D TEOM Monitor but does only measures PM_{10} or $PM_{2.5}$ depending on the size selective head fitted to the instrument.

Department of Environment
and Heritage Protection

Airport Link/Northern Busway Dust Monitoring Investigation

Report on April to July 2011 monitoring

Queensland Government

Prepared by: Department of Environment and Heritage Protection

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April 2012

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Summary

An investigation of air quality in the community surrounding the Airport Link/Northern Busway construction works at Lutwyche was conducted by the former Department of Environment and Resource Management between April and July 2011. The report was commissioned following concerns raised by a resident regarding crystalline silica levels near the Lamington Avenue worksite. In response to ongoing community concerns about dust impacts arising from construction activities, the monitoring investigation was designed to obtain information on both particle and crystalline silica levels in residential areas adjacent to construction activities.

Monitoring was conducted at two locations—Lamington Avenue at the southern extent of construction works and Lutwyche Road east of the central construction area. Both monitoring sites were situated as close as possible to the construction works to obtain a measure of the highest particle levels leaving the Airport Link/Northern Busway construction area.

Monitoring conducted by the department between April and July 2011 found that ambient particle concentrations predominantly complied with the Queensland Environmental Protection (Air) Policy 2008 (EPP Air) 24-hour average air quality objectives for particles. PM_{10} (particles less than 10 micrometres (µm) in diameter) levels only exceeded the EPP Air objective of 50 µg/m^3 on one day at the Lutwyche Road site during the investigation period. On this day strong westerly winds contributed to higher than normal levels of windblown dust from exposed ground and earthworks. While discrete 24-hour PM_{10} sampling was not conducted at the Lamington Avenue monitoring site, compliance with the 24-hour PM_{10} objective can be deduced from the seven-day average PM_{10} concentrations measured at this site.

$PM_{2.5}$ levels were found to comply with the EPP Air 24-hour average objective of 25 µg/m^3 over the entire monitoring period at the Lutwyche Road monitoring site. As with PM_{10}, $PM_{2.5}$ (particles less than 2.5 µm in diameter) levels at the Lamington Avenue monitoring site will have complied with the EPP Air 24-hour objective based on the low seven-day average $PM_{2.5}$ concentrations measured at this site. Average $PM_{2.5}$ concentrations over the period April to July 2011 were higher than the EPP Air annual average objective of 8 µg/m^3 at both monitoring sites. However, further monitoring is necessary before non-compliance with the annual objective can be adequately assessed.

In the absence of Queensland or national ambient air quality standards, crystalline silica concentrations have been assessed against the ambient crystalline silica criterion contained in the Victorian Government's Protocol for Environmental Management for Mining and Extractive Industries (PEMMEI). Average crystalline silica concentrations over the investigation period were less than 50 per cent of the Victorian annual average criterion value of 3 µg/m^3 at the Lutwyche Road monitoring site and less than 20 per cent of the criterion value at the Lamington Avenue monitoring site. At these levels, crystalline silica exposure in the surrounding community is expected to comply with the Victoria criterion for protection of human health over a 12-month period.

During the investigation period there was a high frequency of winds blowing from the direction of Lutwyche Road and the Airport Link/Northern Busway construction works towards the Lutwyche Road monitoring site. As a result, particle and crystalline silica levels measured at this site were representative of worst-case conditions in the surrounding community during the period of monitoring. There was a low incidence of winds blowing from construction areas towards the Lamington Avenue monitoring site and measured levels at this location were not indicative of worst-case conditions.

Monitoring has identified the Airport Link/Northern Busway construction works as an additional contributor to ambient particle and crystalline silica in the surrounding community. Analysis of the relationship between particle and crystalline silica levels and wind direction found that higher pollutant levels at the Lutwyche monitoring sites were associated with winds blowing from the direction of Lutwyche Road and the Airport Link/Northern Busway construction area. Higher average PM_{10} and $PM_{2.5}$ concentrations at the Lutwyche monitoring sites compared to those measured at the department's roadside monitoring sites at Woolloongabba and South Brisbane over the same period indicate the contribution of additional local particle sources in addition to emissions from motor vehicles travelling along Lutwyche Road.

The department will continue monitoring at the Lutwyche Road monitoring site until construction of the Airport Link/Northern Busway is completed in June 2012 to provide ongoing assessment of the environmental performance of the project in relation to PM_{10} emissions as required by the Coordinator-General's conditions, and to assess performance against the annual air quality objectives for $PM_{2.5}$ and crystalline silica.

Introduction

The Airport Link is a toll road under construction in the northern suburbs of Brisbane to link the Brisbane central business district and existing Clem Jones Tunnel with the East–West Arterial Road leading to the Brisbane Airport. Much of the Airport Link will be an underground tunnel. The Northern Busway is a two-lane road for buses only. It connects the Inner Northern Busway at the Royal Brisbane and Women's Hospital in Herston, to Kedron via the Lutwyche Road corridor. The Windsor to Kedron section of the Northern Busway is being constructed in conjunction with the Airport Link infrastructure. The project is expected to be completed in June 2012.

There have been many complaints from residents living in the vicinity of the Airport Link/Northern Busway construction works in relation to a range of amenity issues in the surrounding community—including dust and noise impacts resulting from construction activities. Another concern that has been raised is the possible health risk posed by the presence of airborne silica in ambient air in the surrounding community resulting from construction works.

Under the conditions imposed on the construction of the Airport Link/Northern Busway Project by the Coordinator-General, Theiss John Holland (the joint venture undertaking the design and construction of the project) is required to conduct sampling of dust deposition and real-time respiratory dust (PM_{10}) at a number of locations nominated by the Coordinator-General. The project must be managed to ensure that dust deposition and PM_{10} levels at the nominated locations do not exceed the goals specified by the Coordinator-General.

In response to the concern regarding exposure to airborne silica and ongoing community concerns about dust impacts as a result of activities taking place on the Airport Link/Northern Busway construction site, the department undertook to conduct a separate three-month particle monitoring program at two sites located in residential areas adjacent to the construction site at Lutwyche. Included in the department's monitoring program was the measurement of airborne $PM_{2.5}$ and silica levels, two pollutants that Theiss John Holland are not required to monitor under the Coordinator-General's conditions.

This report summarises the particle and crystalline silica monitoring results obtained by the department for the period from mid-April to the end of July 2011.

Monitoring program design

The potential health effects of dust are closely related to particle size. The size range of airborne particles varies from less than 0.1 µm up to about 500 µm or half a millimetre. Human health effects of airborne dust are mainly associated with particles less than 10 µm in size (commonly termed PM_{10}), which are small enough to be inhaled into the lower respiratory tract. The composition of, or contaminants present in, the particles may also be of concern.

The department's dust monitoring program at the Airport Link/Northern Busway construction works between April and July 2011 focused on acquiring data on two particle size fractions and levels of crystalline silica in the dust. The monitoring program collected information on:

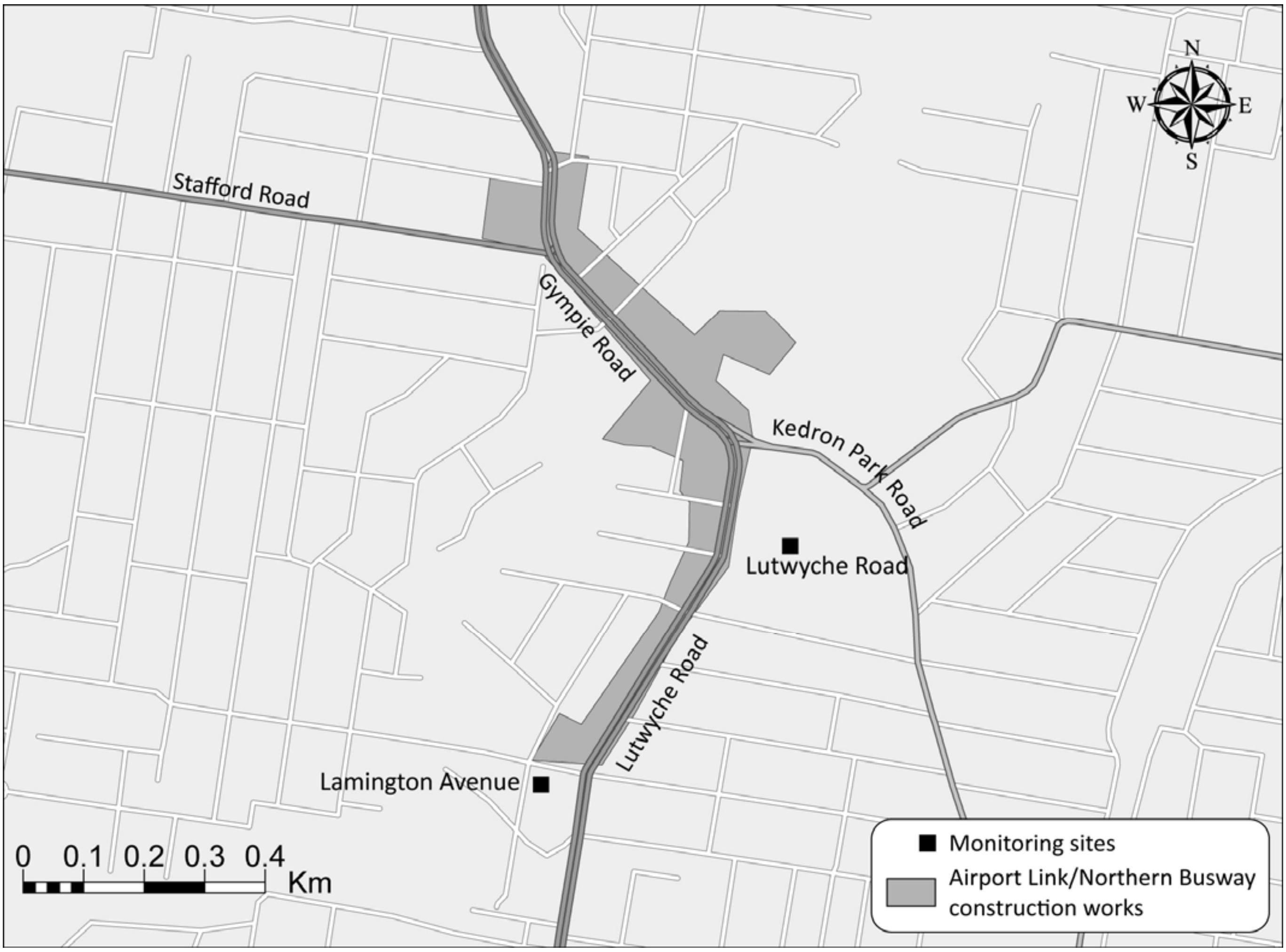
- PM_{10} levels—for assessment against criteria based on health
- $PM_{2.5}$ levels—for assessment against criteria based on health
- crystalline silica levels in both PM_{10} and $PM_{2.5}$ particles—for assessment against criteria based on health.

PM_{10} results were compared with the Queensland Environmental Protection (Air) Policy 2008 (EPP Air) 24-hour air quality objective of 50 µg/m^3. $PM_{2.5}$ results were compared with the EPP Air annual objective of 8 µg/m^3 and 24-hour objective of 25 µg/m^3. In the absence of an EPP Air objective for crystalline silica, measured crystalline silica levels were compared against the annual assessment criterion of 3 µg/m^3 (as $PM_{2.5}$) set in the Victorian Government's PEMMEI.

The locations of the two monitoring sites at Lutwyche are shown in Figure 1. The Lamington Avenue monitoring site was located at the property of a concerned resident adjacent to the southern end of construction works and operated from 16 April 2011. The Lutwyche Road monitoring site was located within the grounds of the St Andrew's Church east of the central construction works area and operated from 28 April 2011.

Both monitoring sites were situated as close as possible to the construction works to obtain a measure of the highest particle levels leaving the Airport Link/Northern Busway construction area.

Figure 1: Map showing the location of the Lamington Avenue and Lutwyche Road monitoring sites in relation to the Airport Link/Northern Busway construction works.



PM_{10} is the term given to the fraction of total particles suspended in the air having diameters less than 10 µm. PM_{10} particles pose a hazard to human health because they are small enough to pass through the filtration mechanisms in the upper respiratory tract and penetrate beyond the larynx to the lower airways. PM_{10} particles can arise from combustion processes (e.g. motor vehicle engines) and mechanical processes (e.g. rock crushing, windblown dust).

$PM_{2.5}$ is the term given to the fraction of total particles suspended in the air having diameters less than 2.5 micrometres. There is an increasing body of evidence to suggest that, of the total PM_{10} fraction of airborne particles, the $PM_{2.5}$ particles may be the major area of concern with regard to adverse effects on human health. $PM_{2.5}$ particles arise predominantly from combustion processes (e.g. motor vehicle engines).

Two techniques were used to measure PM_{10} and $PM_{2.5}$ particles during the monitoring period. PM_{10} and $PM_{2.5}$ sampling was conducted using dichotomous Partisol® Model 2025 sequential low-volume air samplers at the Lamington Avenue and Lutwyche Road monitoring sites. These samplers were operated in accordance with Australian/New Zealand Standard AS/NZS 3580.9.10:2006 Method 9.10: Determination of suspended particulate matter–$PM_{2.5}$ low-volume sampler–Gravimetric method. The sequential air samplers operated by drawing air through a PM_{10} size-selective inlet (to remove particles larger than 10 µm) followed by further separation into two particle streams, one containing particles less than 2.5 µm in diameter and the other containing particles between 2.5 µm and 10 µm in diameter.

The separated particle streams were then deposited on separate pre-weighed 47 mm diameter Teflon® filters over a seven-day period. After sampling, the filters were again weighed, with the difference in weight being the mass of $PM_{2.5}$ or $PM_{2.5\text{-}10}$ particles collected. PM_{10} particle mass was the sum of the $PM_{2.5}$ and $PM_{2.5\text{-}10}$ particle masses. The $PM_{2.5}$ and PM_{10} mass concentrations were calculated by dividing the mass of particles collected by the volume of air drawn through the sampler. The sample collection was carried out by departmental staff and the gravimetric analysis was carried out by the Queensland Government Safety in Mines, Testing and Research Station (Simtars). In addition to obtaining information on PM_{10} and $PM_{2.5}$ levels, the particle matter collected by these samplers was analysed for crystalline silica content. Sample collection was conducted over seven days to collect sufficient particle matter for the crystalline silica analysis.

At the Lutwyche Road monitoring site, 30-minute averaged PM_{10} and $PM_{2.5}$ measurements were also collected using a dichotomous TEOM® (tapered element oscillating microbalance) analyser operated in accordance with Australian Standard AS 3580.9.8:2008 Method 9.8. Determination of suspended particulate matter—PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser. The analyser drew air through a PM_{10} size-selective inlet (to remove particles larger than 10 µm) followed by further separation into two particle streams, one containing particles less than 2.5 µm in diameter and the other containing particles between 2.5 µm and 10 µm in diameter. The separated particle streams then passed through separate filters mounted on vibrating glass tubes. Particle mass was measured by the change in the oscillating frequency of each glass tube following particle deposition on the filter. PM_{10} was calculated as the sum of simultaneous mass measurements from both particle streams. The information provided by the dichotomous TEOM® sampler permitted assessment to be made against the EPP Air 24-hour average air quality objectives for PM_{10} and $PM_{2.5}$, and also assisted in identification of the contribution of different particle sources to overall particle levels at the monitoring site.

While silica can exist in both crystalline and non-crystalline forms, only exposure to crystalline silica is associated with adverse health effects. In this investigation crystalline silica was measured in both the $PM_{2.5}$ and PM_{10} particle fractions. Analysis of the crystalline silica content of the particles collected on the Partisol® sampler filters was determined by infrared spectroscopy using a method based on Methods for Measurement of Quartz in Respirable Airborne Dust by Infrared Spectroscopy and X-Ray Diffractometry, National Health and Medical Research Council 1984 and NIOSH Method 7602 Silica, Crystalline by IR (KBr pellet). The crystalline silica analysis was carried out by Simtars.

For this investigation it was necessary to use ambient particle samplers designed for continuous outdoor use which were not capable of collecting the respirable particle fraction (particles less than 4 µm in diameter, or PM_4) commonly sampled in occupational exposure monitoring. To obtain an approximation of respirable crystalline silica levels, determination of the crystalline silica content of both the $PM_{2.5}$ and PM_{10} particle fractions was undertaken. Respirable crystalline silica levels will lie between the measured $PM_{2.5}$ crystalline silica concentrations and the measured PM_{10} crystalline silica concentrations.

To assist with the determination of the contribution of road construction works to overall particle levels, wind speed and direction measurements averaged over 30-minute periods were recorded at the Lutwyche Road monitoring site. The wind sensor was located at a height of 6 m above ground level.

Results and discussion

Meteorology

Wind direction was a critical factor in the measurement of dust impacts from road construction works at the monitoring sites. For dust generated by Airport Link/Northern Busway construction works to impact the Lamington Avenue monitoring site, the wind direction had to be between north and north-east (see Figure 1). For the Lutwyche Road monitoring site, the wind direction had to be between south-west and north. A summary of the wind characteristics during the monitoring period is provided in Table 1.

There was a low incidence of winds favourable for measurement of dust impacts from construction works at the Lamington Avenue monitoring site between April and July 2011. Winds from the direction of construction works only accounted for between zero and 10 per cent of all winds during weekly sampling periods at this site. Particle measurements obtained during the monitoring period were likely to be non-representative of worst-case conditions.

There was a high incidence of winds favourable for measurement of dust impacts from construction works at the Lutwyche Road monitoring site between April and July 2011. Winds from the direction of construction works made up 35–81 per cent of all winds during weekly sampling periods at this site. Particle measurements obtained during the monitoring period were likely to representative of worst-case conditions.

Rainfall was another factor influencing the outcome of the investigation through possible dust suppression. Daily rainfall information was available from the Bureau of Meteorology rainfall recording site at Eagle Farm (approximately 4 km east of the monitoring site) and has been summarised in Table 1. Rainfall of up to 30 mm occurred during weekly sampling periods in April and May, however there was very little rain recorded during June and July. It is unlikely that measured particle concentrations, particularly in the latter half of the monitoring period, would have been suppressed to a significant degree by rainfall events during the monitoring period.

Table 1: Wind and rainfall conditions during the Airport Link/Northern Busway dust monitoring investigation from April to July 2011.

Sampling period	Winds from direction of Airport Link/Northern Busway construction works						Rain (mm)
	Lamington Avenue monitoring site			Lutwyche Road monitoring site			
	Proportion of winds (%)	Average wind speed (m/s)	Maximum wind speed (m/s)	Proportion of winds (%)	Average wind speed (m/s)	Maximum wind speed (m/s)	
16 April to 22 April	7.4	0.9	1.8	Monitoring site not operational			28.0
23 April to 29 April	0.0	-	-	Monitoring site not operational			31.5
30 April to 6 May	6.5	0.7	1.3	55.7	0.5	3.4	16.0
7 May to 13 May	8.3	0.6	1.3	75.3	1.0	3.1	6.0
14 May to 20 May	0.9	0.2	0.3	38.1	0.6	1.6	2.0
21 May to 27 May	9.5	0.4	0.9	67.0	1.1	3.3	31.0
28 May to 3 June	3.0	0.5	1.0	54.5	0.5	1.3	8.5
4 June to 10 June	3.9	0.3	0.8	76.5	0.8	2.5	0.0
11 June to 17 June	1.8	0.3	0.7	81.0	1.1	4.2	3.0
18 June to 24 June	4.8	0.5	1.0	75.3	1.1	2.9	0.0
25 June to 1 July	1.2	0.5	0.8	34.5	0.4	1.2	3.0
2 July to 8 July	6.5	0.6	1.0	69.0	1.3	3.4	0.0
9 July to 15 July	8.3	0.4	0.9	63.4	1.2	3.1	10.0
16 July to 22 July	1.2	0.1	0.3	72.9	1.3	3.2	0.0
23 July to 29 July	8.9	0.6	1.2	53.0	0.5	1.5	0.0
30 July to 5 August†	2.1	0.6	1.0	45.5	0.5	0.9	0.0

PM_{10}

The 24-hour average PM_{10} monitoring results obtained from the TEOM® instrument at the Lutwyche Road monitoring site are displayed graphically in Figure 2 and summarised in Table 2. The highest 24-hour average PM_{10} concentration was 50.2 µg/m^3. The average PM_{10} concentration over the period April to July 2011 was 24.0 µg/m^3.

The EPP Air 24-hour air quality objective for PM_{10} particles is 50 µg/m^3. During the investigation period only one exceedence of the EPP Air objective was measured at the Lutwyche Road monitoring site on 21 June 2011. The PM_{10} concentration on this day was 50.2 µg/m^3 (100.4 per cent of the EPP Air objective).

The PM_{10} concentrations measured at the Lutwyche Road monitoring site were higher than the corresponding values recorded at the roadside monitoring sites on Ipswich Road at Woolloongabba and adjacent to the South-East Freeway at South Brisbane (Figure 2 and Table 2).

Figure 2: 24-hour average PM_{10} concentrations at the Lutwyche Road monitoring site and at roadside monitoring sites at Woolloongabba and South Brisbane, April to July 2011.

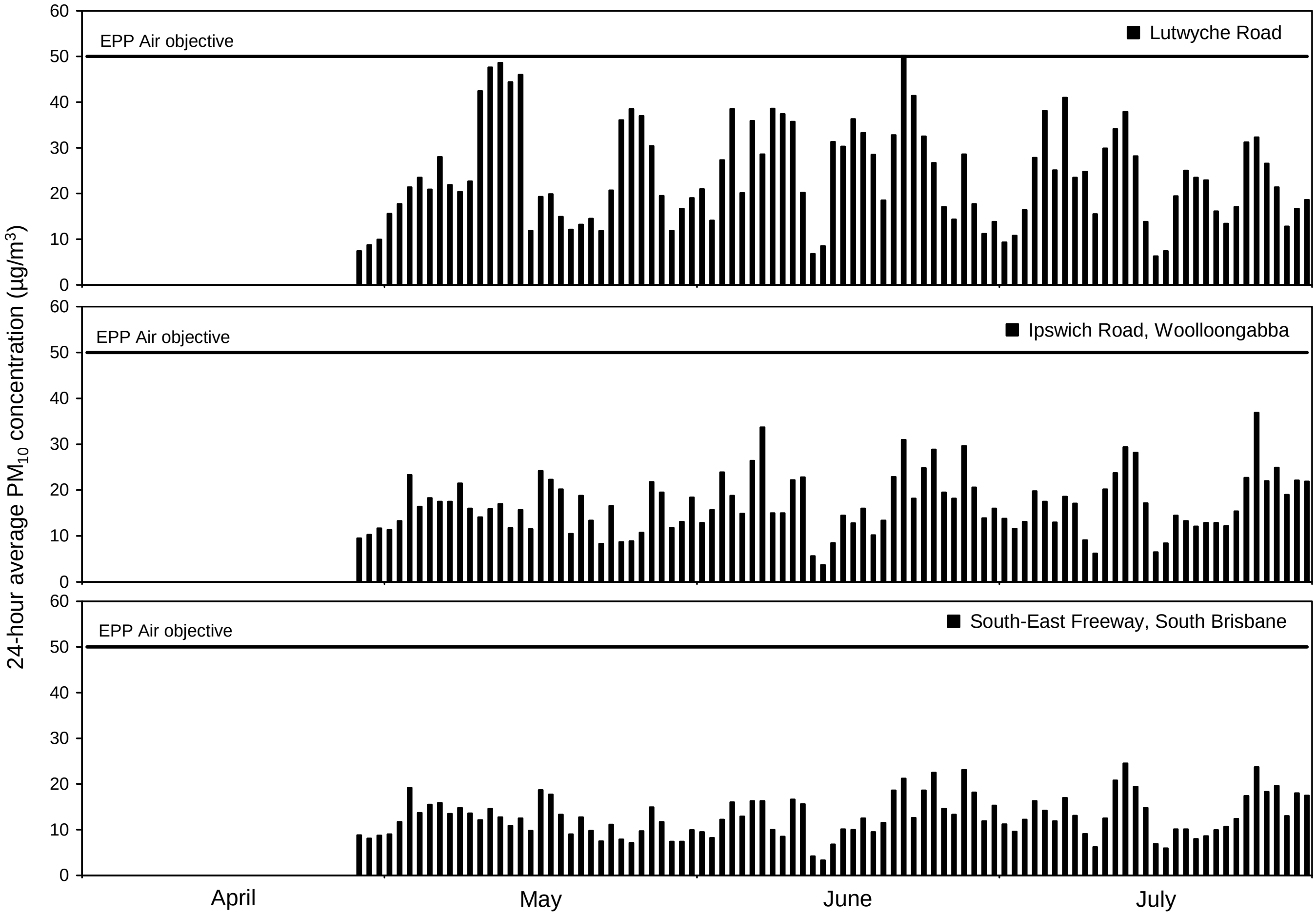


Table 2: 24-hour average PM_{10} concentration statistics at the Lutwyche Road monitoring site and roadside monitoring sites at Woolloongabba and South Brisbane, 28 April to 31 July 2011.

Monitoring site	Maximum concentration (µg/m^3)	Average concentration (µg/m^3)	Median concentration (µg/m^3)	Minimum concentration (µg/m^3)	Number of 24-hour values
Lutwyche Road Lutwyche	50.2	24.0	21.4	6.3	95
Ipswich Road Woolloongabba	36.9	16.9	16.0	3.7	95
South-East Freeway South Brisbane	24.5	12.9	12.5	3.3	95

Days when the 24-hour average PM_{10} concentration at the Lutwyche Road monitoring site was greater than 40 µg/m^3 were generally characterised by an extended period of low rainfall and strong westerly winds, which would have carried wind blown dust from exposed ground and earthworks on the construction site over the monitoring site.

The seven-day average PM_{10} monitoring results obtained from the Partisol® instruments at the Lamington Avenue and Lutwyche Road monitoring sites are displayed graphically in Figure 3 and summarised in Table 3. The highest seven-day average PM_{10} concentration at the Lamington Avenue monitoring site was 18.0 µg/m^3 and the average PM_{10} concentration over the period April to July 2011 was 12.3 µg/m^3. The highest seven-day average PM_{10}

concentration at the Lutwyche Road monitoring site was 27.6 µg/m^3 and the average PM_{10} concentration over the period April to July 2011 was 20.0 µg/m^3.

Figure 3: Seven-day average PM_{10} concentrations at the Lamington Avenue and Lutwyche Road monitoring sites, April to July 2011.

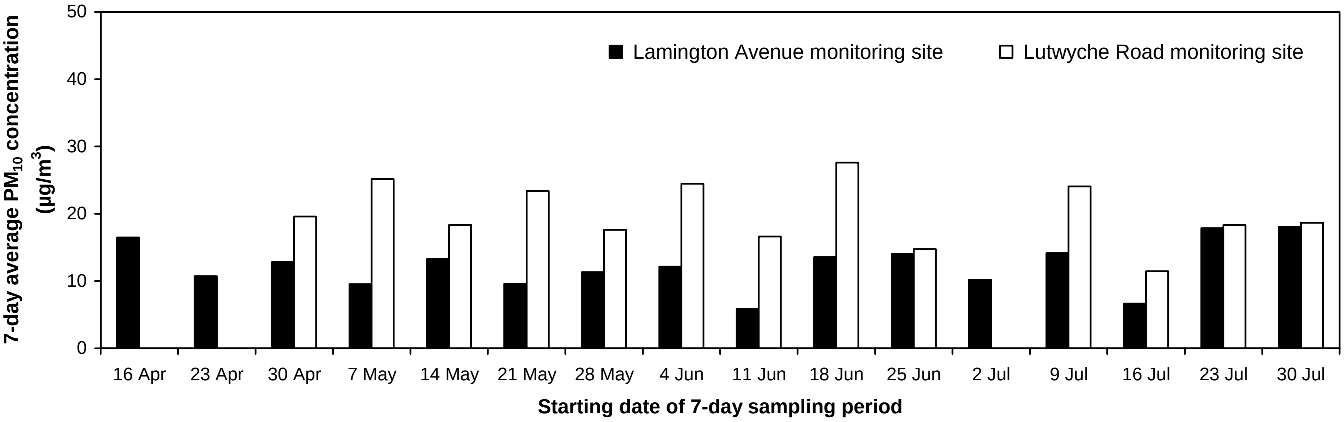


Table 3: Seven-day average PM_{10} monitoring results at the Lamington Avenue and Lutwyche Road monitoring sites, April to July 2011.

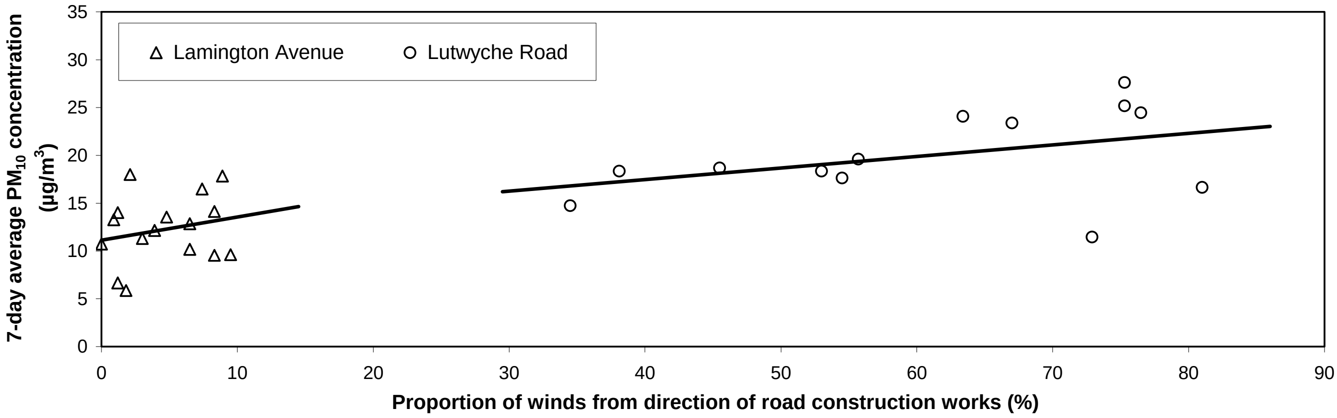
Sampling period	Lamington Avenue monitoring site		Lutwyche Road monitoring site		Rainfall during sampling period (mm)
	Seven-day average PM_{10} concentration (µg/m^3)	Proportion of winds from direction of construction works (%)	Seven-day average PM_{10} concentration (µg/m^3)	Proportion of winds from direction of construction works (%)	
16 April to 22 April	16.5	7.4	Monitoring site not operational		28.0
23 April to 29 April	10.7	0.0	Monitoring site not operational		31.5
30 April to 6 May	12.9	6.5	19.6	55.7	16.0
7 May to 13 May	9.5	8.3	25.2	75.3	6.0
14 May to 20 May	13.3	0.9	18.3	38.1	2.0
21 May to 27 May	9.6	9.5	23.4	67.0	31.0
28 May to 3 June	11.3	3.0	17.6	54.5	8.5
4 June to 10 June	12.2	3.9	24.5	76.5	0.0
11 June to 17 June	5.9	1.8	16.6	81.0	3.0
18 June to 24 June	13.5	4.8	27.6	75.3	0.0
25 June to 1 July	14.0	1.2	14.7	34.5	3.0
2 July to 8 July	10.2	6.5	Sampler did not run due to power failure		0.0
9 July to 15 July	14.1	8.3	24.1	63.4	10.0
16 July to 22 July	6.7	1.2	11.5	72.9	0.0
23 July to 29 July	17.8	8.9	18.3	53.0	0.0
30 July to 5 August†	18.0	2.1	18.7	45.5	0.0
† Sampling at the Lamington Avenue monitoring site concluded at 10 am on 4 August 2011.					

As discrete 24-hour PM_{10} samples were not collected at the Lamington Avenue monitoring site, it is not possible to directly compare measured PM_{10} concentrations against the EPP Air 24-hour objective at this site. However, the fact that seven-day average PM_{10} concentrations at this site were lower than the corresponding seven-day average measurements at the Lutwyche Road site suggests that PM_{10} levels would not have exceeded the EPP Air objective at the Lamington Avenue site between April and July 2011.

The PM_{10} measurements obtained by the department at the Lutwyche Road monitoring site are considered to be representative of worst-case conditions at this site during the monitoring period as the incidence of winds blowing from Lutwyche Road and the Airport Link/Northern Busway construction site towards the sampling equipment was around 60 per cent across the monitoring period and up to 80 per cent for individual sampling periods. In contrast, the PM_{10} measurements obtained at the Lamington Avenue monitoring site are unlikely to be representative of worst-case conditions at this site as the incidence of winds blowing from the Airport Link/Northern Busway construction site towards the sampling equipment was consistently below ten per cent across the monitoring period.

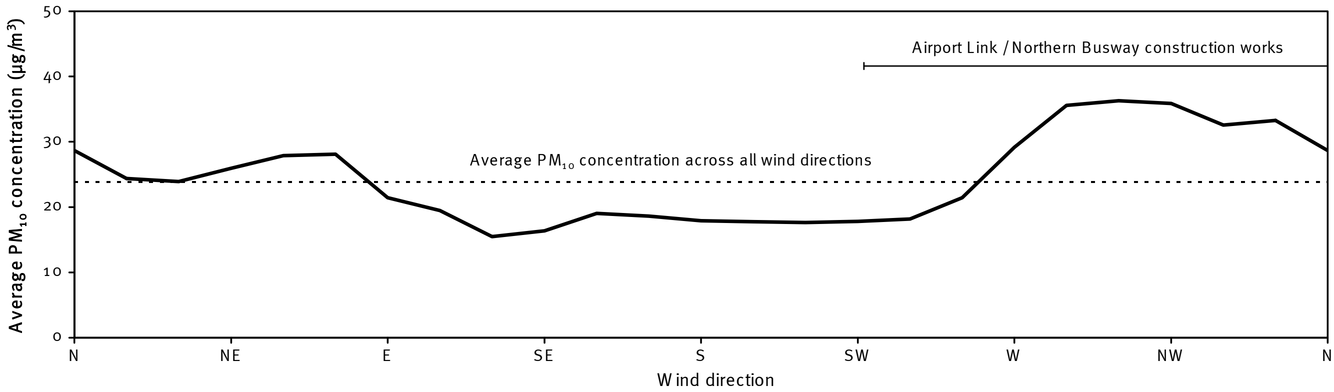
The relationship between seven-day PM_{10} concentrations and the proportion of winds blowing from the direction of the Airport Link/Northern Busway construction works towards the monitoring sites during the sampling period is plotted in Figure 4. At both monitoring sites there was a trend towards increasing PM_{10} concentrations with higher proportion of winds coming from the direction of Lutwyche Road and construction works during the sampling period (shown by the heavy lines in Figure 4).

Figure 4: Relationship between seven-day average PM_{10} concentrations and proportion of winds from the direction of the Airport Link/Northern Busway construction works at the Lamington Avenue and Lutwyche Road monitoring sites, April to July 2011.



The availability of continuous 30-minute averaged TEOM® PM_{10} and wind measurements at the Lutwyche Road monitoring site allowed a more in-depth analysis of the relationship between wind direction and PM_{10} levels at this site. Using the complete PM_{10} dataset from April to July 2011, average PM_{10} concentrations for discrete 15 degree wind direction ranges were calculated to determine if higher PM_{10} concentrations were associated with winds from a particular direction. Figure 5 displays the relationship between the PM_{10} concentrations for each 15 degree wind direction range and the average PM_{10} concentration across all wind directions (shown by the dotted line in Figure 5). It can be seen that PM_{10} levels higher than the overall average PM_{10} concentration were largely associated with winds in the west to north quadrant, which coincided with winds coming from the direction of Lutwyche Road and the Airport Link/Northern Busway construction works.

Figure 5: Average PM_{10} concentrations for 15 degree wind direction ranges at the Lutwyche Road monitoring site, April to July 2011.



These results indicate that construction activities associated with the Airport Link/Northern Busway project do contribute to PM_{10} concentrations at the two monitoring site locations. However, it is not possible to quantify the contribution from road construction works compared to that from other PM_{10} sources such as emissions from motor vehicles travelling along Lutwyche Road. Comparison of PM_{10} concentrations measured at the two Lutwyche monitoring sites with the levels measured at other roadside monitoring sites in Brisbane (Table 2) shows that average PM_{10} concentrations measured adjacent to the Airport Link/Northern Busway construction works were seven to 11 µg/m^3 higher than at the other roadside monitoring sites.

$PM_{2.5}$

The 24-hour average $PM_{2.5}$ monitoring results obtained from the TEOM® instrument at the Lutwyche Road monitoring site are displayed graphically in Figure 6 and summarised in Table 4. The highest 24-hour average $PM_{2.5}$ concentration was 21.2 µg/m^3. The average $PM_{2.5}$ concentration over the period April to July 2011 was 11.0 µg/m^3.

The EPP Air 24-hour air quality objective for $PM_{2.5}$ particles is 25 µg/m^3. During the investigation period no exceedences of the EPP Air 24-hour objective were measured at the Lutwyche Road monitoring site.

The EPP Air annual air quality objective for $PM_{2.5}$ particles is 8 µg/m^3. While the average $PM_{2.5}$ concentration over the period from April to July 2011 (11.0 µg/m^3) was higher than the annual average EPP Air objective, the period of monitoring is too short to determine if the objective would be exceeded over a 12-month period—as data for at least 75 per cent of the averaging period (or nine months) is required to undertake a valid assessment of compliance with the objective[1].

[1] National Environment Protection (Ambient Air Quality) Measure Technical Paper No. 5—Data Collection and Handling, available from <www.ephc.gov.au/sites/default/files/AAQPRC_TP__05_Data_Collection_200105_Final.pdf>.

Figure 6: 24-hour average $PM_{2.5}$ concentrations at the Lutwyche Road monitoring site and roadside monitoring sites at Woolloongabba and South Brisbane, April to July 2011.

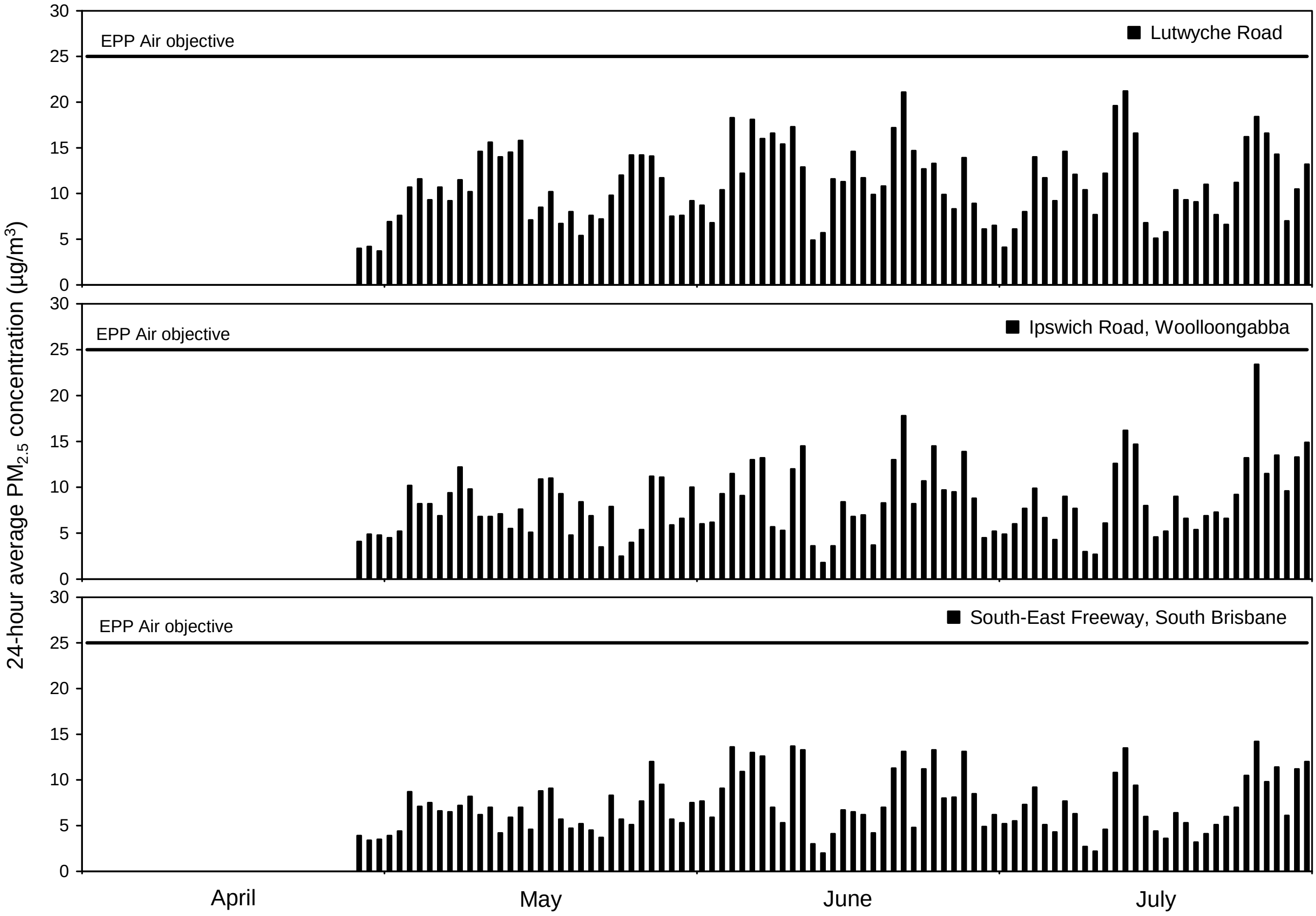


Table 4: 24-hour average $PM_{2.5}$ concentration statistics at the Lutwyche Road monitoring site and roadside monitoring sites at Woolloongabba and South Brisbane, 28 April to 31 July 2011.

Monitoring site	Maximum concentration (µg/m^3)	Average concentration (µg/m^3)	Median concentration (µg/m^3)	Minimum concentration (µg/m^3)	Number of 24-hour values
Lutwyche Road Lutwyche	21.2	11.0	10.7	3.7	95
Ipswich Road Woolloongabba	23.4	8.3	7.7	1.8	95
South-East Freeway South Brisbane	14.2	7.2	6.5	2.0	95

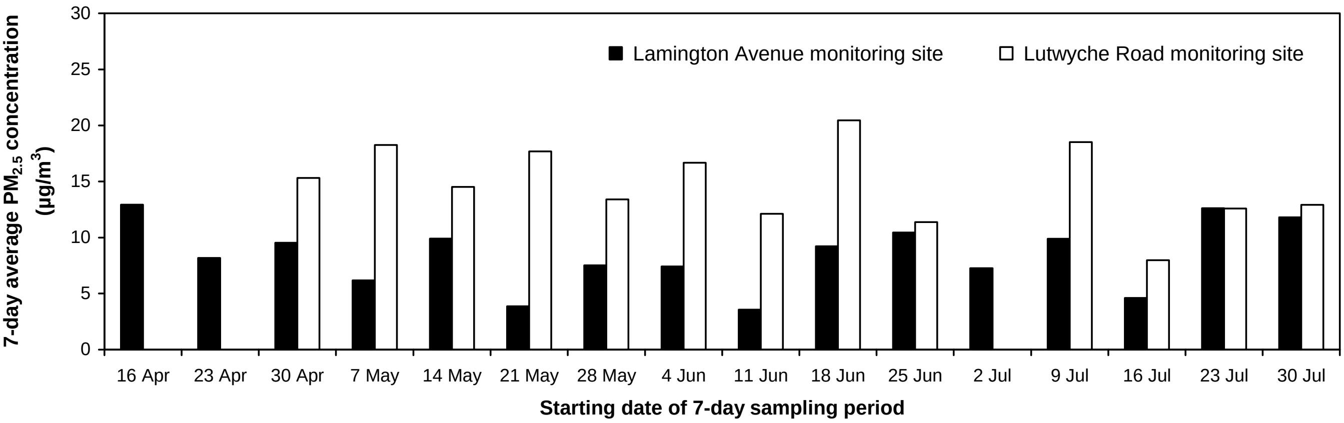
The $PM_{2.5}$ concentrations measured at the Lutwyche Road monitoring site were generally higher than the corresponding values recorded at the DERM roadside monitoring sites on Ipswich Road at Woolloongabba and adjacent to the South-East Freeway at South Brisbane (Table 4).

The seven-day average $PM_{2.5}$ monitoring results obtained from the Partisol® instruments at the Lamington Avenue and Lutwyche Road monitoring sites are summarised in Table 5 and displayed graphically in Figure 7. The highest seven-day average $PM_{2.5}$ concentration at the Lamington Avenue monitoring site was 12.9 µg/m^3 and the average $PM_{2.5}$ concentration over the period April to July 2011 was 8.4 µg/m^3. The highest seven-day average $PM_{2.5}$ concentration at the Lutwyche Road monitoring site was 20.5 µg/m^3 and the average $PM_{2.5}$ concentration over the period April to July 2011 was 14.8 µg/m^3.

Table 5: Seven-day average $PM_{2.5}$ monitoring results at the Lamington Avenue and Lutwyche Road monitoring sites, April to July 2011.

Sampling period	Lamington Avenue monitoring site		Lutwyche Road monitoring site		Rainfall during sampling period (mm)
	Seven-day average $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of construction works (%)	Seven-day average $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of construction works (%)	
16 April to 22 April	12.9	7.4	Monitoring site not operational		28.0
23 April to 29 April	8.2	0.0	Monitoring site not operational		31.5
30 April to 6 May	9.5	6.5	15.3	55.7	16.0
7 May to 13 May	6.2	8.3	18.3	75.3	6.0
14 May to 20 May	9.9	0.9	14.5	38.1	2.0
21 May to 27 May	3.9	9.5	17.7	67.0	31.0
28 May to 3 June	7.5	3.0	13.4	54.5	8.5
4 June to 10 June	7.4	3.9	16.7	76.5	0.0
11 June to 17 June	3.6	1.8	12.1	81.0	3.0
18 June to 24 June	9.2	4.8	20.5	75.3	0.0
25 June to 1 July	10.4	1.2	11.4	34.5	3.0
2 July to 8 July	7.3	6.5	Sampler did not run due to power failure		0.0
9 July to 15 July	9.9	8.3	18.5	63.4	10.0
16 July to 22 July	4.6	1.2	8.0	72.9	0.0
23 July to 29 July	12.6	8.9	12.6	53.0	0.0
30 July to 5 August†	11.8	2.1	12.9	45.5	0.0
† Sampling at the Lamington Avenue monitoring site concluded at 10 am on 4 August 2011.					

Figure 7: Seven-day average $PM_{2.5}$ concentrations at the Lamington Avenue and Lutwyche Road monitoring sites, April to July 2011.



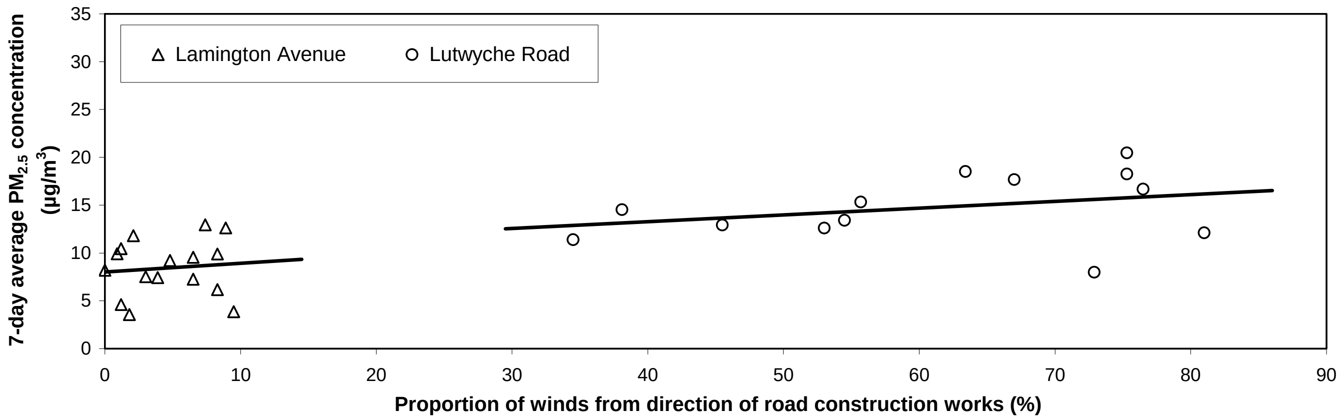
As discrete 24-hour $PM_{2.5}$ samples were not collected at the Lamington Avenue monitoring site, it is not possible to directly compare measured $PM_{2.5}$ concentrations against the EPP Air 24-hour objective at this site. However, the fact that seven-day average $PM_{2.5}$ concentrations at this site were lower than the corresponding seven-day average measurements at the Lutwyche Road site suggests that $PM_{2.5}$ levels would not have exceeded the EPP Air 24-hour objective at the Lamington Avenue site between April and July 2011.

At both monitoring sites the average $PM_{2.5}$ concentration over the monitoring period was greater than the EPP Air annual objective value of 8 µg/m^3. However, as described above for the TEOM® sampler results, the period of monitoring is too short to determine if the annual objective would be exceeded over a full 12-month period.

The $PM_{2.5}$ measurements obtained by DERM at the Lutwyche Road monitoring site are representative of worst-case conditions at this site during the monitoring period. This is because the incidence of winds blowing from Lutwyche Road and the Airport Link/Northern Busway construction site towards the sampling equipment was around 60 per cent across the monitoring period and up to 80 per cent for individual sampling periods. In contrast, the $PM_{2.5}$ measurements obtained at the Lamington Avenue monitoring site are unlikely to be representative of worst-case conditions at this site. The incidence of winds blowing from Lutwyche Road and the Airport Link/Northern Busway construction site towards the sampling equipment was consistently below 10 per cent across the monitoring period.

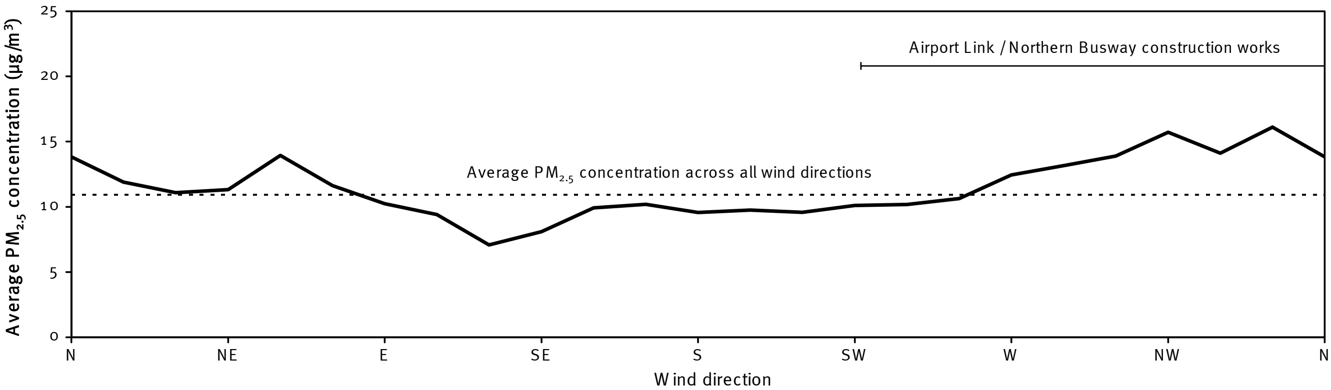
The relationship between seven-day $PM_{2.5}$ concentrations and the proportion of winds blowing from the direction of the Airport Link/Northern Busway construction works towards the monitoring sites during the sampling period is plotted in Figure 8. At both monitoring sites there was a trend towards increasing $PM_{2.5}$ concentrations with higher proportion of winds coming from the direction of construction works during the sampling period (shown by the heavy lines in Figure 8).

Figure 8: Relationship between seven-day average $PM_{2.5}$ concentrations and proportion of winds from the direction of the road construction works at the Lamington Avenue and Lutwyche Road monitoring sites, April to July 2011.



The availability of continuous 30-minute averaged TEOM® $PM_{2.5}$ and wind measurements at the Lutwyche Road monitoring site allowed a more in-depth analysis of the relationship between wind direction and $PM_{2.5}$ levels at this site. Using the complete $PM_{2.5}$ dataset from April to July 2011, average $PM_{2.5}$ concentrations for discrete 15 degree wind direction ranges were calculated to determine if higher $PM_{2.5}$ concentrations were associated with winds from a particular direction. Figure 9 displays the relationship between the $PM_{2.5}$ concentrations for each 15 degree wind direction range and the average $PM_{2.5}$ concentration across all wind directions (shown by the dotted line in Figure 9). It can be seen that $PM_{2.5}$ levels higher than the overall average $PM_{2.5}$ concentration were largely associated with winds in the west to north quadrant, which coincided with winds coming from the direction of Lutwyche Road and the Airport Link/Northern Busway construction works.

Figure 9: Average $PM_{2.5}$ concentrations for 15 degree wind direction ranges at the Lutwyche Road monitoring site, April to July 2011.



These results point to construction activities associated with the Airport Link/Northern Busway project contributing to overall $PM_{2.5}$ concentrations at the two monitoring site locations. However, it is not possible to quantify the contribution from road construction works compared to that from other $PM_{2.5}$ sources such as emissions from motor vehicles travelling along Lutwyche Road. Comparison of $PM_{2.5}$ concentrations measured at the two Lutwyche monitoring sites with the levels measured at other roadside monitoring sites in Brisbane (Table 4) shows that average $PM_{2.5}$ concentrations measured adjacent to the Airport Link/Northern Busway construction works were three to 4 $\mu g/m^3$ higher than at the other roadside monitoring sites.

Differences in the profile of the particle and wind direction plots for PM_{10} and $PM_{2.5}$ at the Lutwyche Road monitoring site suggest that road construction activities make a greater contribution to ambient PM_{10} concentrations than to ambient $PM_{2.5}$ concentrations. The slope of the PM_{10} seven-day trend line (Figure 4) is approximately twice the slope of the $PM_{2.5}$ seven-day trend line (Figure 8). West to north winds are associated with a greater fraction of total PM_{10} (Figure 5) than is the case for $PM_{2.5}$ (Figure 9). These observations are consistent with the general understanding that the particles generated by mechanical processes such as earthworks are predominantly greater than 2.5 µm in diameter, while particles emitted by combustion processes are generally less than 2.5 µm in diameter. Dust emissions from the Airport Link/Northern Busway construction works are expected to impact to a greater degree on PM_{10} rather than $PM_{2.5}$ levels, which seems to be borne out in the monitoring results obtained by the department. Emissions from motor vehicles using Lutwyche Road and other surrounding roads are likely to be a major source of $PM_{2.5}$ particles at the monitoring sites, an assumption which is supported by the fact that there is less variation in average $PM_{2.5}$ concentrations with wind direction (Figure 9) than is the case for PM_{10} (Figure 5).

Crystalline silica

The amount of airborne crystalline silica present at the monitoring sites was determined by spectroscopic analysis of the particles collected on the Partisol® low-volume sampler filters. The seven-day average PM_{10} and $PM_{2.5}$ crystalline silica monitoring results obtained at the Lamington Avenue and Lutwyche Road monitoring sites are summarised in Table 6.

Table 6: Seven-day average PM_{10} and $PM_{2.5}$ crystalline silica monitoring results at the Lamington Avenue and Lutwyche Road monitoring sites, April to July 2011.

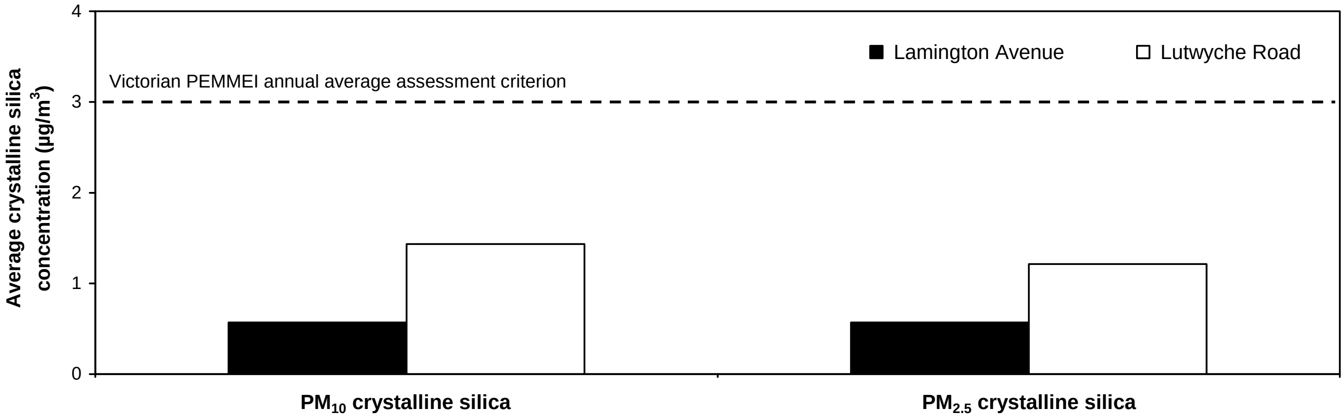
Sampling period	Lamington Avenue monitoring site			Lutwyche Road monitoring site			Rainfall during sampling period (mm)
	Seven-day average PM_{10} crystalline silica concentration (µg/m^3)	Seven-day average $PM_{2.5}$ crystalline silica concentration (µg/m^3)	Proportion of winds from direction of construction works (%)	Seven-day average PM_{10} crystalline silica concentration (µg/m^3)	Seven-day average $PM_{2.5}$ crystalline silica concentration (µg/m^3)	Proportion of winds from direction of construction works (%)	
16 April to 22 April	0.74	0.77	7.4	Monitoring site not operational			28.0
23 April to 29 April	0.29	0.28	0.0	Monitoring site not operational			31.5
30 April to 6 May	0.41	0.42	6.5	1.21	1.21	55.7	16.0
7 May to 13 May	0.51	0.49	8.3	2.22	1.97	75.3	6.0
14 May to 20 May	0.63	0.63	0.9	1.32	1.33	38.1	2.0
21 May to 27 May	0.35	0.35	9.5	2.09	1.97	67.0	31.0
28 May to 3 June	0.54	0.56	3.0	1.45	1.47	54.5	8.5
4 June to 10 June	0.69	0.70	3.9	2.33	2.17	76.5	0.0
11 June to 17 June	0.28	0.28	1.8	3.72	1.61	81.0	3.0
18 June to 24 June	1.00	0.97	4.8	0.50	0.21	75.3	0.0
25 June to 1 July	0.63	0.63	1.2	0.53	0.56	34.5	3.0
2 July to 8 July	0.38	0.35	6.5	Sampler did not run due to power failure			0.0
9 July to 15 July	0.75	0.76	8.3	1.25	1.25	63.4	10.0
16 July to 22 July	0.22	0.21	1.2	0.63	0.63	72.9	0.0
23 July to 29 July	0.94	0.90	8.9	0.81	0.83	53.0	0.0
30 July to 5 August†	0.75	0.79	2.1	0.56	0.56	45.5	0.0
† Sampling at the Lamington Avenue monitoring site concluded at 10 am on 4 August 2011.							

The average PM_{10} crystalline silica concentation over the monitoring period from April to July 2011 was 0.57 µg/m^3 at the Lamington Avenue monitoring site and 1.43 µg/m^3 at the Lutwyche Road monitoring site. The corresponding average $PM_{2.5}$ crystalline silica concentrations were 0.57 µg/m^3 at the Lamington Avenue site and 1.21 µg/m^3 at the Lutwyche Road site.

There is no EPP Air air quality objective for ambient crystalline silica. In the absence of a Queensland or national ambient air quality guideline for crystalline silica, measured crystalline silica concentrations were compared against the annual assessment criterion of 3 µg/m^3 adopted in the Victorian Government's PEMMEI. The Victorian criterion is based on crystalline silica present in the $PM_{2.5}$ particle fraction.

Average $PM_{2.5}$ crystalline silica concentrations between April and July 2011 were less than half the Victorian criterion at both monitoring sites (Figure 10). While the period of monitoring is too short to confirm compliance with the Victorian Government's PEMMEI annual assessment criterion, the average $PM_{2.5}$ crystalline silica concentrations measured suggest that compliance would be achieved over a 12-month period. This is particularly the case for the Lutwyche Road monitoring site where airborne crystalline silica levels will have been representative of worst-case conditions—given the high incidence of winds blowing from the direction of the Airport Link/Northern Busway construction works towards this monitoring site during the monitoring period.

Figure 10: Average PM_{10} and $PM_{2.5}$ crystalline silica concentrations at the Lamington Avenue and Lutwyche Road monitoring sites, April to July 2011.



Little difference was found between average PM_{10} crystalline silica concentrations and average $PM_{2.5}$ crystalline silica concentrations at both monitoring sites over the monitoring period. Based on this observation, it can be concluded that the average $PM_{2.5}$ crystalline silica values are a close approximation of respirable (PM_4) crystalline silica levels at the monitoring site locations.

The relationship between seven-day PM_{10} crystalline silica concentrations and the proportion of winds blowing from the direction of the Airport Link/Northern Busway construction works towards the monitoring sites during the sampling period is plotted in Figure 11. The corresponding relationship between seven-day $PM_{2.5}$ crystalline silica concentrations and the proportion of winds blowing from the direction of the construction works is plotted in Figure 12. At both monitoring sites there was a trend towards increasing crystalline silica concentrations with higher proportion of winds coming from the direction of construction works during the sampling period (shown by the heavy lines in figures 11 and 12). It is clear from these results that the Airport Link/Northern Busway construction works are a source of crystalline silica in the surrounding community, however these crystalline silica emissions do not result in ambient concentrations in the community that would pose a risk to human health.

Figure 11: Relationship between seven-day average PM_{10} crystalline silica concentrations and proportion of winds from the direction of the road construction works at the Lutwyche Road monitoring site, April to July 2011.

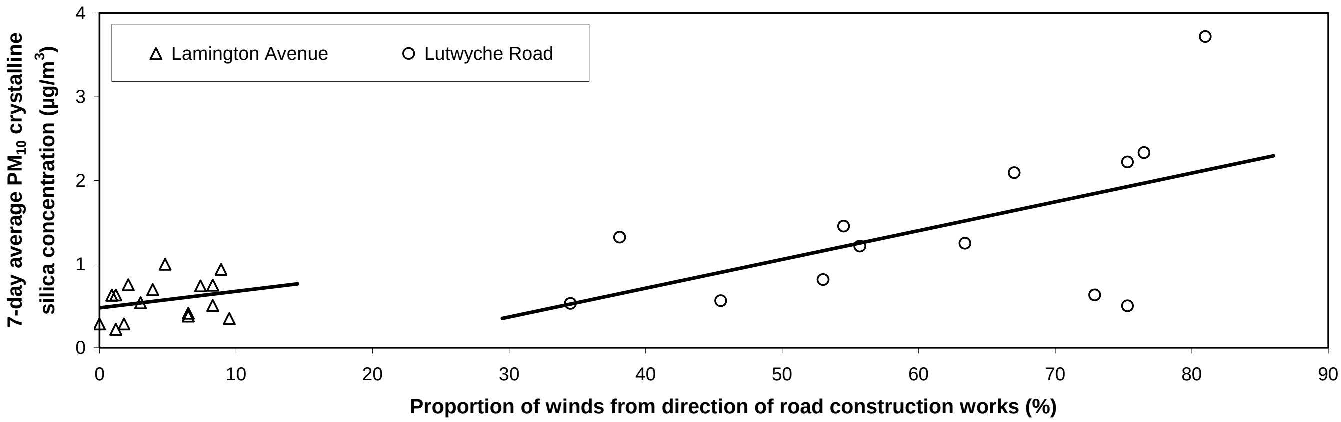
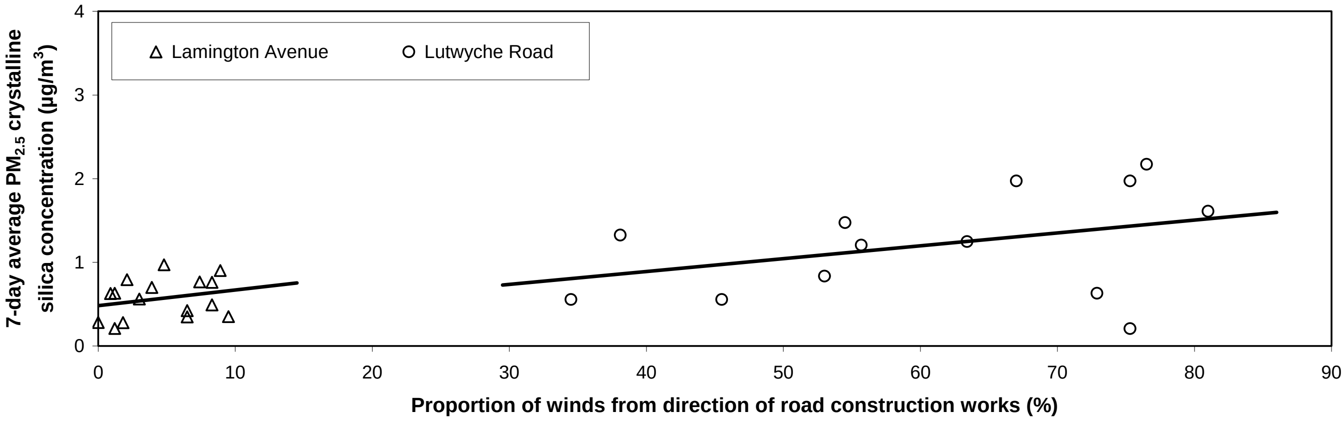


Figure 12: Relationship between seven-day average $PM_{2.5}$ crystalline silica concentrations and proportion of winds from the direction of the road construction works at the Lutwyche Road monitoring site, April to July 2011.



Conclusions

Monitoring in the community adjacent to Airport Link/Northern Busway construction works at Lutwyche conducted by the department between April and July 2011 has found that ambient particle concentrations generally complied with ambient air quality objectives. Average crystalline silica concentrations over the period of monitoring were well below the annual average criterion value.

PM_{10} levels only exceeded the EPP Air 24-hour air quality objective of 50 µg/m^3 on one day at the Lutwyche Road monitoring site during the entire three-month investigation period. On this day, dry conditions and strong westerly winds contributed to higher than normal levels of windblown dust from exposed ground and earthworks. PM_{10} levels at the Lamington Avenue monitoring site were likely to have complied with the EPP Air 24-hour objective based on the low seven-day average PM_{10} concentrations measured at this site in comparison to corresponding seven-day PM_{10} concentrations at the Lutwyche Road monitoring site.

$PM_{2.5}$ levels were found to comply with the EPP Air 24-hour average objective of 25 µg/m^3 over the entire monitoring period at the Lutwyche Road monitoring site. As for PM_{10}, $PM_{2.5}$ levels at the Lamington Avenue monitoring site were likely to have complied with the EPP Air 24-hour objective based on the low seven-day average $PM_{2.5}$ concentrations measured at this site in comparison to corresponding seven-day $PM_{2.5}$ concentrations at the Lutwyche Road monitoring site.

Average $PM_{2.5}$ concentrations at both monitoring sites over the period April to July 2011 were higher than the EPP Air annual average objective of 8 µg/m^3, however compliance or non-compliance with the annual objective could not be determined based on only three months sampling.

Although crystalline silica could be detected in all the collected PM_{10} and $PM_{2.5}$ particle samples, the average concentration over the monitoring period was less than 50 per cent of the Victorian Government's PEMMEI annual criterion value of 3 µg/m^3 at the Lutwyche Road monitoring site and less than 20 per cent of the criterion value at the Lamington Avenue monitoring site. At these levels, crystalline silica exposure in the surrounding community is expected to comply with the Victoria criterion for protection of human health over a 12-month period.

Monitoring has identified the Airport Link/Northern Busway construction works as an additional contributor to ambient particle and crystalline silica in the surrounding community. Analysis of the relationship between particle and crystalline silica levels and wind direction found that higher pollutant levels at the Lutwyche monitoring sites were associated with winds blowing from the direction of Lutwyche Road and the Airport Link/Northern Busway construction area. The contribution of additional local particle sources in addition to emissions from motor vehicles travelling along Lutwyche Road was seen in the higher average PM_{10} and $PM_{2.5}$ concentrations at the Lutwyche monitoring sites compared to those measured at roadside monitoring sites at Woolloongabba and South Brisbane over the same period.

The high frequency of winds blowing from the direction of Lutwyche Road and the Airport Link/Northern Busway construction works towards the Lutwyche Road monitoring site between April and July 2011 means particle and crystalline silica levels measured at this site will be representative of worst-case conditions in the surrounding community during the monitoring period. The low incidence of winds blowing from construction areas towards the Lamington Avenue monitoring site meant that measured levels were not indicative of worst-case conditions at this location.

To provide ongoing assessment of the environmental performance of the project in relation to PM_{10} emissions as required by the Coordinator-General's conditions, and to enable assessment of performance against the annual air quality objectives for $PM_{2.5}$ and crystalline silica, the department will continue monitoring at the Lutwyche Road monitoring site until construction of the Airport Link/Northern Busway is completed in June 2012.

Department of Science, Information Technology, Innovation and the Arts

Caboolture Industrial Estate Particle Monitoring Investigation

January to February 2014

Great state. Great opportunity.

Queensland Government

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January 2015

Executive summary

In January 2014 the Department of Science, Information Technology, Innovation and the Arts (DSITIA) commenced a one-month investigation into particle levels adjacent to a waste transfer facility situated in an industrial estate at Caboolture. The objective of the investigation was to obtain information on ambient particle levels at adjoining premises and to assess the impacts, if any, of waste transfer facility operations on adjoining properties.

The investigation acquired data for assessment of both health and nuisance impacts, together with determination of the types of particles present in the dust to assist with identification of the sources contributing to the dust. The monitoring program collected information on:

- PM_{10} (particles less than 10 micrometres in diameter) and $PM_{2.5}$ (particles less than 2.5 micrometres in diameter) concentrations—to assess the potential for human health impacts;
- crystalline silica content in the $PM_{2.5}$ particles—to assess the potential for human health impacts; and
- deposited dust (dustfall) levels—to assess the potential for amenity degradation (dust nuisance) impacts and to determine the types of particles present in the deposited dust.

The monitoring results showed that ambient particle concentrations complied with ambient air quality objectives at all rail corridor monitoring sites during both the pre- and post-veneering monitoring periods.

Ambient PM_{10} concentrations exceeded the Queensland Environmental Protection (Air) Policy 2008 (EPP Air) 24-hour average air quality objectives of 50 µg/m^3 on any day during the investigation period.

The highest average PM2.5 concentration measured during either the pre- or post-veneering periods was less than the EPP Air annual objective value of 8 µg/m3.

Insoluble dust deposition rates exceeded the trigger level for dust nuisance of 4 g/m2/30days above background levels (or 130 mg/m2/day averaged over a 30-day period) recommended by the New Zealand Ministry for the Environment at any of the rail corridor monitoring sites during both the pre- and post-veneering monitoring periods.

Microscopic examination showed that mineral dust (soil or rock dust) was the major component (50 to 90 per cent) of larger particles that settled from the air at the monitoring site. Significantly, cement dust comprised about 5% of the collected dust.

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Introduction

A waste transfer operation for receiving construction and demolition waste commenced at a site within an industrial estate off Pasturage Road at Caboolture in 2008. The waste transfer station received construction and demolition waste in skip bins which were unloaded onto a concrete sorting pad, where waste material was sorted into recyclable bins/piles of concrete, earth, metal and other recyclables. Non-recyclable materials were loaded into skips for disposal at landfill. The sorting area was screened on three sides with shadecloth material to a height of approximately 10 metres.

In 2010 the Moreton Bay Regional Council (MBRC) referred the site to the then Department of Environment and Resource Management for follow up in regards to permit requirements for carrying out environmentally relevant activity (ERA) 62 – waste transfer station operation.

The waste transfer operation took place on a largely unsealed site out in the open and, despite the operation of a sprinkler system, ongoing complaints relating to dust nuisance and concerns about possible health risks resulting from exposure to the dust were received by the Department of Environment and Heritage Protection (EHP) and MBRC since the waste transfer operation commenced. Complaints related to the dust adversely affecting the operation of a nearby business were also received.

In 2011-2012 the operator of the waste transfer station conducted particle monitoring at EHP's request which showed compliance with dust nuisance levels set in the operator's development permit. However EHP identified a number of factors potentially contributing to favourable results during the period of monitoring, including high rainfall and low throughput as the monitoring was conducted over the December-January Christmas holiday period.

Complainants raised concerns about the waste transfer station operator conducting any further dust monitoring as they believed the operator had the option to redirect 'high risk' dusty loads to alternative Brisbane depots which would have resulted in monitoring results that did not reflect the true nature of the business during normal operation.

To address the complainants' concerns, EHP subsequently sought assistance from DSITIA to undertake air quality monitoring in the vicinity of the waste transfer facility to evaluate dust nuisance and health risk concerns arising from alleged particle emissions the waste transfer station site.

This report summarises the findings of the particle monitoring investigation conducted by DSITIA at a premises adjoining the waste transfer station site between 22 January and 24 February 2014.

Monitoring program design

The particle monitoring investigation conducted by DSITIA at the industrial property at Caboolture in January and February 2014 acquired data on three particle size fractions, together with the types of particles present, including crystalline silica. The monitoring program collected information on:

- PM_{10} levels—for assessment against criteria based on health
- $PM_{2.5}$ levels—for assessment against criteria based on health
- crystalline silica content in the $PM_{2.5}$ particles—for assessment against criteria based on health
- deposited dust (dustfall) levels—for assessment against criteria based on dust nuisance and to determine the types of particles present in the collected dust.

PM_{10} is the term given to the fraction of total particles suspended in the air having diameters less than 10 micrometres (µm). PM_{10} particles pose a hazard to human health because they are small enough to pass through the filtration mechanisms in the upper respiratory tract and penetrate beyond the larynx to the lower airways. PM_{10} particles can arise from combustion processes (e.g. motor vehicle engines) and mechanical processes (e.g. rock crushing, windblown dust).

$PM_{2.5}$ is the term given to the fraction of total particles suspended in the air having diameters less than 2.5 micrometres. There is an increasing body of evidence to suggest that, of the total PM_{10} fraction of airborne particles, the $PM_{2.5}$ particles may be the major area of concern with regard to adverse effects on human health[1]. $PM_{2.5}$ particles arise predominantly from combustion processes (e.g. motor vehicle engines).

Dust arising from waste sorting activities within the waste transfer station was expected to comprise mainly particles greater than 2.5 µm in size, which would be reflected in PM_{10} concentrations being significantly higher than the corresponding $PM_{2.5}$ concentrations.

As waste streams containing cement were handled by the waste transfer facility, dust generated from handling activities could potentially contain silica. Silica can exist in both crystalline and non-crystalline forms, however only exposure to crystalline silica is associated with adverse health effects. In this investigation the amount of crystalline silica present in the $PM_{2.5}$ particle fraction was measured.

Nuisance impacts from dust emissions often relate to the settling out of particles on surfaces, leading to soiling and/or the need for a greater frequency of cleaning. Dust that settles from the air is made up almost entirely of particles 30 µm and greater in diameter[2]. For dust sources of the magnitude of the waste transfer station, such impacts will tend to be confined to areas in close proximity to the source of the particles.

The location of the monitoring equipment relative to the waste transfer facility is shown in Figure 1. The monitoring equipment was located on the premises adjoining the waste transfer station, about 25 metres from the nearest boundary of the waste transfer facility. Waste sorting activities taking place within the screened concrete pad were situated approximately 50 metres south-east of the monitoring equipment.

[1] National Environment Protection Council, October 2002, *Impact Statement for $PM_{2.5}$ Variation: Setting a $PM_{2.5}$ Standard in Australia*, available at http://www.scew.gov.au/system/files/resources/9947318f-af8c-0b24-d928-04e4d3a4b25c/files/aaq-pm25-impstat-impact-statement-pm25-variation-final-200210.pdf.

[2] J.H. Fairweather, A.F. Sidlow and W.L. Faith, *Particle size distribution of settled dust*, Journal of the Air Pollution Control Association, 15:8, 345-347, 1965, available at http://dx.doi.org/10.1080/00022470.1965.10468389.

Figure 1. Location of industrial estate monitoring site relative to the waste transfer station.

Monitoring equipment

Continuous measurement of PM_{10} and $PM_{2.5}$ particles was conducted using a Model 1405DF dichotomous Tapered Element Oscillating Microbalance (TEOM) instrument operated in accordance with Australian/New Zealand Standard AS/NZS 3580.9.13:2013 Method 9.13: Determination of suspended particulate matter—$PM_{2.5}$ continuous direct mass method using a tapered element oscillating microbalance monitor. The TEOM instrument drew air through a PM_{10} size-selective inlet (to remove particles larger than 10 µm) followed by further separation into two particle streams, one containing particles less than 2.5 µm in diameter and the other containing particles between 2.5 µm and 10 µm in diameter. The separated particle streams then each passed through a filter mounted on a glass tube (tapered element) vibrating at its natural frequency (similar to the way a tuning fork operates). Particle mass was measured by the change in the oscillating frequency of the glass tube following particle deposition on the filter. From the flow rates for each stream the particle concentrations were calculated. PM_{10} was calculated as the sum of the simultaneous concentration measurements from both particle streams.

Samples of $PM_{2.5}$ particles for crystalline silica content analysis were collected over seven-day periods using a Partisol® Model 2025 sequential low-volume air sampler. Sample collection was conducted over a seven-day period to collect sufficient particle matter for the crystalline silica analysis. The sampler was operated in accordance with Australian/New Zealand Standard AS/NZS 3580.9.10:2006 Method 9.10: Determination of suspended particulate matter–$PM_{2.5}$ low-volume sampler–Gravimetric method. The sequential air sampler operated by drawing air first through a PM_{10} size-selective inlet to remove particles larger than 10 µm, then through a very sharp cut cyclone to remove particles larger than 2.5 µm. The $PM_{2.5}$ particle stream was then deposited on a pre-weighed 47 mm diameter Teflon® filter over a seven-day period. After sampling, the filter was again weighed, with the difference in weight being the mass of $PM_{2.5}$ particles collected. The $PM_{2.5}$ mass concentration was calculated by dividing the mass of particles collected by the volume of air drawn through the sampler over the seven-day period. Sample collection was carried out by departmental staff and the gravimetric analysis was carried out by the Queensland Government Safety in Mines, Testing and Research Station (Simtars). Analysis of the crystalline silica content of the collected $PM_{2.5}$ particles was determined by infrared spectroscopy using a method based on Methods for Measurement of Quartz in Respirable Airborne Dust by Infrared Spectroscopy and X-Ray Diffractometry, National Health and Medical Research Council 1984 and NIOSH Method 7602 Silica, Crystalline by IR (KBr pellet). The crystalline silica analysis was also carried out by Simtars.

Deposited dust was monitored by determining the amount of dust collected over an exposed surface in a fixed period of time. Measurement was by means of a funnel and collection bottle, which simply caught the dust settling over a fixed surface area over a period of 33 days. Deposited dust samples were collected and analysed in accordance with Australian/New Zealand Standard AS/NZS 3580.10.1:2003 Method 10.1 Determination of particulates—Deposited Matter—Gravimetric method. Prior to analysis, the solution contained in the collection bottle was homogenised and a 100 ml sub-sample was extracted for the particle type identification analysis. The results were reported in terms of the weight of dust collected per unit of surface area over the sampling period, normalised to a 30-day period. Two collection bottles were deployed for added confidence in the results. Sample collection was carried out by DSITIA field staff and the analysis was carried out by DSITIA's Chemistry Centre laboratory.

Determination of the types of particles present in the deposited dust was performed by microscope examination of the sub-sample extracted from the deposited dust samples before the deposited dust analysis was carried out. The deposited dust sub-sample solution was filtered onto a membrane filter and examined by stereomicroscopy for particle distribution (surface coverage) and general appearance. This was followed by the use of scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDS) of selected individual particles to ensure the elemental composition was consistent with the stereomicroscopy particle distribution assessment. The particle identification work was performed by the Applied Materials Characterisation and Performance Laboratory (AMCP) at the University of Queensland.

To assist with the determination of the contribution from waste transfer facility activities to overall particle levels, wind speed and direction measurements were recorded at the monitoring site. The wind sensor was located at a height of six metres above ground level. Rainfall was also measured at the site during the monitoring period.

Assessment criteria

Evaluation of the risk posed to human health and wellbeing was conducted by comparing the ambient concentrations measured at the industrial estate monitoring site against recognised assessment criteria.

PM_{10} and $PM_{2.5}$ results were compared to the Queensland Environmental Protection (Air) Policy 2008[3] (EPP Air) 24-hour average air quality objectives of 50 µg/m^3 and 25 µg/m^3 respectively. Although the waste transfer station did not operate on a 24-hour basis, it was not possible to assess the potential risk of particle exposure over periods less than one day as no ambient PM_{10} or $PM_{2.5}$ guidelines for protection of human health have been developed for exposure periods shorter than 24 hours. The average $PM_{2.5}$ concentration measured over the investigation period was compared with the EPP Air annual objective of 8 µg/m^3 to provide a qualitative indication of whether $PM_{2.5}$ exposure over longer periods was likely to pose a health risk. The one-month monitoring period did not permit a definitive assessment of compliance with this objective.

Health criteria relating to crystalline silica are often expressed in terms of the amount present in the respirable particle fraction, which are particles less than 4 µm in diameter, or PM_4. However, respirable particle samplers are typically designed for short-term occupational exposure monitoring and are generally not suited to continuous outdoor use. In the light of this, the Victorian Government has developed an annual average assessment criterion for crystalline silica in ambient air of 3 µg/m^3 based on levels present in the $PM_{2.5}$ particle fraction[4]. In this investigation a $PM_{2.5}$ particle sampler designed for continuous outdoor use was used to collect the particle samples for subsequent crystalline silica analysis. The average $PM_{2.5}$ crystalline silica concentration measured over the investigation period was compared against the Victorian annual assessment criterion to evaluate if exposure was likely to pose a health risk.

Guidelines for assessment of the potential for dust nuisance are commonly expressed in terms of the rate of deposition of particulate matter per unit surface area, measured as the mass of dust that accumulates per square metre over the measurement period, or as the average daily dust deposition rate over the measurement period. In this investigation, dust nuisance impacts were evaluated by comparing the measured deposited dust (insoluble solids fraction) levels against the limit value of 120 mg/m^2/day specified in the Queensland Department of Environment and Heritage Protection guideline document EM960 *Application requirements for activities with impacts to air*[5].

Results and discussion

Meteorology

One factor with the potential to influence the outcome of this investigation was dust suppression due to heavy or persistent rainfall. Daily rainfall totals measured at the monitoring site over the investigation period are shown in Figure 2. Apart from two heavy rainfall events on 23 January and 17-18 February, dry conditions prevailed during most of the investigation period. On this basis, it is considered that ambient particle measurements obtained during the majority of the investigation period would have adequately reflected levels expected to occur during dry conditions.

[3] Available from www.legislation.qld.gov.au/LEGISLTN/CURRENT/E/EnvProtAirPo08.pdf.

[4] EPA Victoria. *Protocol for Environmental Management: Mining and extractive industries*. Publication 1191, December 2007. Available from www.epa.vic.gov.au/our-work/publications/publication/2007/december/1191.

[5] Available from www.ehp.qld.gov.au/era/air-impacts-em960.pdf.

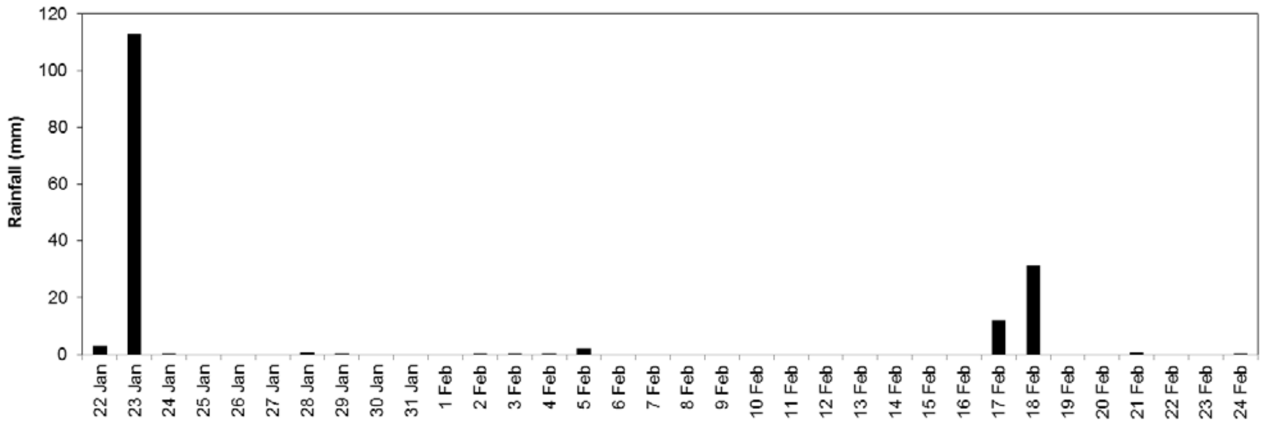

Figure 2. Daily rainfall measurements at the industrial estate monitoring site during the investigation period.

Wind direction was another important factor in the measurement of dust impacts at the monitoring site. For dust emissions from the waste transfer station to impact on the monitoring station, winds needed to blow from directions between 60 degrees and 140 degrees. Highest dust impacts from the waste transfer station were expected to occur during winds from the direction of the waste sorting area, which corresponded to wind directions between 110 degrees and 140 degrees.

Figure 4 displays the distribution of winds (as 30-minute averages) over the investigation period as a wind rose, overlaid on the location map. The wind rose shows the relative frequency of winds for ten degree direction ranges (the black vertical bar indicates the wind frequency scale). Within each wind direction range, the colour bands show the relative frequency of winds within specified speed ranges.

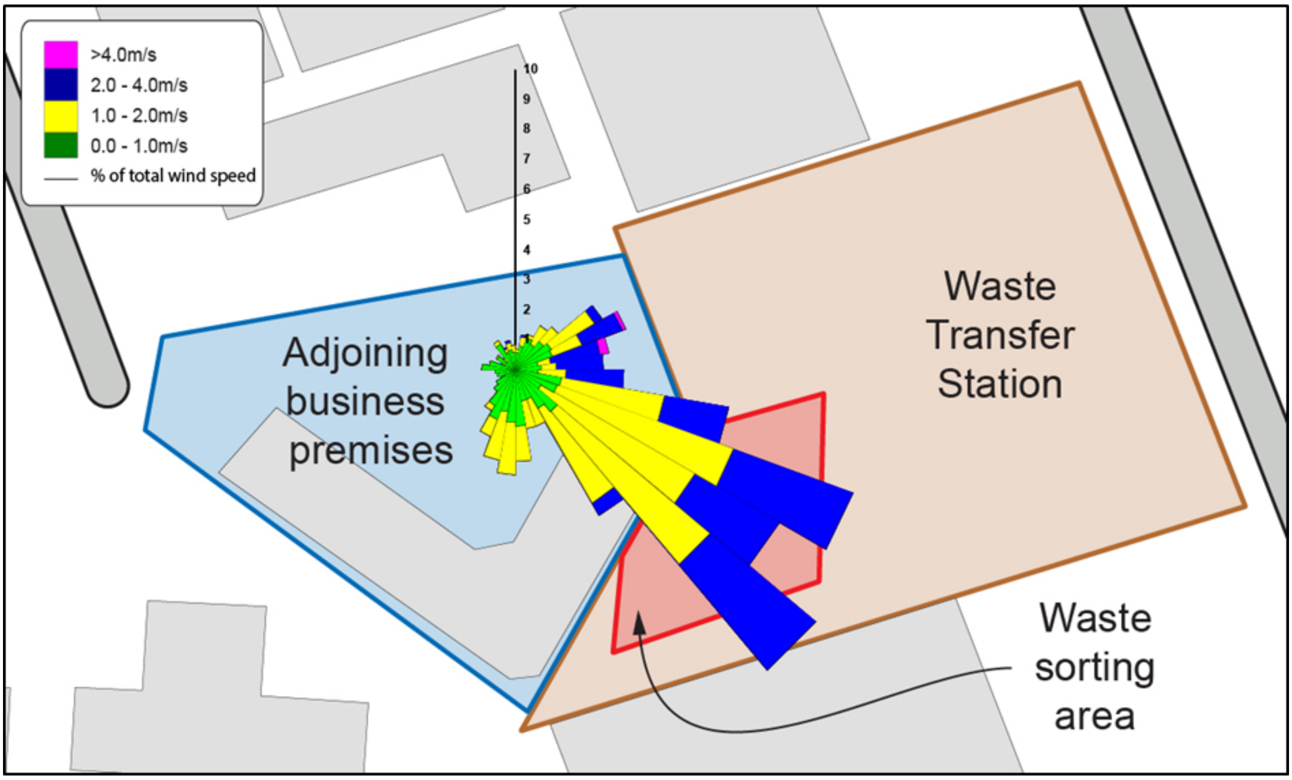

Figure 3. Wind distribution (30-minute averages) at the industrial estate monitoring site during the investigation period.

Figure 4 shows that greater than 56 per cent of all winds blew from the direction of the waste transfer station during the investigation period. Higher wind speeds, which could result in increased dust emissions, were also associated with winds from the direction of the waste transfer station. Winds from the direction of the waste sorting area accounted for around 35 per cent of all winds. On this basis, it is considered that ambient particle measurements obtained during the investigation period would provide results indicative of the upper range of particle concentrations experienced at adjoining properties.

PM_{10}

The daily average PM_{10} monitoring results obtained at the industrial estate monitoring site from 23 January to 2 February 2014 are displayed graphically in Figure 5 relative to the EPP Air 24-hour objective of 50 µg/m^3. The daily average PM_{10} concentration values are provided in Table 2 in the Appendix of this report. Unfortunately, a fault with the instrument meant that no valid PM_{10} data was available during the second half of the investigation period.

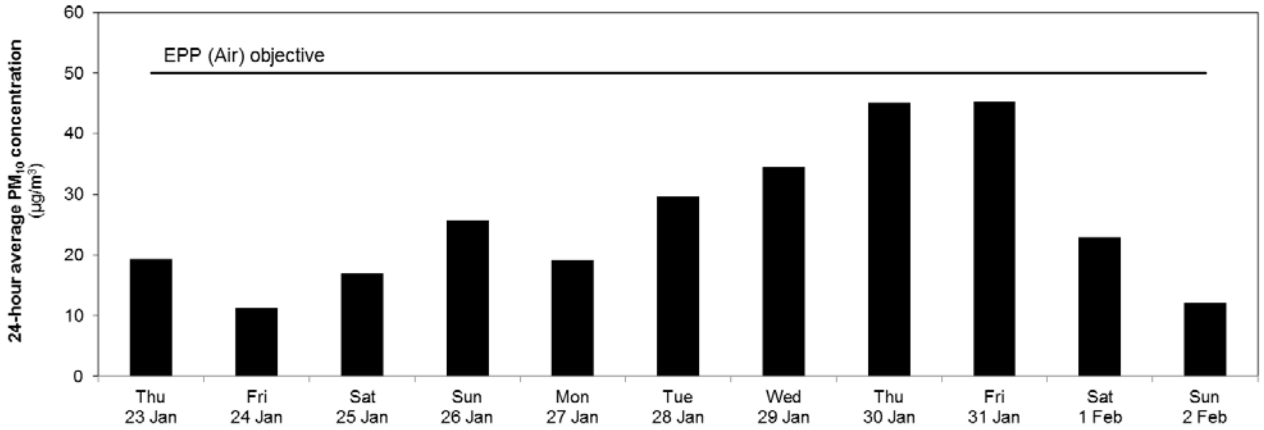

Figure 4. Daily average PM_{10} concentrations measured at the industrial estate monitoring site between 23 January and 2 February.

The PM_{10} values shown in Figure 5 were the total concentrations resulting from all PM_{10} emission sources in proximity to the monitoring site, not solely PM_{10} emissions from the waste transfer station site.

The EPP Air 24-hour objective for PM_{10} was not exceeded at the industrial estate monitoring site during the period 23 January to 2 February 2014.

During the period 23 January to 2 February, the waste transfer station would have been operating on all weekdays with the exception of Monday 27 January which was a public holiday. It can be seen from Figure 5 that PM_{10} concentrations at the monitoring site on the four weekdays from 28 January to 30 January were significantly higher than those observed on weekend/public holiday days. Heavy rain experienced on 23 January is likely to have accounted for the absence of similarly elevated PM_{10} levels on 23 January and 24 January.

The PM_{10} instrumentation used was able to measure PM_{10} concentrations over periods as short as 30 minutes. This information, combined with the corresponding wind direction information, made it possible to identify likely emission sources contributing to PM_{10} levels at the monitoring site on the basis of those wind directions associated with higher PM_{10} levels. The relationship between

30-minute averaged PM_{10} concentrations and wind direction for each day from 26 January to 2 February is shown in Figure 6.

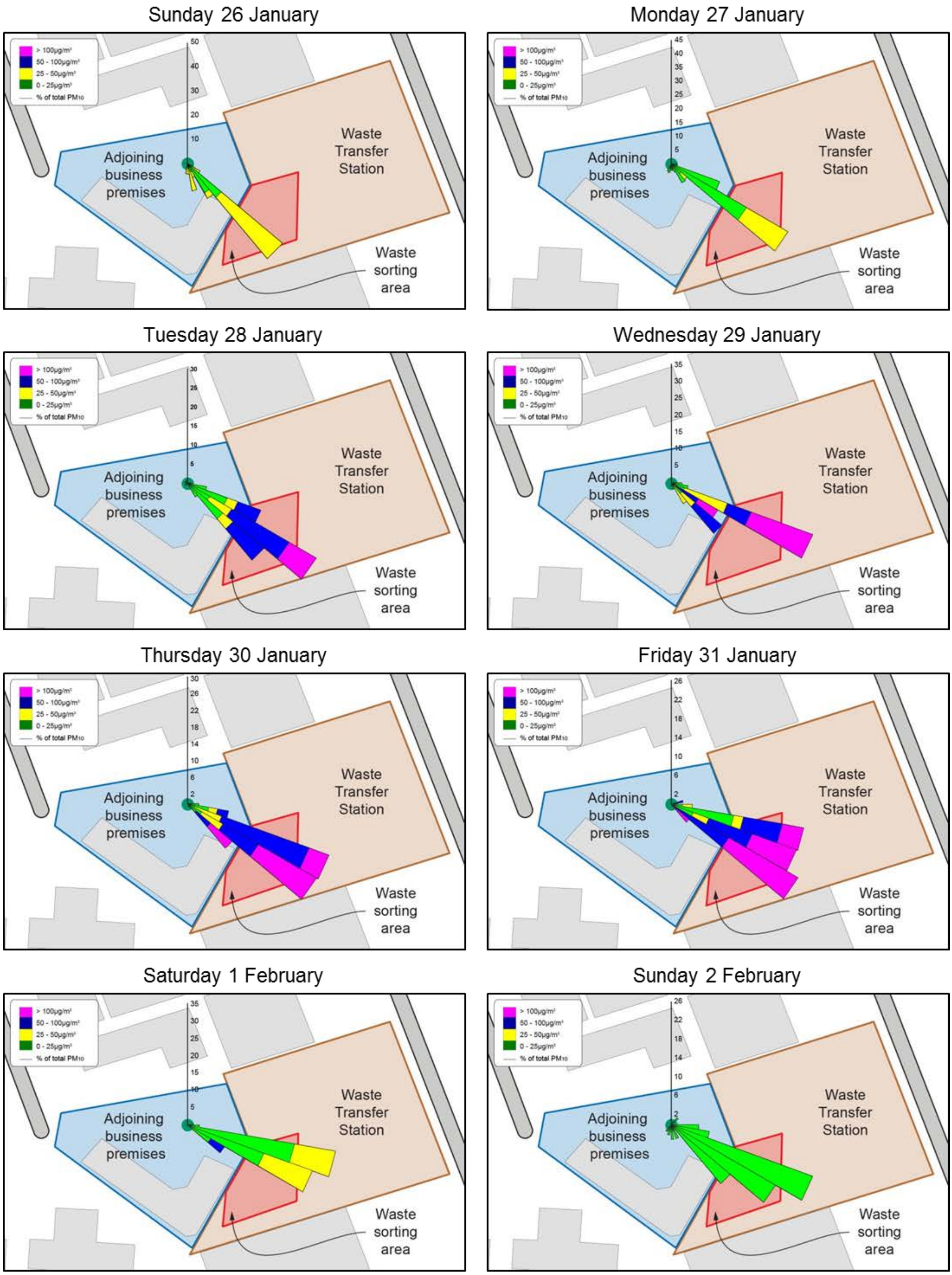

Figure 5. Relationship between 30-minute averaged PM_{10} concentrations and wind direction at the industrial estate monitoring site between 28 January and 2 February.

The PM_{10} roses show the relative frequency of 30-minute averaged PM_{10} concentrations for ten degree wind direction ranges (the black vertical bar indicates the PM_{10} frequency scale). Within each wind direction range, the colour bands show the relative frequency of PM_{10} concentrations within specified concentration ranges from the given wind direction.

During the six day period covered by Figure 6, winds consistently blew from the south-east, putting the monitoring site downwind of the waste transfer station's waste sorting area. It can be seen that 30-minute average PM_{10} concentrations greater than 50 µg/m^3 were highly correlated with winds from the direction of the waste sorting area and days when the waste transfer station was operating. In the absence of information on PM_{10} concentrations upwind of the waste transfer station on these days it is not possible to quantify the contribution of waste transfer station activities to PM_{10} measured at the monitoring site. However, based on the types of activities known to be taking place at the waste transfer station, it would be reasonable to assume that dust emissions from the site would have accounted for a significant proportion of the increased PM_{10} measured at the monitoring site on days when the waste transfer station was operating.

$PM_{2.5}$

The daily average $PM_{2.5}$ monitoring results obtained at the industrial estate monitoring site from 23 January to 2 February 2014 are displayed graphically in Figure 7 relative to the EPP Air 24-hour objective of 25 µg/m^3. The daily average $PM_{2.5}$ concentration values are provided in Table 2 in the Appendix of this report. Unfortunately, a fault with the TEOM instrument meant that no valid 24-hour average $PM_{2.5}$ data was available during the second half of the investigation period.

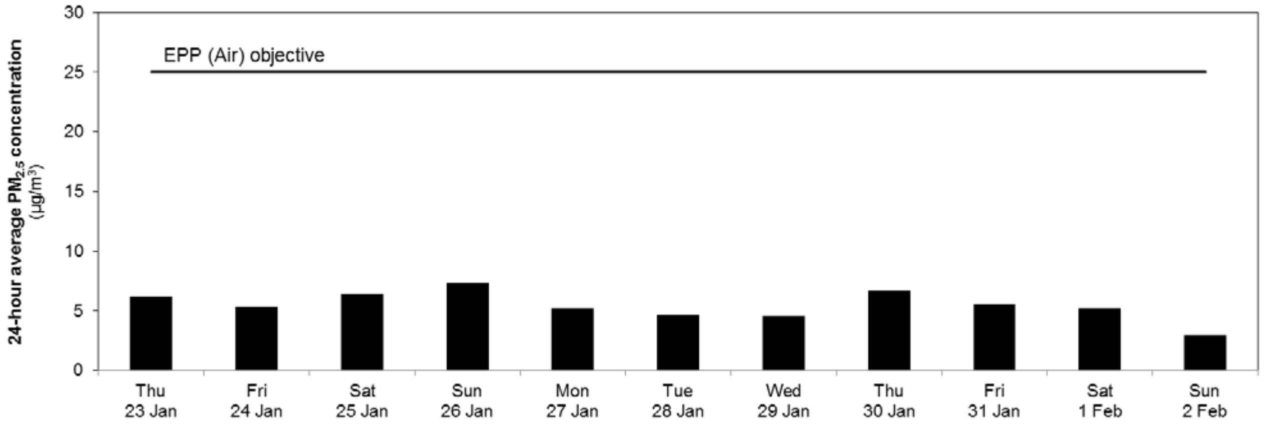

Figure 6. Daily average $PM_{2.5}$ concentrations measured at the industrial estate monitoring site between 23 January and 2 February.

The $PM_{2.5}$ values shown in Figure 7 were the total concentrations resulting from all $PM_{2.5}$ emission sources in proximity to the monitoring site, not solely $PM_{2.5}$ emissions from the waste transfer station site.

The EPP Air 24-hour objective for $PM_{2.5}$ was not exceeded at the industrial estate monitoring site during the period 23 January to 2 February 2014. Daily average $PM_{2.5}$ concentrations were less than 30 per cent of the EPP Air objective value during this period.

While not providing daily $PM_{2.5}$ concentration information, the weekly $PM_{2.5}$ sampling conducted for measurement of crystalline silica did provide an average $PM_{2.5}$ concentration at the monitoring site for the four week period from 23 January to 19 February 2014. The average $PM_{2.5}$ concentration over this period is plotted against the EPP Air annual $PM_{2.5}$ objective value in Figure 8. The individual 7-day average $PM_{2.5}$ concentrations used to calculate the average $PM_{2.5}$ concentration are provided in Table 3 in the Appendix to this report.

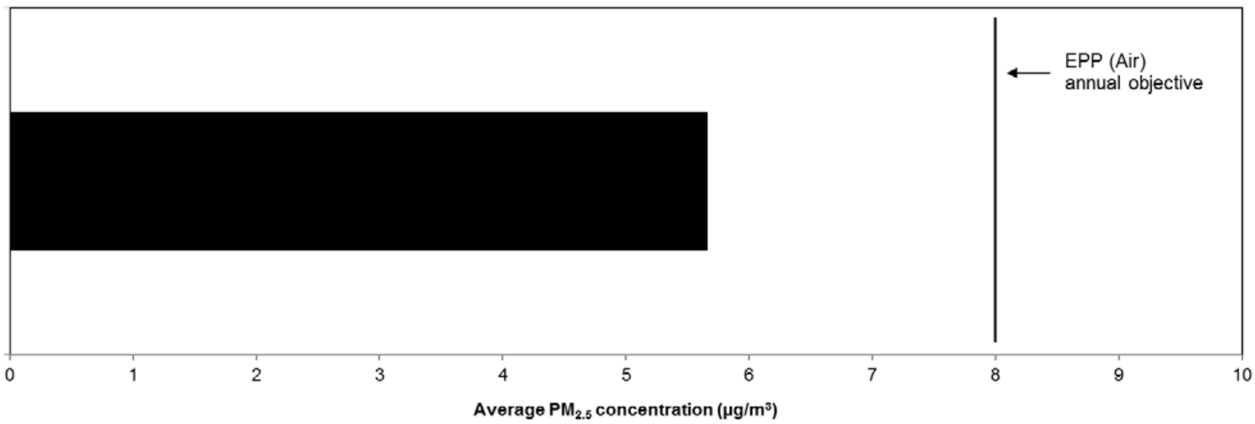

Figure 7. Average $PM_{2.5}$ concentration measured at the industrial estate monitoring site between 23 January and 19 February.

The average $PM_{2.5}$ concentration of 5.7 µg/m^3 was less than the EPP Air annual $PM_{2.5}$ objective value of 8 µg/m^3. Assuming that the $PM_{2.5}$ concentrations measured during the investigation period are representative of $PM_{2.5}$ levels present at the monitoring site over a twelve month period, it is likely that annual average $PM_{2.5}$ concentrations will comply with the EPP Air annual objective.

Figure 7 shows little variation in measured 24-hour average $PM_{2.5}$ concentrations between weekdays and weekends/public holidays. This indicates that activities undertaken at businesses within the industrial estate that operate on weekdays only do not contribute significantly to ambient $PM_{2.5}$ concentrations.

When viewed in conjunction with the corresponding PM_{10} data which showed significantly higher PM_{10} levels on weekdays, it is clear that particles generated by emission sources in the vicinity of the monitoring site were predominantly larger than 2.5 µm in size. This indicates that the elevated PM_{10} concentrations measured between 28 January and 31 January were the result of mechanical, rather than combustion, processes. These findings are consistent with what would be expected if waste sorting activities undertaken at the waste transfer station were a significant contributor to PM_{10} levels at the monitoring site.

Crystalline silica

The amount of airborne crystalline silica present at the monitoring site was determined by spectroscopic analysis of the $PM_{2.5}$ particle samples collected over seven day periods by the low-volume sampler. The seven-day average $PM_{2.5}$ crystalline silica concentration results obtained at the monitoring site are summarised in Table 3 in the Appendix to this report. Crystalline silica was detected in only two of the four $PM_{2.5}$ samples collected.

Figure 9 plots the average $PM_{2.5}$ crystalline silica concentration measured at the monitoring site over the four week period from 23 January to 19 February 2014 against the annual assessment criterion value specified in the Victorian Government's *Protocol for Environmental Management: Mining and extractive industries*.

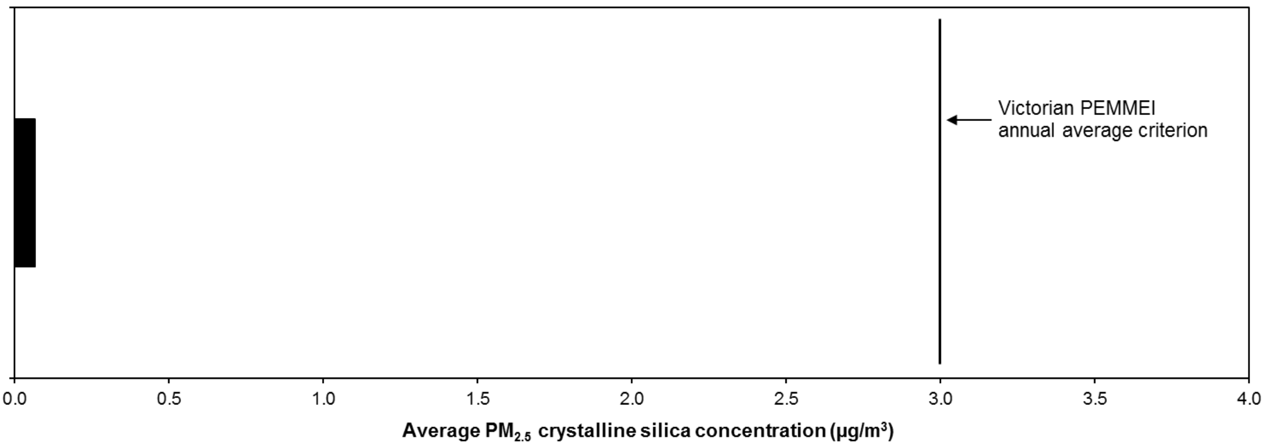

Figure 8. Average $PM_{2.5}$ crystalline silica concentration measured at the industrial estate monitoring site between 23 January and 19 February.

$PM_{2.5}$ crystalline silica concentrations complied with the Victorian Government's annual average assessment criterion at the monitoring site during the investigation period. The average $PM_{2.5}$ crystalline silica concentration measured at the monitoring site over the investigation period was only 0.07 µg/m^3, 2.3 per cent of the Victorian Government's annual assessment criterion of 3 µg/m^3. Given the high proportion of winds blowing from the waste transfer station site towards the monitoring site during the investigation period, it can be concluded that the average $PM_{2.5}$ crystalline silica measurement obtained adequately represents typical crystalline silica exposure levels. On this basis, it is unlikely that any adverse health effects would result from crystalline silica exposure at the monitoring location.

Deposited dust

In this investigation the potential for dust nuisance was evaluated by measuring dust deposition, i.e. the amount of dust settling from the air at the monitoring site.

The dust deposition analysis method allows for the determination of total, dissolved and insoluble deposited matter, with a further breakdown of the insoluble fraction into organic (combustible) matter and mineral (ash) content. Insoluble matter is the solid material collected by filtering the sample, while the dissolved matter is determined by evaporating some or all of the liquid filtrate. As a general rule, dissolved material is of minor importance in assessing nuisance effects. In a coastal environment a large proportion of the dissolved matter would be marine salt. Organic (combustible) matter is that portion of the insoluble matter lost on heating at a temperature of 850^{o}C for 30 minutes and is an indication of the amount of organic material in the dust. This organic matter fraction can include material such as plant fragments, insect material, plastic fragments, wood dust, soot and rubber dust. The mineral (ash) content of the dust is the material remaining after heating at 850^{o}C for 30 minutes, and primarily comprises soil or rock particles.

Reported dust deposition values are the combined total from all dust emission sources in proximity to the monitoring site, not just dust originating from the waste transfer station. Two samples were collected simultaneously at the monitoring site during the investigation period to ensure consistency in the findings.

The results of dust deposition samples collected at the monitoring site during the investigation period are displayed graphically in Figure 10 against the EHP dust nuisance limit value of 120 µg/m^2/day. In Figure 10 the contributions from combustible (organic) matter particle types and ash (mineral) particle types to the overall insoluble dust deposition rate are shown by the divisions on each column. Details of the analysis results for the individual dust deposition samples can be found in Table 4 in the Appendix of this report.

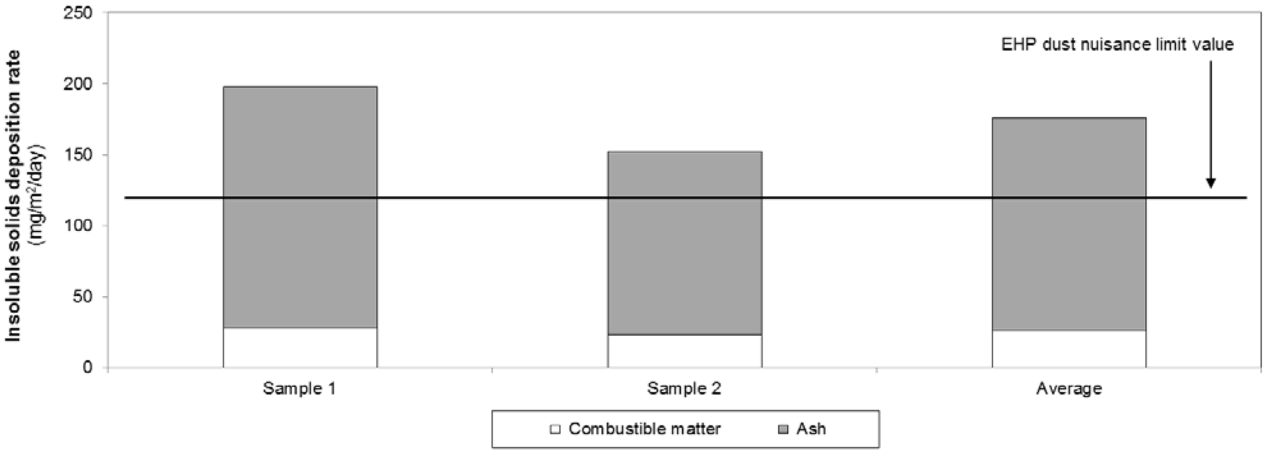

Figure 9. Insoluble dust deposition rates at the industrial estate monitoring site, 22 January to 24 February 2014.

The insoluble dust deposition rate was above the EHP dust nuisance limit value in both samples collected at the monitoring site. The average insoluble dust deposition rate measured during the investigation period was 186 mg/m^2/day. On the basis of these findings, complainant concerns about dust nuisance being experienced appear justified.

Particle composition

The dust deposition sample results described in the previous section (Figure 10) showed that the dust settling out was made up primarily of mineral particle types. Further characterisation of the particles contributing to the dust settling out at the monitoring site was carried out using microscope techniques on a sub-sample taken from the deposited dust samples before the deposited dust analysis was carried out.

The dust composition analysis was performed by filtering the sub-sample through a membrane filter, followed by microscopic examination of the insoluble particles retained on the surface of filter. The microscope techniques used by the University of Queensland's Materials Performance Laboratory were capable of distinguishing a number of different types of particles in the deposited dust. The particle types able to be identified included a range of black-coloured particles (coal, soot and rubber dust), mineral dust (e.g. soil, rock, fly ash, cement, glass), biological particles (e.g. insect and plant fragments) and other general organic particles (e.g. wood, fibres, paint, plastics).

The relative proportions of the different particles present in the dust sample were based on the surface area coverage of each particle type on the membrane filter. The microscope techniques were capable of resolving the relative surface area proportions of the different particle types to an accuracy of around 5 per cent. As the particle composition analysis is based on surface area coverage and the dust deposition rate analysis is based on particle mass, it is not possible to derive a quantitative deposition rate for individual particle types from the particle composition analysis results.

The relative proportions of the different particle types found to be present in the deposited dust samples at the monitoring site are displayed graphically in Figure 11. Details of the composition results for the individual dust deposition samples can be found in Table 5 in the Appendix of this report.

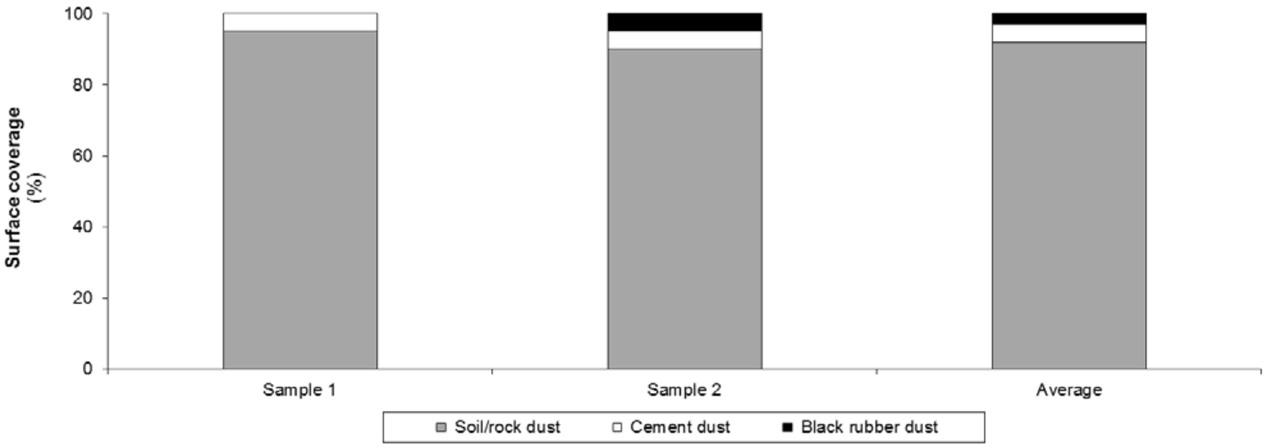

Figure 10. Relative proportions of the different particle types found in the deposited dust samples at the industrial estate monitoring site, 22 January to 24 February 2014.

The major component of the deposited dust in both samples collected at the monitoring site was found to be mineral dust (soil or rock dust), accounting for greater than 90 per cent of the coverage area. Cement dust was present in both samples, at around five per cent of the coverage area. The only other particle type observed at greater than trace levels was black rubber dust, which made up five per cent of the surface coverage in one of the dust deposition samples.

The presence of cement dust is indicative of dust emissions from waste transfer station activities contributing to deposited dust levels at the monitoring site, as significant emissions of cement dust would only arise from activities involving concrete products. The high soil/rock dust content is also consistent with dust emissions arising from waste transfer operations involving construction and demolition wastes, although other activities taking place within the industrial estate could have contributed to deposition of soil/rock dust at the monitoring site.

The black rubber dust is most likely to have come from vehicle tyre wear during driving on roads in and around the industrial estate.

Conclusions

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Appendix

Table 1. 24-hour average PM_{10} and $PM_{2.5}$ concentrations measured at the Caboolture industrial estate monitoring site from 23 January to 2 February 2014, together with daily wind frequency from the direction of the waste transfer station and rainfall.

Sampling day	24-hour average PM_{10} concentration (µg/m³)	24-hour average $PM_{2.5}$ concentration (µg/m³)	Proportion of winds from the direction of the waste transfer station (%)		Rainfall (mm)
			All hours	7:00am to 5:00pm only	
Thursday 23 January 2014	19.3	6.2	40	85	112.8
Friday 24 January 2014	11.2	5.3	33	50	0.4
Saturday 25 January 2014	16.9	6.4	35	30	0.0
Sunday 26 January 2014	25.7	7.3	56	80	0.0
Monday 27 January 2014	19.2	5.2	67	85	0.0
Tuesday 28 January 2014	29.6	4.6	87	95	0.5
Wednesday 29 January 2014	34.5	4.6	83	80	0.4
Thursday 30 January 2014	45.1	6.7	94	100	0.0
Friday 31 January 2014	45.3	5.6	100	100	0.0
Saturday 1 February 2014	22.9	5.2	100	100	0.0
Sunday 2 February 2014	12.0	2.9	85	90	0.4

Table 2. Seven-day average $PM_{2.5}$ and crystalline silica concentrations measured at the Caboolture industrial estate monitoring site from 23 January to 19 February 2014, together with wind frequency from the direction of the waste transfer station and rainfall during the sampling period.

Sampling period	7-day average $PM_{2.5}$ concentration ($\mu g/m^3$)	7-day average $PM_{2.5}$ crystalline silica concentration[a] ($\mu g/m^3$)	Proportion of winds from the direction of the waste transfer station (%)		Rainfall (mm)
			All hours	7:00am to 5:00pm only	
Thursday 23 January 2014 to Wednesday 29 January 2014	5.8	ND	57	72	114.1
Thursday 30 January 2014 to Wednesday 5 February 2014	6.8	0.06	77	86	2.8
Thursday 6 February 2014 to Wednesday 12 February 2014	4.2	ND	55	77	0.0
Thursday 13 February 2014 to Wednesday 19 February 2014	5.8	0.13	44	64	43.1

[a] ND = not detected. The minimum measurable $PM_{2.5}$ crystalline silica concentration that could be determined with the sampling equipment and laboratory method used was 0.06 $\mu g/m^3$. Where $PM_{2.5}$ crystalline silica concentrations were below this minimum measurable concentration the value is reported as 'ND' in the table.

Table 3. Dust deposition sampling results for the Caboolture industrial estate monitoring site, 22 January to 24 February 2014.

Sample	Dust deposition rate ($mg/m^2/day$)					Winds from direction of waste transfer station (%)	Rainfall (mm)
	Total solids	Insoluble solids	Mineral (ash) content	Organic (combustible matter) content	Soluble solids		
Sample 1	155	151	128	23	4	56	164
Sample 2	216	198	170	28	18		
Average	186	175	149	26	11		

Table 4. Composition of the insoluble solids component of the deposited dust samples collected at the Caboolture industrial estate monitoring site, 22 January to 24 February 2014.

Particle type		Surface coverage (%)[a]	
		Sample 1	Sample 2
Black	Coal	not detected	not detected
	Soot	trace	trace
	Black rubber dust	trace	**5**
Inorganics and minerals	Mineral dust (soil or rock dust)	**95**	**90**
	Mineral dust (fly ash)	not detected	not detected
	Mineral dust (cement dust)	**5**	**5**
	Mineral dust (glassy)	not detected	not detected
	Glass fragments	not detected	not detected
	Copper sludge	not detected	not detected
Biological	Photosynthetic slime and fungi	not detected	not detected
	Insect debris	not detected	not detected
	Plant debris (general)	trace	trace
	Plant debris (plant char)	trace	trace
	Plant debris (other)	not detected	not detected
General organic types	Wood dust	not detected	not detected
	Fibres (miscellaneous)	not detected	not detected
	Starch	not detected	trace
	Paint	not detected	not detected
	Plastic fragments	not detected	not detected
	Red rubber dust	not detected	not detected

[a] The uncertainty in the measurement of surface coverage is ±5 per cent

Department of Science, Information Technology and Innovation

Ormeau/Yatala air quality investigation

September 2015 to November 2016

Queensland Government

Prepared by

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Acknowledgements

This report has been prepared by the Department of Science, Information Technology and Innovation. Acknowledgement is made of the assistance provided by Ormeau/Yatala community members who allowed DSITI to locate monitoring equipment on their property or who assisted with sample collection for asbestos analysis. The assistance provided by Department of Environment and Heritage Protection officers based on the Gold Coast is also acknowledged.

April 2017

Executive summary

The Department of Science, Information Technology and Innovation (DSITI) was engaged by the Department of Environment and Heritage Protection (DEHP) to conduct an investigation of air quality in residential suburbs bordering hard rock quarries in the Ormeau and Yatala areas. The aim of the monitoring program was to obtain data to assess community concern about potential risks to human health, in particular respirable crystalline silica and asbestos, from dust emissions from local quarry operations.

Monitoring was conducted at residential properties in relatively close proximity to quarries where highest pollutant levels resulting from quarrying activities were expected to be experienced. Monitoring took place between September 2015 and November 2016.

Results from the monitoring program found no evidence that quarry dust emissions were resulting in pollutant levels in the community that would lead to adverse health effects. Levels of PM_{10} (particles less than 10 micrometres in diameter), $PM_{2.5}$ (particles less than 2.5 micrometres in diameter), TSP (total suspended particles), respirable crystalline silica and asbestos all complied with relevant air quality criteria for protection of human health at all monitoring locations during the investigation period.

While there were infrequent exceedances of dust nuisance criteria for suspended particles (TSP) and deposited dust, evidence was inconclusive that quarrying activities were the primary cause of these exceedances. However, ongoing dust complaints relating to quarry operations recorded by DEHP over the investigation period, particularly between April and September 2016, highlight that the current dust nuisance assessment method may not adequately capture nuisance impacts from infrequent high dust episodes that are of relatively short duration.

The air pollutants of particular concern, respirable crystalline silica and asbestos, were not present at levels that would lead to adverse health effects. Respirable crystalline silica concentrations were less than two per cent of the assessment criterion for protection of human health. More than 85 per cent of particle samples contained no crystalline silica. No asbestos was detected in any of the particle samples collected during the investigation.

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Introduction

Six large quarries operate in the northern Darlington Range region located west of Ormeau and south of Yatala in South East Queensland. The quarried rock is used for concrete and asphalt aggregates and crushed road base. Manufactured sand is also produced in substantial volumes. The resource in the northern Darlington Range will provide the main long-term source of aggregates for markets in the Brisbane-Gold Coast growth corridor, and has been identified as a Key Resource Area under the *State Planning Policy 2/07 – Protection of Extractive Resources*[1].

The geological composition of the Ormeau/Yatala area in which these quarries exist consist of regionally metamorphosed sedimentary and volcanic rocks containing siliceous compounds. It is therefore expected that dust from quarrying operations in this area may include crystalline silica, however it is important to note that only respirable crystalline silica (i.e. found in particles less than 4 micrometres in diameter) is associated with adverse human health effects. Testing has identified that although the non-fibrous form of actinolite (acicular actinolite) is present in trace amounts, the fibrous form (asbestiform actinolite, an asbestos material) is not present[2]. Acicular actinolite poses a low risk to human health and is not considered hazardous.

The Department of Environment and Heritage Protection (DEHP) regulates emissions to the environment from activities designated as Environmentally Relevant Activities (ERAs) through conditions attached to Environmental Authorities issued in accordance with the *Environmental Protection Act 1994*. When directed by DEHP industries must monitor air quality to show compliance with these conditions, set to protect sensitive receptors from nuisance and health-related impacts. The six significant quarry operations in the Ormeau/Yatala area hold Environmental Authorities to conduct ERAs, under which they are prohibited from releasing airborne contaminants which cause a nuisance at a sensitive place, such as a private residence. All of the quarries in the northern Darlington Range region conduct dust deposition monitoring on their sites to identify potential nuisance.

In 2014–15, DEHP received numerous complaints from Yatala residents and the Yatala Residents Association regarding silica and asbestos impacts from these hard rock quarrying activities. Although the dust monitoring conducted by the quarries on their sites indicated that relevant dust deposition criterion were likely to be met at the nearest off-site receptor, the respirable fraction of any dust emitted (including the amount of respirable crystalline silica) could not be determined.

In response to these concerns, the Ormeau/Yatala air quality monitoring investigation was initiated by DEHP to obtain data to assess community concern about the impacts of quarry dust emissions on air quality and human health in residential areas of Ormeau and Yatala.

DEHP engaged the Department of Science, Information Technology and Innovation (DSITI) to conduct a monitoring program to gather air quality data at residential sites in the Ormeau/Yatala area that were likely to experience highest impacts from quarrying activities based on proximity and prevailing wind directions. The program was designed to measure levels of deposited dust, suspended particles, and respirable crystalline silica and asbestos. The monitoring program ran from 3 September 2015 to 14 November 2016. This report details the results of the investigation.

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[1] available at https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0015/114171/dme-stateplan-policy-1.pdf

[2] Holcim, *Actinolite Questions and answers*, 2015, available at http://www.holcim.com.au/fileadmin/templates/AU/doc/Community_Link/Beenleigh/QAsBeenleighActinolite.pdf

Monitoring program design

Impacts of airborne particles are closely related to particle size. Human health impacts are generally associated with particles less than 10 micrometres (μm) in diameter (called PM_{10}) which are small enough to be inhaled in to the lower respiratory tract. Of the total PM_{10} fraction of airborne particles, particles less than 2.5 μm in diameter (called $PM_{2.5}$) are now understood to be the primary size fraction of concern with regard to adverse human health effects. Airborne particles larger than 10 μm in diameter are generally associated with impacts on amenity (e.g. dust nuisance).

PM_{10} may be generated by both combustion processes (e.g. motor vehicle engines) and mechanical processes (e.g. rock crushing and windblown dust). While $PM_{2.5}$ is primarily formed by combustion processes, emissions from mechanical processes can contain some $PM_{2.5}$.

The composition of these small airborne particles may also be of concern. Of particular relevance to particle emissions from hard rock quarries are silica and asbestos. Silica can exist in both crystalline and non-crystalline forms. The non-crystalline form of silica does not pose a health risk. However, prolonged exposure to crystalline silica in the respirable size fraction (less than 4 μm in size and small enough to penetrate deep into the lung) may cause lung damage (silicosis)[3].

Silicate materials can also exist in fibrous and non-fibrous forms. Asbestos is the term for six naturally occurring fibrous silicate materials that, when inhaled, may lead to adverse human health effects. When bonded with other materials (e.g. cement) and undisturbed, asbestos generally does not pose a risk to human health.

DSITI's air quality monitoring program in the Ormeau/Yatala area was conducted over a 14-month period, from September 2015 to November 2016. To assess the potential for human health impacts, the monitoring program collected information on levels of:

- respirable crystalline silica
- particles less than 10 μm in diameter (PM_{10})
- particles less than 2.5 μm in diameter ($PM_{2.5}$)
- asbestos.

To assess the potential for dust nuisance impacts, the monitoring program collected information on levels of:

- total suspended particles (TSP)
- deposited dust.

Measurement of local meteorology (wind speed, wind direction and rainfall) was also undertaken to assist with assessment of possible sources of monitored particle levels and contributing factors.

Assessment criteria

In this study, assessment of possible health and amenity effects associated with particle levels and composition was conducted by comparing measured levels against recognised ambient air quality criteria. These criteria are summarised in Table 1.

[3] Safe Work Australia, *Crystalline silica*, 2013, available at http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/797/Crystalline%20Silica.pdf

Table 1. Air quality assessment criteria.

Pollutant	Criteria	Averaging period	Criteria source
Crystalline silica	3 µg/m³ 0.1 mg/m³ (100 µg/m³)*	Annual 8-hour time-weighted average	EPA Victoria Safe Work Australia
PM_{10}	50 µg/m³	24-hour	EPP Air and AAQ NEPM
	25 µg/m³	Annual	AAQ NEPM
$PM_{2.5}$	25 µg/m³	24-hour	EPP Air and AAQ NEPM
	8 µg/m³	Annual	EPP Air and AAQ NEPM
TSP	90 µg/m³	Annual	EPP Air
	60 µg/m³† 200 µg/m³†	24-hour 1-hour	NZ MfE
Deposited dust	120 mg/m² per day (insoluble dust fraction)	Month	DEHP
Asbestos	0.1 fibres/mL*	8-hour time-weighted average	Safe Work Australia

* occupational, not ambient, exposure standard
EPA Victoria = Environment Protection Authority Victoria
EPP Air = Queensland Environmental Protection (Air) Policy 2008
AAQ NEPM = Commonwealth National Environment Protection (Ambient Air Quality) Measure
NZ MfE = New Zealand Ministry for the Environment
† applicable to high sensitivity receiving environments such as residential areas

While there is a standard for occupational exposure (Safe Work Australia 8-hour time-weighted average workplace exposure standard)[4], there are no Queensland or national criteria for ambient (i.e. in the community) respirable crystalline silica concentrations. In the absence of Queensland or national ambient criteria for crystalline silica, measured respirable (as $PM_{2.5}$) crystalline silica concentrations in the Ormeau/Yatala area were compared against the annual assessment criterion in EPA Victoria's *Protocol for Environmental Management: Mining and Extractive Industries (PEMMEI)*[5]. The criterion in this document was adopted from the California EPA Office for Environmental Health Hazard Assessment Reference Exposure Levels (RELs) for respirable crystalline silica.

24-hour average PM_{10}, and 24-hour average and annual average $PM_{2.5}$ concentrations were compared with air quality objectives in the Queensland Environmental Protection (Air) Policy 2008 (EPP Air)[6]. Annual average PM_{10} concentrations were compared with the air quality standard in the Commonwealth National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM)[7].

Annual average TSP concentrations were compared with the EPP Air objective for assessment of human health risk. TSP is, however, mainly associated with dust nuisance impacts. Dust nuisance can be experienced at TSP levels below the health protection criterion, with the result that

[4] available at http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/workplace-exposure-standards

[5] EPA Victoria, *Protocol for Environmental Management: Mining and Extractive Industries (PEMMEI)*, Publication 1191, Victoria, Australia, December 2007, available at http://www.epa.vic.gov.au/our-work/publications/publication/2007/december/1191

[6] available at https://www.legislation.qld.gov.au/LEGISLTN/CURRENT/E/EnvProtAirPo08.pdf

[7] available at https://www.legislation.gov.au/Details/F2016C00215

guidelines designed for avoidance of dust nuisance are set at lower levels and for shorter averaging periods. There are no Queensland or national TSP dust nuisance guidelines, so the high sensitivity receiving environment dust nuisance trigger levels for 24-hour and one-hour average TSP concentrations provided in the New Zealand Ministry for the Environment (NZ MfE) document *Good practice guide for assessing and managing the environmental effects of dust emissions*[8], as recommended by DEHP[9], have been used to assess dust nuisance potential in this investigation. The NZ MfE document applies the high sensitivity criteria to residential areas.

The dust deposition limit value commonly applied to Environmentally Relevant Activities by DEHP[10] was used to assess the potential for nuisance dust impacts resulting from measured levels of deposited dust.

There are no Queensland or national criteria for ambient (i.e. in the community) asbestos levels. In the absence of Queensland or national ambient criteria for asbestos, the results of asbestos monitoring at Ormeau and Yatala were compared with Safe Work Australia's Workplace Exposure Standards for Airborne Contaminants[11].

Monitoring data collection methods

$PM_{2.5}$ and crystalline silica filter-based monitoring

In this study, crystalline silica concentrations were determined from $PM_{2.5}$ samples collected over seven-day periods. Collection of filter samples over seven-day periods was necessary to collect sufficient $PM_{2.5}$ material for the crystalline silica laboratory analysis method.

It was necessary in this investigation to use ambient particle samplers designed for ongoing outdoor use, which collected $PM_{2.5}$ rather than the respirable particle fraction (particles less than 4 µm in diameter, or PM_4) commonly sampled in occupational exposure monitoring. The measured $PM_{2.5}$ crystalline silica concentrations were compared with EPA Victoria's PEMMEI criterion for crystalline silica present in $PM_{2.5}$, which has been set at a level that provides equivalent protection to respirable crystalline silica guidelines.

Seven-day sampling was conducted using Partisol® Model 2025 sequential low-volume air samplers operated in accordance with the Australian/New Zealand Standard *AS/NZS 3580.9.10:2006 Method 9.10: Determination of suspended particulate matter—$PM_{2.5}$ low-volume sampler—Gravimetric method*. These samplers drew air through a $PM_{2.5}$ size-selective inlet (which removed particles larger than $PM_{2.5}$) and then through pre-weighed 47 millimetre diameter Teflon® filters over a seven-day period. The sampler automatically inserted a new pre-weighed filter in the air stream every seven days. The filters were weighed again after sampling and the difference in the weight was the mass of the $PM_{2.5}$ particles collected. From this, the mass concentrations of $PM_{2.5}$ were calculated by dividing the mass of collected particles by the volume of air drawn through the sampler.

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[8] available from http://www.mfe.govt.nz/publications/air/good-practice-guide-assessing-and-managing-environmental-effects-dust

[9] DEHP, *Application requirements for activities with impacts to air*, 2015, available at http://www.ehp.qld.gov.au/assets/documents/regulation/era-gl-air-impacts.pdf

[10] DEHP, *Common conditions – Prescribed environmentally relevant activities*, 2016, available at https://www.ehp.qld.gov.au/assets/documents/regulation/pr-co-common-conditions-prescribed-eras.pdf

[11] available at http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/workplace-exposure-standards

The $PM_{2.5}$ collected on Partisol® sampler filters were analysed for crystalline silica content by infrared spectroscopy using a method based on the NHMRC *Method for Measurement of Quartz in Respirable Airborne Dust by Infrared Spectroscopy and X-Ray Diffractometry*[12] and NIOSH Method 7602 Silica, Crystalline by IR (KBr pellet)[13]. The crystalline silica analysis was conducted by the NATA-accredited Queensland Government Safety In Mines Testing and Research Station (Simtars) laboratory.

PM_{10}, $PM_{2.5}$ and TSP continuous monitoring

Over the course of the investigation, continuous suspended particle monitoring was conducted using two different methods: TEOM® analysers and DustMasterPro™ instruments.

Between 3 September 2015 and 6 May 2016, continuous PM_{10} and $PM_{2.5}$ measurements were collected at the Harts Road, Luscombe monitoring site using a Model 1405-DF dichotomous TEOM® analyser fitted with a Filter Dynamics Measurement System (FDMS) unit, operated in accordance with the Australian/ New Zealand Standard *AS/NZS 3580.9.13:2013 Method 9.13: Determination of suspended particulate matter—$PM_{2.5}$ continuous direct mass method using a tapered element oscillating microbalance analyser*. The TEOM® analyser drew air through a PM_{10} size-selected inlet (which removed particles larger than PM_{10}), then through a very sharp cut cyclone (VSCC) which separated the particle stream into two; one of particles less than 2.5 µm in diameter ($PM_{2.5}$) and the other of particles between 2.5 and 10 µm in diameter ($PM_{2.5-10}$). The separated particle streams then passed through separate filters mounted on vibrating glass tubes. Particle mass was measured by the change in oscillating frequency of each glass tube following particle deposition on the filter. PM_{10} mass was calculated as the sum of simultaneous mass measurements from both particle streams.

Continuous TSP monitoring was conducted at the Harts Road, Luscombe monitoring site over the same period using an a Model 1405 TEOM® analyser operated in accordance with the above Australian Standard method, but without an FDMS unit and fitted with a TSP size-selective inlet in place of the PM_{10} inlet.

The TEOM® analysers were removed from the Harts Road, Luscombe monitoring site on 7 May 2016 (the instruments were required for other DSITI monitoring investigations) and a DustMasterPro™ 6000 series instrument was used to continuously monitor PM_{10} only for the remainder of the monitoring investigation. The DustMasterPro™ instrument was operated in accordance with the manufacturer's operating instructions. For the month prior to the removal of the TEOM® analysers, the DustMasterPro™ instrument was operated in conjunction with the TEOM® analysers to ensure data continuity following the change in instrumentation. From 8 July 2016, a second DustMasterPro™ 6000 series instrument was operated at the Vennor Drive, Ormeau monitoring site to provide continuous PM_{10} measurements at this site.

The DustMasterPro™ instruments measured PM_{10} by first drawing air through a PM_{10} size-selective inlet (which removed particles larger than PM_{10}). Inside the instrument, the air stream was illuminated with the beam from a laser light source, and reflected light scattered by particles in the air stream measured by a detector. The electrical signal from the detector was proportional to the amount of scattered light, which was, in turn, multiplied by an internal calibration factor to give the PM_{10} mass concentration.

[12] National Health and Medical Research Council, Canberra, ACT, 1984.

[13] National Institute for Occupational Safety and Health, Issue 3, NIOSH Manual of Analytical Methods (NMAM) Fourth Edition, 2003, available at https://www.cdc.gov/NIOSH/DOCS/2003-154/pdfs/7602.pdf

Deposited dust monitoring

Levels of deposited dust – the amount of dust that settles out of the air over time – were measured at Ormeau and Yatala using dust deposition gauges, which comprised a funnel and collection bottle to catch dust settling over a fixed area (the internal area of the funnel) over a one-month sampling period. Following sampling, the collected dust and rainwater were passed through a sieve to remove any extraneous matter greater than one millimetre in size (e.g. leaves, insects). The sieved sample was separated into insoluble and soluble fractions by filtration and dried, then the dried solids weighed. The results of the dust deposition analysis were expressed as the weight of dried solids per unit of surface area for the sampling period (e.g. $mg/m^2/day$ averaged over a 30-day period).

The insoluble solids were further analysed and identified as:

- ash – the mass of the insoluble portion which remained after heating the sample to a temperature of 850 degrees Celsius for 30 minutes, which is indicative of the mineral content of the dust (e.g. rock dust); and
- combustible matter – the mass of the insoluble portion of particles deposited which was lost on heating the sample to a temperature of 850 degrees Celsius for 30 minutes, which is indicative of organic matter (e.g. plant, insect material).

Deposited dust samples were collected and analysed in accordance with the Australian/New Zealand Standard *AS/NZ 3580.10.1:2016 Method 10.1 Determination of particulate matter—Deposited Matter—Gravimetric Method*.

Asbestos sampling

Particle samples for asbestos analysis was collected by residents living in suburbs surrounding the quarries over eight-hour periods when residents considered they were experiencing dust impacts from quarrying operations. Residents were supplied with a personal air sampling unit (SKC Aircheck Model 224-PCXR8 sampler), together with track-etched membrane filter cowls supplied by the laboratory undertaking the asbestos analysis. The sampling units were configured with a flow rate of 1 L/min, which equated to an air volume of about 500 litres over the eight hour collection period. This sample volume was recommended by the laboratory to maximise the detection of asbestos fibres. Four particle samples were received for asbestos analysis.

The membrane filters were analysed using Scanning Electron Microscopy (SEM) in accordance with International Organization for Standardization Method: *ISO 14966 – Ambient air – Determination of numerical concentration of inorganic fibrous particles – Scanning electron microscopy method* to count the respirable fibres collected on the filters (respirable fibres are less than 3 µm wide, greater than 5 µm long, and have an aspect ratio of length to width greater than 3:1). The composition of these respirable fibres were then assessed using X-ray Energy Dispersive Spectroscopy (EDS) to identify fibres as organic or inorganic, with additional characterisation of the inorganic fibres.

The reporting limit of detection of the sampling and analysis method was 0.001 fibres per millilitre (f/mL).

The asbestos analysis was conducted by COHLABS in conjunction with Glossop Consultancy. COHLABS is a NATA-accredited laboratory for asbestos identification and airborne fibre counting analysis.

Monitoring site locations

Monitoring site locations were chosen in close proximity to quarrying operations to obtain a measure of the highest concentrations likely to be experienced in residential areas of Yatala and Ormeau. The locations of these monitoring stations in relation to local quarries are shown in Figure 1.

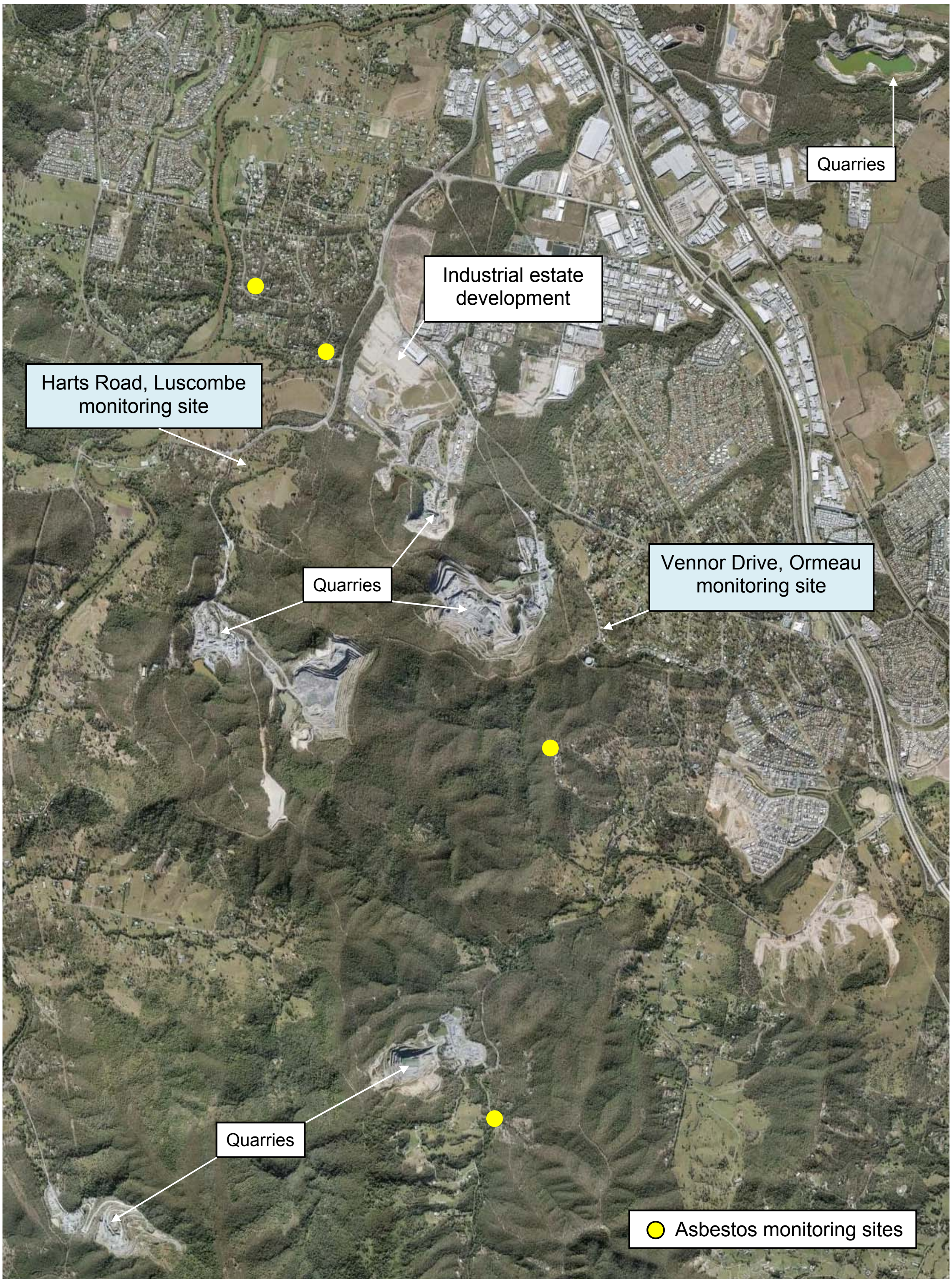


Figure 1. Monitoring site and quarry locations.

To assess dust impacts on Yatala residential areas, monitoring equipment was sited at a private residence on Harts Road in Luscombe, approximately 1.5 kilometres north of the nearest quarry and 150m from the road used by trucks transporting quarry products. This location was expected to experience highest quarry dust impacts during south-easterly and southerly winds.

To assess dust impacts on Ormeau residential areas, monitoring equipment was sited at a private residence on Vennor Drive in Ormeau, approximately 500 metres east of the nearest quarry. Historically, this area has been a source of ongoing dust complaints, particularly during westerly winds.

At both monitoring sites, collection of weekly $PM_{2.5}$ samples for crystalline silica analysis and monthly deposited dust samples were collected.

At the Harts Road, Luscombe monitoring site, continuous measurement of PM_{10}, $PM_{2.5}$, TSP and meteorological parameters was also undertaken (scaled back to just PM_{10} and meteorology from May 2016). The Vennor Drive, Ormeau monitoring was upgraded to include continuous measurement of PM_{10} and meteorology from July 2016.

Asbestos sampling was conducted at four additional residential locations, two in Yatala, one in Ormeau Hills and one in Kingsholme. The sampling was undertaken by community members who had previously experienced dust nuisance perceived to originate from quarrying operations, or who had concerns about dust impacts from quarrying operations.

Results and discussion

Meteorology

For dust generated at quarries to impact on the Harts Road, Luscombe monitoring site, the wind had to blow from an east to south-west direction. During the monitoring period there were also extensive earthworks associated with the development of an industrial estate taking place approximately 1.5 kilometres from the Harts Road, Luscombe monitoring site. During north-east to east winds the potential existed for dust from these earthworks to impact at the monitoring site, although monitoring results did not indicate any significant contribution (see Figure 2 later in this report).

For dust generated at quarries to impact on the Vennor Drive, Ormeau monitoring site, the wind had to blow from a south-west to a north-west direction.

In the assessment of the potential sources of elevated particle concentrations in this report, pollution roses (diagrams showing pollutant concentration frequency and wind direction relationships) and the proportion of winds from the direction of the quarries have been included in the pollutant analyses.

Rainfall can impact particle emissions and concentrations. Rainfall totals during the individual monitoring periods were generally low (predominantly less than 10 millimetres in any seven-day sampling period), so it is unlikely that particle concentrations would have been significantly affected by rainfall events during the majority of the investigation period. Particle levels monitored during this period are therefore likely to include conditions representative of worst-case scenarios.

Wind direction and rainfall summaries for each seven-day monitoring period at the Harts Road, Luscombe and Vennor Drive, Ormeau monitoring sites are shown in the Appendix to this report.

Crystalline silica

Summary statistics for the seven-day average $PM_{2.5}$ crystalline silica concentrations measured at the Harts Road, Luscombe and Vennor Drive, Ormeau monitoring sites are shown in Table 2. Data for individual seven-day monitoring periods can be found in the Appendix to this report.

Table 2. $PM_{2.5}$ crystalline silica statistics at the Harts Road, Luscombe and Vennor Drive, Ormeau monitoring sites.

Statistic	Harts Road Luscombe	Vennor Drive Ormeau
Monitoring period	3 September 2015 to 2 November 2016	10 September 2015 to 2 November 2016
Number of valid 7-day average samples	56 (92%)	60 (100%)
Number of samples where crystalline silica was detected	8	5
Average concentration (µg/m^3)*‡	0.04	0.03
Maximum 7-day average concentration (µg/m^3)	0.13	0.07
Theoretical maximum 8-hour average concentration (µg/m^3)†	2.73	1.47

† Calculated by assuming that the maximum respirable crystalline silica mass collected over seven days was sampled over a single 8-hour period.

* The EPA Victoria Protocol for Environmental Management: Mining and Extractive Industries (PEMMEI) assessment criterion for respirable crystalline silica (as $PM_{2.5}$) is an annual average of 3 µg/m^3.

‡ In calculating the average concentration over the monitoring period, a concentration of 0.03 µg/m^3 (50% of the detection limit of the sampling and analysis method) has been assumed for those 7-day sampling periods where the crystalline silica concentration was below the detection limit.

Measured $PM_{2.5}$ crystalline silica levels were very low. The maximum seven-day crystalline silica concentrations measured in this study were 0.13 µg/m^3 at the Harts Road, Luscombe monitoring site and 0.07 µg/m^3 at the Vennor Drive, Ormeau monitoring site. A crystalline silica content above the detection limit of the sampling and analysis method (0.06 µg/m^3) was only measured in 14 per cent of samples collected at the Harts Road, Luscombe monitoring site and 8 per cent of samples collected at the Vennor Drive, Ormeau monitoring site.

In the absence of a Queensland or national ambient air quality guideline for crystalline silica, measured concentrations of crystalline silica were compared against the annual assessment criterion of 3 µg/m^3 in EPA Victoria's *Protocol for Environmental Management: Mining and Extractive Industries* (PEMMEI). The EPA Victoria criterion is based on crystalline silica present in $PM_{2.5}$.

Average crystalline silica concentrations monitored in this study were less than two per cent of the EPA Victoria annual criterion. The average crystalline silica concentration measured at the Harts Road, Luscombe monitoring site was 0.04 µg/m^3. At the Vennor Drive, Ormeau monitoring site, the average crystalline silica concentration was 0.03 µg/m^3.

To assess short-term respirable crystalline silica exposure, the theoretical maximum 8-hour average concentration was calculated for each monitoring site and compared against the Safe Work Australia 8-hour time-weighted average workplace exposure standard of 0.1 mg/m^3 (100 µg/m^3). The maximum 8-hour average concentration was calculated by assuming that the highest mass of respirable crystalline silica measured in the weekly samples collected during the investigation period was sampled during a single 8-hour period. Using this approach, the theoretical maximum 8-hour average respirable crystalline silica concentrations were 2.73 µg/m^3 at the Harts Road, Luscombe site and 1.47 µg/m^3 at the Vennor Drive, Ormeau site. These concentrations were well below the Safe Work Australia standard for occupational exposure.

The monitoring conducted at Harts Road, Luscombe and Vennor Drive, Ormeau demonstrates that dust emissions from local quarry operations contain very low levels of respirable crystalline silica. This finding is in line with that of a previous quarry dust investigation conducted by DSITI at Mount Cotton[14].

Based on the very low levels of respirable crystalline silica relative to the health risk assessment criterion measured in the air at the two monitoring sites in close proximity to quarrying operations, it is very unlikely that ambient exposure in residential areas in Yatala and Ormeau would lead to adverse health impacts.

PM_{10}

Summary statistics for PM_{10} concentrations measured at the Harts Road, Luscombe and Vennor Drive, Ormeau monitoring sites are shown in Table 3.

Table 3. PM_{10} concentration statistics at the Harts Road, Luscombe and Vennor Drive, Ormeau monitoring sites.

Statistic	Harts Road Luscombe	Vennor Drive Ormeau
Monitoring period	3 September 2015 to 14 November 2016	8 July 2016 to 14 November 2016
Number of valid 1-hour average values	10,129 (96%)	2784 (90%)
Number of valid 24-hour average values	422 (96%)	116 (90%)
Maximum 24-hour average concentration (µg/m^3)	37.9	32.2
Exceedances of EPP Air 24-hour objective†	0	0
Average concentration (µg/m^3)‡	12.0	18.9
Exceedances of AAQ NEPM annual standard*	0	0
Median 24-hour average concentration (µg/m^3)	11.2	18.3
Minimum 24-hour average concentration (µg/m^3)	2.3	11.6

† The EPP Air objective (and AAQ NEPM standard) for 24-hour average PM_{10} concentration is 50 µg/m^3.
* The AAQ NEPM standard for annual average PM_{10} concentration is 25 µg/m^3.
‡ Average concentration for the study period calculated from 1-hour average concentrations.

24-hour average PM_{10} concentrations did not exceed the EPP Air objective at either monitoring site during the period of monitoring at each site.

The average PM_{10} concentration at the Harts Road, Luscombe monitoring site over the study period was less than 50 per cent of the AAQ NEPM annual standard. The average PM_{10}

[14] available at https://www.qld.gov.au/environment/pollution/monitoring/air-programs/

concentration over the four-month period during which PM_{10} monitoring was undertaken at the Vennor Drive, Ormeau monitoring site was also less than the AAQ NEPM annual standard value.

As many processes (both mechanical and combustion-related) can give rise to PM_{10} emissions, the continuous PM_{10} monitoring data from both the Harts Road, Luscombe and Vennor Drive, Ormeau monitoring sites was examined relative to wind direction to identify potential sources of elevated PM_{10} concentrations. The results of this analysis are displayed below as pollution roses showing the frequency of measured one-hour average PM_{10} concentrations for ten degree wind direction ranges (direction being where the wind is blowing from).

Pollution roses for one-hour average PM_{10} concentrations at the Harts Road monitoring site are shown in Figure 2 and Figure 3. The pollution rose in Figure 2 includes PM_{10} concentrations for the whole of the study period. The pollution rose in Figure 3 includes only PM_{10} concentrations measured during the hours of operation of the quarries (7am to 5pm, Monday to Friday). The red lines in the two figures indicate the wind direction range where quarry dust emissions could impact on the Harts Road, Luscombe monitoring site. The black vertical scale indicates the percentage of total measurements.

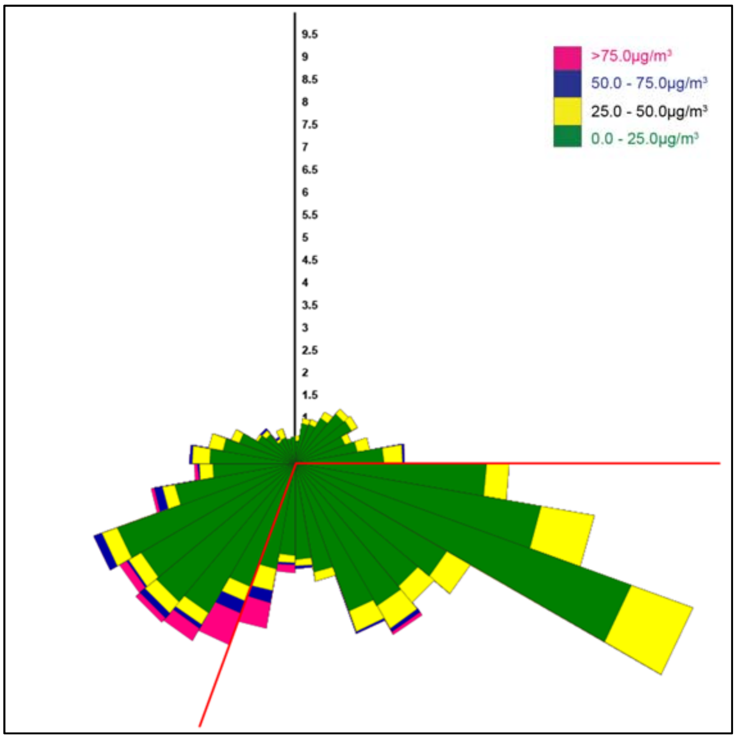


Figure 2. PM_{10} pollution rose for the Harts Road, Luscombe monitoring site for all hours during the monitoring period.

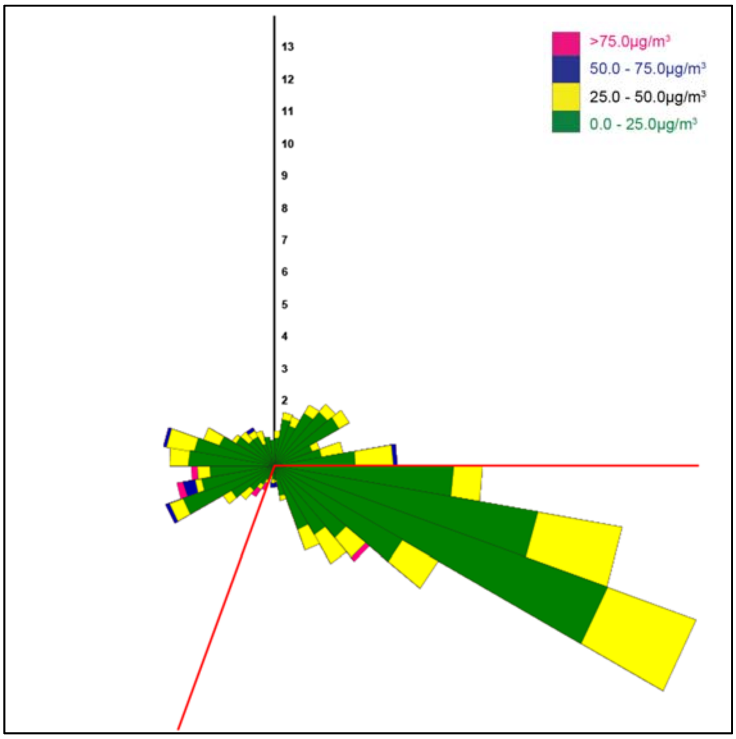


Figure 3. PM_{10} pollution rose for the Harts Road, Luscombe monitoring site during quarry operating hours (7am-5pm, Monday–Friday).

These pollution roses show that during the period from September 2015 to November 2016 winds blew predominantly from the south to south-east, while the highest one-hour average PM_{10} concentrations at the Harts Road, Luscombe monitoring site occurred during south to south-westerly winds. Comparison of Figure 2 (all hours) with Figure 3 (quarry operating hours only) indicates that the majority of the elevated one-hour average PM_{10} concentrations (i.e. >50 µg/m^3) occurred outside of normal quarry operating hours and were likely to have resulted from sources other than quarrying activities. Other possible PM_{10} sources contributing to these elevated concentrations could have been windblown dust from dry ground and vegetation burning.

In Figure 3 the spread of one-hour average PM_{10} concentrations observed for wind directions associated with quarry dust emissions is similar to that seen for non-quarry wind directions. This indicates that for the Harts Road, Luscombe monitoring site (located greater than 1.5 kilometres from quarrying operations) PM_{10} impacts resulting from quarrying activities are comparable to those coming from other PM_{10} sources.

Corresponding pollution roses for one-hour average PM_{10} concentrations at the Vennor Drive, Ormeau monitoring site between July and November 2016 are shown in Figure 4 and Figure 5. The pollution rose in Figure 4 includes PM_{10} concentrations for the whole period during which PM_{10} monitoring was undertaken at the site, and shows that during this period winds blew predominantly from either the east or the west. Elevated one-hour average PM_{10} concentrations (i.e. >50 µg/m^3) occurred mainly during winds from the west where a quarry is located, but also to a lesser extent on winds from the east and south from non-quarry PM_{10} sources.

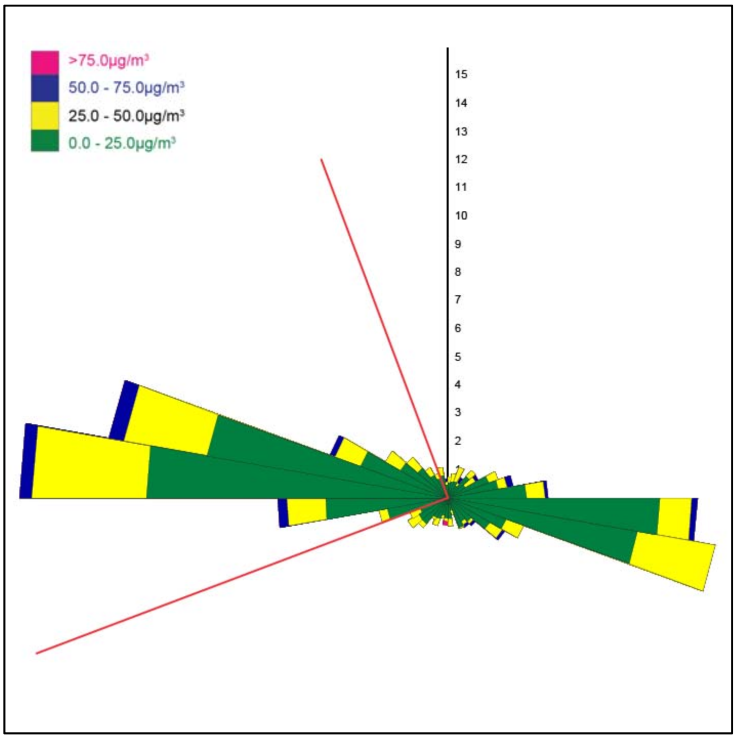


Figure 4. PM_{10} pollution rose for the Vennor Drive, Ormeau monitoring site for all hours during the PM_{10} monitoring period.

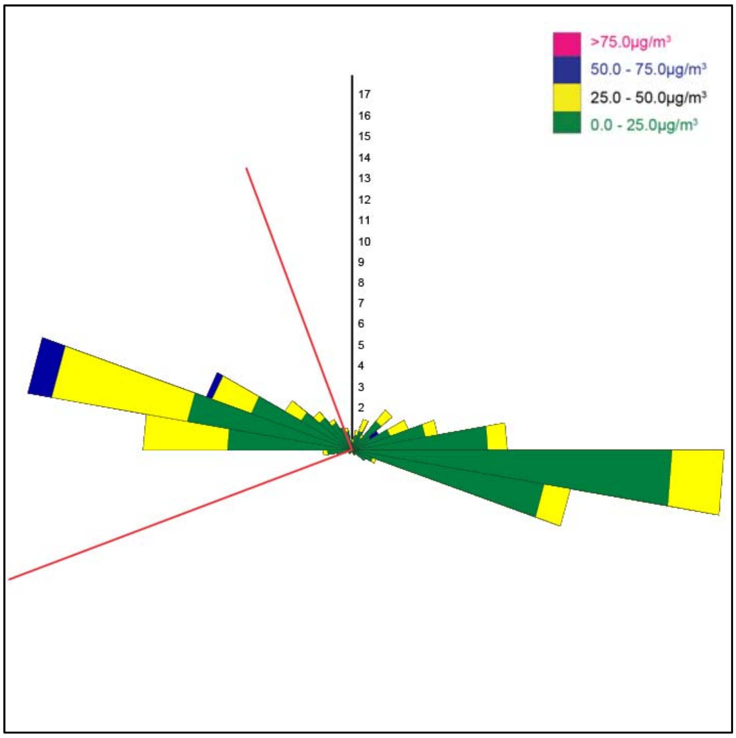


Figure 5. PM_{10} pollution rose for the Vennor Drive, Ormeau monitoring site during quarry operating hours (7am–5pm, Monday–Friday).

The pollution rose in Figure 5 for PM_{10} concentrations measured during the normal quarry operating hours (7am to 5pm, Monday to Friday) shows that during these periods one-hour average PM_{10} concentrations greater than 25 µg/m^3 were highly correlated with winds from the west, indicating that quarry dust emissions made up a significant proportion of overall PM_{10} at the Vennor Drive, Ormeau monitoring site when quarry activities were taking place. This result is likely to be influenced to a significant degree by the local topography and proximity to the closest quarry of this monitoring site (located on a ridge overlooking the quarry approximately 500m away). Residential areas in Ormeau further from the quarries and below the ridge line are expected to experience lesser impacts from quarry dust emissions.

While the monitoring data shows quarry operations noticeably impacting on PM_{10} concentrations at the Vennor Drive, Ormeau monitoring site, quarry dust emissions did not cause PM_{10} concentrations to exceed air quality guideline values during the four month period in which PM_{10} monitoring was conducted at this site.

$PM_{2.5}$

Summary statistics for $PM_{2.5}$ concentrations measured at the Harts Road, Luscombe and Vennor Drive, Ormeau monitoring sites are shown in Table 4.

Table 4. $PM_{2.5}$ concentration statistics at the Harts Road, Luscombe and Vennor Drive, Ormeau monitoring sites.

Statistic	Harts Road, Luscombe		Vennor Drive, Ormeau
Monitoring instrument	TEOM®	Partisol®	Partisol®
Monitoring period	3 September 2015 to 5 May 2016	3 September 2015 to 2 November 2016	10 September 2015 to 2 November 2016
Number of 1-hour average values	5875 (99%)	n/a	n/a
Number of 24-hour average values	245 (99%)	n/a	n/a
Maximum 24-hour average concentration (μg/m^3)	13.9	n/a	n/a
Exceedances of EPP Air 24-hour objective†	0	n/a	n/a
Median 24-hour average concentration (μg/m^3)	5.7	n/a	n/a
Minimum 24-hour average concentration (μg/m^3)	2.0	n/a	n/a
Number of 7-day average values	n/a	56 (92%)	60 (100%)
Maximum 7-day average concentration (μg/m^3)	n/a	16.0	8.6
Average concentration (μg/m^3)	5.0‡	4.5	4.3
Exceedances of EPP Air annual average objective value*	0	0	0

n/a = not applicable
† The EPP Air objective (and AAQ NEPM standard) for 24-hour average $PM_{2.5}$ concentration is 25 μg/m^3.
* The EPP Air objective (and AAQ NEPM standard) for annual average $PM_{2.5}$ concentration is 8 μg/m^3.
‡ Average concentration for the monitoring period calculated from 1-hour average concentrations.

Assessment of $PM_{2.5}$ levels against the EPP Air 24-hour objective was only possible at the Harts Road, Luscombe site for the eight-month period the TEOM® instrument was located at this site (September 2015 to May 2016). No exceedances of the EPP Air objective for 24-hour average $PM_{2.5}$ concentrations were measured during this period.

The seven-day $PM_{2.5}$ concentration data collected by the Partisol® samplers over the period September 2015 to November 2016 was used to assess compliance with the EPP Air annual objective. The average $PM_{2.5}$ concentrations at the Harts Road, Luscombe and Vennor Drive, Ormeau monitoring sites (as measured by the Partisol® samplers) over the monitoring period were 56 per cent and 54 per cent respectively of the EPP Air annual objective.

Local quarry operations did not lead to levels of $PM_{2.5}$ above guideline values at the two monitoring sites during the monitoring period. This is in line with the general understanding that dust emissions from mechanical processes such as blasting and rock crushing predominantly contain particles larger than 2.5 µm in size.

TSP

Summary statistics for TSP concentrations measured at the Harts Road, Luscombe monitoring site between September 2015 and May 2016 are shown in Table 5.

Table 5. TSP concentration statistics at the Harts Road, Luscombe monitoring site.

Statistic	Harts Road, Luscombe
Monitoring period	3 September 2015 to 5 May 2016
Number of 1-hour average values	5843 (99%)
Number of 24-hour average values	245 (99%)
Maximum 1-hour average concentration ($\mu g/m^3$)	491.8
Exceedances of NZ MfE 1-hour dust nuisance trigger value+	2
Maximum 24-hour average concentration ($\mu g/m^3$)	71.7
Exceedances of NZ MfE 24-hour dust nuisance trigger value†	1
Median 24-hour average concentration ($\mu g/m^3$)	22.2
Minimum 24-hour average concentration ($\mu g/m^3$)	6.1
Average concentration ($\mu g/m^3$)‡	23.7
Exceedances of EPP Air annual objective*	0

+ The NZ MfE criterion for 1-hour TSP concentrations is 200 $\mu g/m^3$.
† The NZ MfE criterion for 24-hour average TSP concentrations is 80 $\mu g/m^3$.
* The EPP Air objective for annual average TSP concentrations is 90 $\mu g/m^3$.
‡ Average concentration for the study period calculated from 1-hour average concentrations.

The New Zealand Ministry for the Environment has developed guidelines for TSP which are designed to trigger when action to control dust is needed to minimise offsite impacts. For high sensitivity receiving environments such as residential areas, a trigger level of 200 $\mu g/m^3$ over a one-hour period and 60 $\mu g/m^3$ over a 24 hour period are suggested. At the Harts Road, Luscombe monitoring site, TSP levels complied with the one-hour trigger level for the entire eight month monitoring period, except for a two-hour period on 11 April 2016. The magnitude of the TSP levels during the dust episode was sufficient to also result in an exceedance of the 24-hour dust trigger level on this day. The elevated TSP concentrations on this day occurred during southerly winds, which is consistent with impacts from quarry dust emissions. However, as the high TSP levels were measured after 5pm (i.e. outside of normal quarry operating hours) it is possible that another dust source was responsible although, given the absence of alternative dust sources in this wind direction, after-hours activities or wind erosion from quarry stockpiles or exposed ground was most likely the source of the high TSP levels.

Based on the assessment criteria used and the TSP monitoring results, levels of suspended particles generated by quarry activities would not be considered to constitute a dust nuisance at distances from quarry operations comparable to that of the Harts Road, Luscombe monitoring site (greater than 1.5 kilometres) under typical operational and weather conditions.

Although a full year of data was not collected, the average TSP concentration over the eight-month monitoring period was just 26 per cent of the EPP Air annual average objective of 90 µg/m^3, indicating that long-term TSP exposure at the monitoring location would almost certainly be below the objective for protection of human health.

Deposited dust

Monthly deposited dust levels measured at the Harts Road, Luscombe monitoring site are displayed in Figure 6 and collated in Table 6. Corresponding data for the Vennor Drive, Ormeau monitoring site are displayed in Figure 7 and collated in Table 7. In Figures 6 and 7 the ash and combustible matter content of the collected insoluble solids is shown by the divisions in each column. Being rock in origin, dust from quarrying operations would appear in the ash fraction of the insoluble solids.

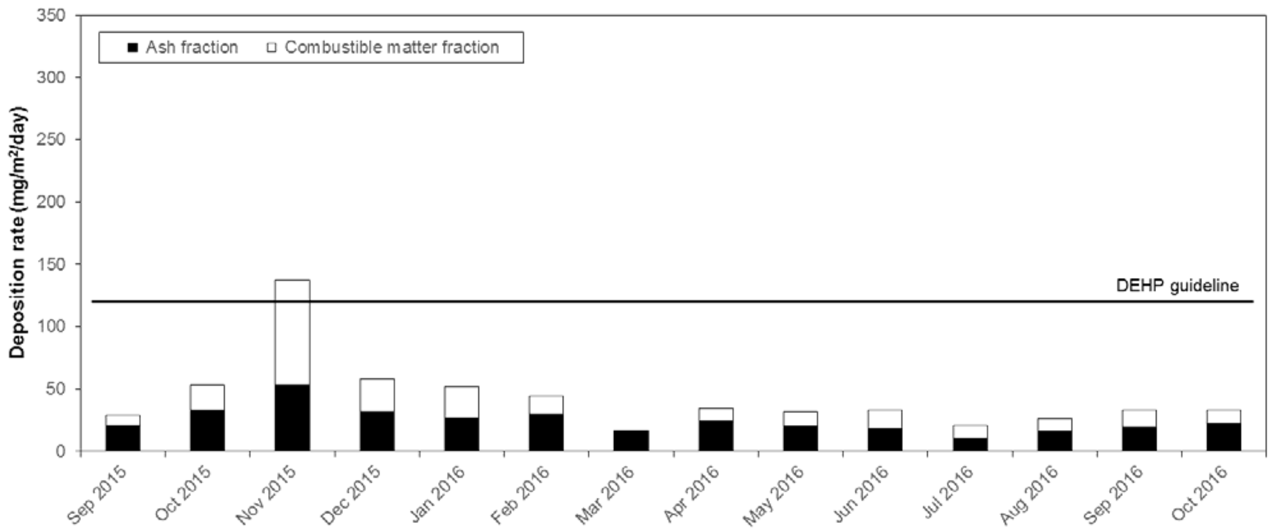


Figure 6. Insoluble dust deposition rates at the Harts Road, Luscombe monitoring site.

Table 6. Deposited dust levels monitored at the Harts Road, Luscombe monitoring site, September 2015 to October 2016.

Month	Deposited dust at Harts Road, Luscombe ($mg/m^2/day$)			Proportion of winds from quarries (%)	Rainfall (mm)
	Insoluble solids*	Ash	Combustible matter		
September 2015	29	20	8	43	26.2
October 2015	53	33	20	53	22.8
November 2015	**137**	53	84	47	91.2
December 2015	58	31	27	56	41.1
January 2016	52	26	26	48	23.2
February 2016	45	30	15	75	74.3
March 2016	17	15	1	61	24.7
April 2016	34	24	10	53	21.8
May 2016	31	20	12	34	0.9
June 2016	33	18	15	28	121.9
July 2016	20	10	10	30	16.4
August 2016	26	16	10	39	18.3
September 2016	33	19	14	36	21.4
October 2016	33	22	11	40	29.6

* Deposited dust levels above the DEHP guideline are shown in **bold** text.
The DEHP guideline for deposited dust is 120 $mg/m^2/day$, averaged over 1 month.

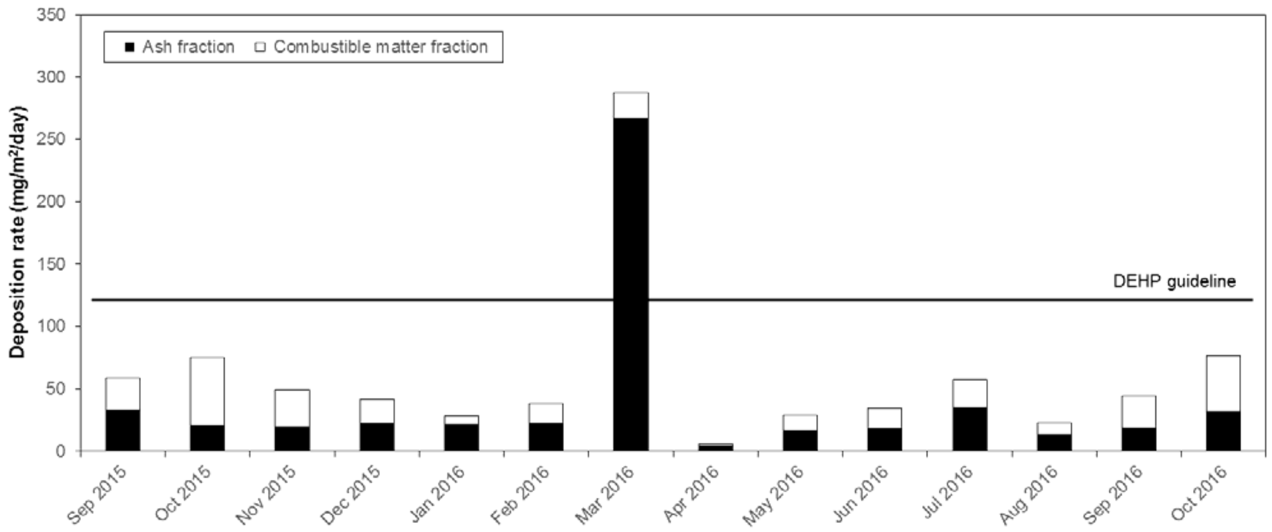


Figure 7. Insoluble dust deposition rates at the Vennor Drive, Ormeau monitoring site.

Table 7. Deposited dust levels monitored at the Vennor Drive, Ormeau monitoring site, September 2015 to October 2016.

Month	Deposited dust at Harts Road, Luscombe ($mg/m^2/day$)			Proportion of winds from quarries (%)	Rainfall (mm)
	Insoluble solids*	Ash	Combustible matter		
September 2015	58	33	25	14	26.2
October 2015	75	21	54	9	22.8
November 2015	49	19	30	13	91.2
December 2015	41	22	20	8	41.1
January 2016	28	21	7	13	23.2
February 2016	38	22	16	3	74.3
March 2016	**287**	267	21	7	24.7
April 2016	6	4	2	9	21.8
May 2016	29	17	12	18	0.9
June 2016	34	18	16	26	121.9
July 2016	57	35	23	36	16.4
August 2016	23	13	10	41	18.3
September 2016	44	18	26	41	21.4
October 2016	76	31	45	35	29.6

* Deposited dust levels above the DEHP guideline are shown in **bold** text.
The DEHP guideline for deposited dust is 120 $mg/m^2/day$, averaged over 1 month.

The DEHP guideline was exceeded at the Harts Road, Luscombe monitoring site in November 2015. During this sampling period, about half of all winds blew from the direction of the quarries. Figure 6 shows that this sample contained a significantly high amount of combustible matter while the ash content, although slightly elevated, was still well below the DEHP guideline value. This indicates that quarry dust emissions were not the major source contributing to the exceedance of the DEHP guideline. In other dust deposition monitoring undertaken by DSITI, a similar elevated combustible matter content at the same time of year was found to be due to high levels of plant material in the deposited dust, possibly from an annual flowering event[15], and it is likely that the November 2015 exceedance at the Harts Road monitoring site was the result of similar circumstances.

The DEHP guideline was exceeded at the Vennor Drive, Ormeau monitoring in March 2016. While this sample had a very high ash content indicative of quarry dust contribution, the proportion of winds blowing from the direction of the quarries was very low – only seven per cent of the sampling period (see Table 7). For quarry dust emissions to have been a significant contributor to this result, dust levels during periods winds blew from the direction of the quarries would have been extremely high and dust complaints would have been expected. As no dust complaints related to quarry operations were recorded by DEHP during the sampling period, it is considered most likely that

[15] DSITI, *Western-Metropolitan Rail System Phase 2 Coal Dust Monitoring Program. Phase 2 monitoring report: February 2014 to December 2015*, 2016, available at http://www.ehp.qld.gov.au/management/coal-dust/pdf/phase2-rail-coal-dust-monitoring-report-feb2014-dec2015.pdf

other dust sources (most probably localised to the immediate vicinity of the sampler) were responsible.

The dust deposition monitoring results indicate that quarry dust emissions did not result in exceedances of the dust nuisance assessment criterion for dust fallout at the two monitoring sites during the period from September 2015 to October 2016. However, dust nuisance impacts from quarries often relate to short duration episodes of high dust levels which may not be adequately captured by an assessment method based on a monthly average deposition rate if dust levels are relatively low at other times during the sampling period. Ongoing dust complaints recorded by DEHP, some corroborated by DEHP officers, over the investigation period, particularly between April and September 2016 when measured dust deposition rates were well below the DEHP guideline value, suggests that this is the case for residential properties situated in close proximity to quarrying operations in the Ormeau/Yatala area.

Asbestos

In this investigation sampling for airborne asbestos was undertaken by residents living in suburbs surrounding the quarries. Residents were supplied with a personal sampling pump and specially prepared membrane collection filter, and asked to operate the sampler when they considered quarry dust impacts were being experienced. A total of four particle samples were received for testing for the presence of asbestiform minerals. The results of the particle sample analysis are shown in Table 8.

Table 8. Asbestos monitoring results.

Sample location	Concentration (fibres/mL)*	Respirable fibres detected	
		Count	Composition
Glen Osmond Road, Yatala	<0.001	8	mica (×5), quartz (×2), halite
Enkleman Road, Yatala	<0.001	4	mica (×3), actinolite
The Plateau, Ormeau Hills	<0.001	3	mica, organic, chlorite
Upper Ormeau Road, Kingsholme	<0.001	4	mica (×2), quartz, halite
* The Safe Work Australia criterion for asbestos is 0.1 fibres/mL.			

No asbestos materials were detected in any of the four particle samples collected in residential areas surrounding the quarries.

One of the particle samples collected in Yatala was found to contain a cleavage fragment of non-asbestiform actinolite. This non-fibrous form of actinolite is present in trace amounts in the rock quarried in the Ormeau and Yatala areas[16].

The other types of respirable fibres detected in the particle samples were consistent with inorganic minerals that could be expected in a suburban housing environment.

In all particle samples the concentration of respirable fibres was below the reporting limit of detection of 0.001 fibres/mL. This concentration is less than 1/100th of the Safe Work Australia eight-hour exposure standard.

[16] Holcim, *Actinolite Questions and answers*, 2015, available at http://www.holcim.com.au/fileadmin/templates/AU/doc/Community_Link/Beenleigh/QAsBeenleighActinolite.pdf

Conclusions

In relation to the main objective of the investigation – to determine if air pollutant levels at residential locations in Ormeau and Yatala were likely to impact on human health – the monitoring results obtained between September 2015 and November 2016 found no evidence that this would be the case. Levels of PM_{10}, $PM_{2.5}$, TSP, respirable crystalline silica and asbestos all complied with relevant air quality guidelines for protection of human health at all monitoring sites.

Measured PM_{10} concentrations did not exceed 76 per cent of the EPP Air 24-hour objective and 73 per cent of the AAQ NEPM annual standard. Annual and maximum 24-hour average $PM_{2.5}$ concentrations were both only 56 per cent of the relevant EPP Air objective. The average TSP concentration measured at the Harts Road, Luscombe monitoring site was 26 per cent of the EPP Air annual objective.

Average $PM_{2.5}$ crystalline silica concentrations measured at the Yatala and Ormeau monitoring sites were both less than two per cent of the EPA Victoria annual assessment criterion. The highest seven-day average concentration recorded during the 14-month investigation period was just 0.13 $\mu g/m^3$ (or 4.3 per cent of the annual criterion). Crystalline silica was only detected in 14 per cent of weekly samples at the Harts Road, Luscombe monitoring site and 8 per cent of weekly samples at the Vennor Drive, Ormeau monitoring site.

No asbestos was detected in the particle samples collected at residential sites during this investigation.

The relationship between one-hour average PM_{10} concentrations and wind direction demonstrated a contribution from quarrying operations to PM_{10} levels at the Vennor Drive, Ormeau monitoring site during winds blowing from the direction of the quarries. However, at the Harts Road, Luscombe monitoring site PM_{10} concentrations measured during winds from the direction of the quarries were comparable to those measured on other wind directions. This suggests that in terms of PM_{10} exposure, quarry dust emissions are only likely to contribute measurably to overall exposure levels for locations in close proximity to quarries, such as residents of Vennor Drive, Ormeau located on the ridge line overlooking one of the quarries. (In saying this, it should be recognised that even at such locations, overall PM_{10} concentrations were compliant with the health-based PM_{10} assessment criteria.) For the majority of Yatala and Ormeau residents living further from the quarries, PM_{10} exposure from quarry emissions would be unlikely to be any greater than that from other urban PM_{10} sources.

The monitoring also determined that quarrying activities did not result in exceedances of the criteria commonly used to assess dust nuisance potential at the Harts Road, Luscombe and Vennor Drive, Ormeau monitoring locations during the investigation period. While there were infrequent exceedances of nuisance criteria for TSP and deposited dust, evidence was inconclusive that quarrying activities were the primary cause of these exceedances. However, with quarry dust complaints being recorded at times during the investigation period, particularly between April and September 2016 when measured dust deposition rates were well below the DEHP guideline value, the commonly used dust nuisance assessment method based on a monthly average dust deposition rate may not adequately capture nuisance impacts from infrequent high dust episodes that are of relatively short duration.

Appendix

Table 9. Seven-day average $PM_{2.5}$ crystalline silica concentration monitoring results at the Harts Road, Luscombe monitoring site, 3 September 2015 to 2 November 2016.

Weekly sampling period	Harts Road, Luscombe		
	7-day average $PM_{2.5}$ crystalline silica concentration* (µg/m^3)	**Proportion of winds from direction of quarries** (%)	**Rainfall during sampling period** (mm)
3 Sep to 9 Sep 2015	**0.06**	34	5.0
10 Sep to 16 Sep 2015	<0.06	49	6.3
17 Sep to 23 Sep 2015	<0.06	52	11.7
24 Sep to 30 Sep 2015	<0.06	32	3.2
1 Oct to 7 Oct 2015	<0.06	30	0.0
8 Oct to 14 Oct 2015	<0.06	58	5.7
15 Oct to 21 Oct 2015	<0.06	58	0.0
22 Oct to 28 Oct 2015	<0.06	54	17.1
29 Oct to 4 Nov 2015	<0.06	51	58.2
5 Nov to 11 Nov 2015	<0.06	63	25.2
12 Nov to 18 Nov 2015	<0.06	53	6.6
19 Nov to 25 Nov 2015	<0.06	39	1.1
26 Nov to 2 Dec 2015	<0.06	39	4.4
3 Dec to 9 Dec 2015	**0.06**	58	0.0
10 Dec to 16 Dec 2015	<0.06	54	4.6
17 Dec to 23 Dec 2015	<0.06	52	0.8
24 Dec to 30 Dec 2015	<0.06	57	13.9
31 Dec to 6 Jan 2016	<0.06	61	22.1
7 Jan to 13 Jan 2016	<0.06	52	0.6
14 Jan to 20 Jan 2016	<0.06	56	0.1
21 Jan to 27 Jan 2016	<0.06	57	3.2
28 Jan to 3 Feb 2016	<0.06	26	14.0
4 Feb to 10 Feb 2016	<0.06	82	2.1
11 Feb to 17 Feb 2016	<0.06	70	2.8
18 Feb to 24 Feb 2016	<0.06	74	1.3
25 Feb to 2 Mar 2016	<0.06	80	56.5
3 Mar to 9 Mar 2016	<0.06	83	15.7
10 Mar to 16 Mar 2016	<0.06	84	18.4
17 Mar to 23 Mar 2016	<0.06	63	0.7

Table 9 (cont.). Seven-day average $PM_{2.5}$ crystalline silica concentration monitoring results at the Harts Road, Luscombe monitoring site, 3 September 2015 to 2 November 2016.

Weekly sampling period	Harts Road, Luscombe		
	7-day average $PM_{2.5}$ crystalline silica concentration* (µg/m³)	Proportion of winds from direction of quarries (%)	Rainfall during sampling period (mm)
24 Mar to 30 Mar 2016	<0.06	34	2.2
31 Mar to 6 Apr 2016	<0.06	53	0.0
7 Apr to 13 Apr 2016	**0.06**	40	0.4
14 Apr to 20 Apr 2016	<0.06	55	2.0
21 Apr to 27 Apr 2016	<0.06	71	0.7
28 Apr to 4 May 2016	<0.06	46	18.7
5 May to 11 May 2016	**0.13**	37	0.0
12 May to 18 May 2016	Sampling fault	21	0.0
19 May to 25 May 2016	**0.06**	35	0.0
26 May to 1 Jun 2016	<0.06	23	0.1
2 Jun to 8 Jun 2016	**0.06**	29	62.3
9 Jun to 15 Jun 2016	<0.06	54	3.2
16 Jun to 22 Jun 2016	**0.06**	23	52.5
23 Jun to 29 Jun 2016	<0.06	11	0.5
30 Jun to 6 Jul 2016	Sampling fault	16	4.2
7 Jul to 13 Jul 2016	<0.06	21	0.0
14 Jul to 20 Jul 2016	<0.06	55	4.0
21 Jul to 27 Jul 2016	**0.06**	15	0.0
28 Jul to 3 Aug 2016	Sampling fault	23	12.5
4 Aug to 10 Aug 2016	<0.06	48	3.2
11 Aug to 17 Aug 2016	<0.06	46	0.3
18 Aug to 24 Aug 2016	<0.06	35	14.0
25 Aug to 31 Aug 2016	<0.06	27	0.0
1 Sep to 7 Sep 2016	<0.06	49	7.0
8 Sep to 14 Sep 2016	Sampling fault	48	6.9
15 Sep to 21 Sep 2016	<0.06	17	7.0
22 Sep to 28 Sep 2016	Sampling fault	25	0.1
29 Sep to 5 Oct 2016	<0.06	27	14.8
6 Oct to 12 Oct 2016	<0.06	45	0.1
13 Oct to 19 Oct 2016	<0.06	54	9.9
20 Oct to 26 Oct 2016	<0.06	29	0.0

Table 9 (cont.). Seven-day average $PM_{2.5}$ crystalline silica concentration monitoring results at the Harts Road, Luscombe monitoring site, 3 September 2015 to 2 November 2016.

Weekly sampling period	Harts Road, Luscombe		
	7-day average $PM_{2.5}$ crystalline silica concentration* ($\mu g/m^3$)	Proportion of winds from direction of quarries (%)	Rainfall during sampling period (mm)
27 Oct to 2 Nov 2016	<0.06	35	5.8
* Samples containing measurable crystalline silica content are shown in bold text.			

Table 10. Seven-day average $PM_{2.5}$ crystalline silica concentration monitoring results at the Vennor Drive, Ormeau monitoring site, 10 September 2015 to 2 November 2016.

Weekly sampling period	Vennor Drive, Ormeau		
	7-day average $PM_{2.5}$ crystalline silica concentration* ($\mu g/m^3$)	Proportion of winds from direction of quarries† (%)	Rainfall during sampling period (mm)*
10 Sep to 16 Sep 2015	<0.06	13	6.3
17 Sep to 23 Sep 2015	<0.06	14	11.7
24 Sep to 30 Sep 2015	<0.06	15	3.2
1 Oct to 7 Oct 2015	<0.06	10	0.0
8 Oct to 14 Oct 2015	<0.06	7	5.7
15 Oct to 21 Oct 2015	<0.06	5	0.0
22 Oct to 28 Oct 2015	<0.06	9	17.1
29 Oct to 4 Nov 2015	<0.06	11	58.2
5 Nov to 11 Nov 2015	<0.06	11	25.2
12 Nov to 18 Nov 2015	<0.06	8	6.6
19 Nov to 25 Nov 2015	<0.06	20	1.1
26 Nov to 2 Dec 2015	**0.07**	19	4.4
3 Dec to 9 Dec 2015	<0.06	5	0.0
10 Dec to 16 Dec 2015	<0.06	9	4.6
17 Dec to 23 Dec 2015	<0.06	7	0.8
24 Dec to 30 Dec 2015	<0.06	7	13.9
31 Dec to 6 Jan 2016	<0.06	7	22.1
7 Jan to 13 Jan 2016	<0.06	9	0.6
14 Jan to 20 Jan 2016	**0.07**	4	0.1
21 Jan to 27 Jan 2016	**0.07**	12	3.2
28 Jan to 3 Feb 2016	**0.07**	25	14.0

Table 10 (cont.). Seven-day average $PM_{2.5}$ crystalline silica concentration monitoring results at the Vennor Drive, Ormeau monitoring site, 10 September 2015 to 2 November 2016.

Weekly sampling period	Vennor Drive, Ormeau		
	7-day average $PM_{2.5}$ crystalline silica concentration* (µg/m^3)	Proportion of winds from direction of quarries† (%)	Rainfall during sampling period (mm)*
4 Feb to 10 Feb 2016	<0.06	2	2.1
11 Feb to 17 Feb 2016	<0.06	2	2.8
18 Feb to 24 Feb 2016	<0.06	3	1.3
25 Feb to 2 Mar 2016	<0.06	1	56.5
3 Mar to 9 Mar 2016	<0.06	5	15.7
10 Mar to 16 Mar 2016	<0.06	6	18.4
17 Mar to 23 Mar 2016	<0.06	5	0.7
24 Mar to 30 Mar 2016	<0.06	10	2.2
31 Mar to 6 Apr 2016	<0.06	10	0.0
7 Apr to 13 Apr 2016	<0.06	12	0.4
14 Apr to 20 Apr 2016	<0.06	4	2.0
21 Apr to 27 Apr 2016	<0.06	3	0.7
28 Apr to 4 May 2016	<0.06	20	18.7
5 May to 11 May 2016	<0.06	17	0.0
12 May to 18 May 2016	<0.06	12	0.0
19 May to 25 May 2016	<0.06	18	0.0
26 May to 1 Jun 2016	<0.06	36	0.1
2 Jun to 8 Jun 2016	<0.06	48	62.3
9 Jun to 15 Jun 2016	<0.06	11	3.2
16 Jun to 22 Jun 2016	<0.06	46	52.5
23 Jun to 29 Jun 2016	<0.06	37	0.5
30 Jun to 6 Jul 2016	<0.06	38	4.2
7 Jul to 13 Jul 2016	**0.06**	73	0.0
14 Jul to 20 Jul 2016	<0.06	28	1.3
21 Jul to 27 Jul 2016	<0.06	70	0.0
28 Jul to 3 Aug 2016	<0.06	64	6.9
4 Aug to 10 Aug 2016	<0.06	40	7.0
11 Aug to 17 Aug 2016	<0.06	41	0.5
18 Aug to 24 Aug 2016	<0.06	32	10.8
25 Aug to 31 Aug 2016	<0.06	54	0.0

Table 10 (cont.). Seven-day average $PM_{2.5}$ crystalline silica concentration monitoring results at the Vennor Drive, Ormeau monitoring site, 10 September 2015 to 2 November 2016.

Weekly sampling period	Vennor Drive, Ormeau		
	7-day average $PM_{2.5}$ crystalline silica concentration* (µg/m³)	**Proportion of winds from direction of quarries†** (%)	**Rainfall during sampling period** (mm)*
1 Sep to 7 Sep 2016	<0.06	36	4.0
8 Sep to 14 Sep 2016	<0.06	15	8.5
15 Sep to 21 Sep 2016	<0.06	60	7.8
22 Sep to 28 Sep 2016	<0.06	55	0.1
29 Sep to 5 Oct 2016	<0.06	74	13.8
6 Oct to 12 Oct 2016	<0.06	30	0.3
13 Oct to 19 Oct 2016	<0.06	18	7.3
20 Oct to 26 Oct 2016	<0.06	33	0.2
27 Oct to 2 Nov 2016	<0.06	26	5.9

* Samples containing measurable crystalline silica content are shown in bold text.
† Wind and rainfall data was only collected at Vennor Drive, Ormeau monitoring site from 7 July to 15 November 2016. Prior to 7 July 2015, wind and rainfall data collected at the Harts Road, Luscombe monitoring site were used.

Department of Environment
and Resource Management

Suntown Landfill Particle Monitoring Investigation

February to April 2010

Prepared by:

Air Quality Sciences

Department of Environment and Resource Management

August 2010

Summary

The Suntown Landfill Particle Monitoring Program was implemented by the Department of Environment and Resource Management (DERM) in February 2010 in response to ongoing community concerns about dust and particulate matter impacts from operations at the adjacent Suntown Landfill. Community concerns have been focussed on perceived health and nuisance impacts from dust and unknown airborne contaminants being released from the site. The monitoring program was designed to obtain information on particle levels and composition in residential areas surrounding the landfill site. Monitoring of gaseous volatile organic compounds (VOCs) and aldehyde compounds was also undertaken. The program also sought to determine the contribution, if any, from Suntown Landfill operations to pollutant levels in the surrounding community.

Monitoring was conducted from February to April 2010 at a site in the Arundel Hills residential community close to the western boundary of the landfill. It was expected that ambient particle levels at this site would reflect worst-case impacts in the residential community from any dust emissions from landfill operations.

Ambient pollutant concentrations measured in the Arundel Hills residential community adjacent to the Suntown Landfill between February and April 2010 were low. PM_{10}, $PM_{2.5}$, heavy metal, VOC and aldehyde compound levels at the monitoring site complied with the EPP Air 24-hour and 7-day air quality objectives during the entire investigation period. No airborne asbestos fibres were detected in ambient air at the monitoring site. Based on the low measured concentrations, compliance with EPP Air annual average objectives, where these exist, would also be likely.

While the monitoring results for gaseous pollutants (VOCs and aldehyde compounds) are likely to be indicative of typical levels, the incidence of frequent heavy rainfall events during February and March meant that ambient particle levels experienced in the community adjacent to the Suntown Landfill site during the investigation period were not representative of conditions giving rise to complaints by Arundel Hills residents. Airborne particle concentrations experienced in the community during drier periods of the year are likely to be higher than those measured during the investigation period. However, with heavy metal and asbestos concentrations being very low or below detection levels during the investigation period, it is highly likely that compliance with criteria for protection of human health for these pollutants will still be achieved under more typical ambient particle levels.

Monitoring between February and April 2010 showed little evidence of the landfill site contributing significantly to particle, heavy metal and asbestos concentrations in the adjacent community. However dust suppression resulting from frequent heavy rainfall events during the investigation period means that this observation may not reflect the situation during drier periods of the year.

The landfill site did not appear to contribute significantly to VOC and aldehyde compound concentrations at the Arundel Hills monitoring site. The range of VOC and aldehyde compounds detected and their concentrations point to motor vehicle emissions being the most likely source of these pollutants in the area.

Contents

Introduction

The Suntown Landfill Particle Monitoring Program was implemented by the Department of Environment and Resource Management (DERM) in response to ongoing community concerns about dust and particulate matter impacts from operations at the Suntown Landfill (the site). Community concerns have been focussed on perceived health and nuisance impacts from dust and unknown airborne contaminants being released from the site.

The Suntown Landfill is located on Captain Cook Drive, Arundel, Queensland and has operated as a putrescibles and solid waste landfill since 1984. In the time since, approximately 2 million cubic metres of waste has been accepted for disposal at the site. A 2010 report detailing the history of the site has revealed that the landfill historically operated as a putrecibles/ municipal solid waste landfill with the public having access to the site. The southern portion of the site was operated by a private contractor until the mid 1990s and received putrescibles/municipal, medical, demolition and industrial waste, with the Gold Coast City Council operating the northern portion of the site from 1986 and receiving demolition and general waste. Council assumed full control of the site from the mid 1990s and from around 2000 ceased to accept putrescibles material. Council approved residential development up the boundary of the site, with dwellings constructed from around the year 2000 onwards.

In February 2010, DERM commenced a short-term monitoring program to gather information on particle levels and particle composition within the Arundel Hills residential community, which is located to the west of the landfill.

Monitoring program design

The potential effects of dust are closely related to particle size. The size range of airborne particles varies from less than 0.1µm up to about 500µm or half a millimetre. Human health effects of airborne dust are mainly associated with particles less than 10µm in size (commonly termed PM_{10}), which are small enough to be inhaled into the lower respiratory tract, although compounds such as heavy metals present in particles may also be of concern. Particulate matter can also cause considerable nuisance problems through soiling of property and materials. Nuisance effects can be caused by particles of any size, but are most commonly associated with those larger than 20µm.

The DERM dust monitoring program at Arundel Hills focused on acquiring data on two particle size fractions and potential contaminants present in the dust. Both current waste streams and waste materials which could possibly be present in the landfill due to former uses of the site were considered when deciding on the range of pollutants to monitor. The monitoring program collected information on:

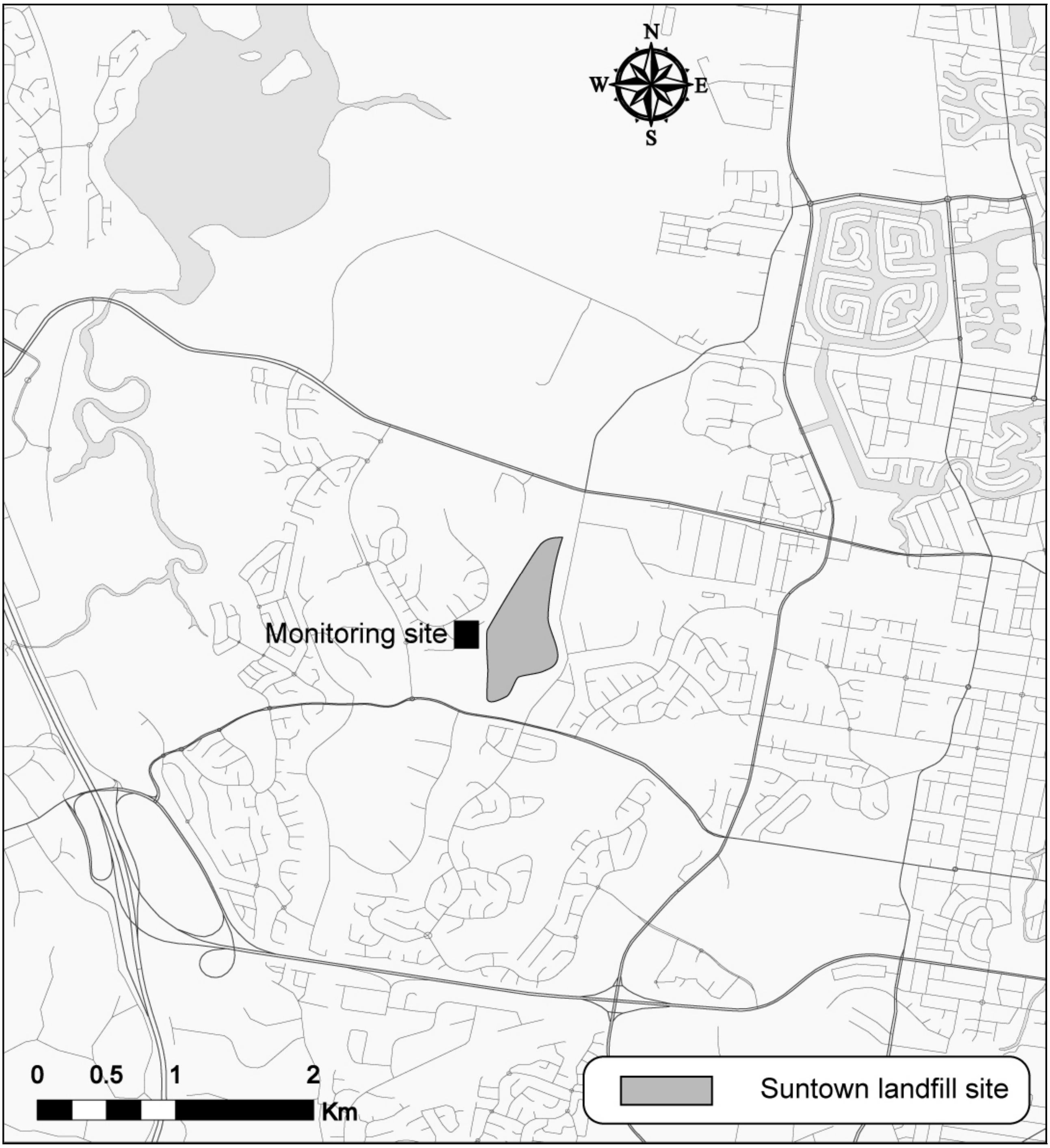
- PM_{10} (particles less than 10µm in diameter) levels – for assessment against criteria based on health
- $PM_{2.5}$ (particles less than 2.5µm in diameter) levels – for assessment against criteria based on health
- heavy metal levels in the PM_{10} particle fraction – for assessment against criteria based on health
- asbestos levels – for assessment against criteria based on health.

While the main focus of the monitoring program was on particles, limited sampling of volatile organic compounds (VOCs) and aldehyde compounds was also undertaken to determine if the landfill was a significant source of these pollutants.

The monitoring site location is shown in Figure 1. The monitoring site was located in the Arundel Hills residential community adjacent to the western boundary of the Suntown landfill to obtain a measure of the highest pollutant levels leaving the landfill area.

PM_{10} is the term given to the fraction of total particles suspended in the air having diameters less than 10µm. PM_{10} particles pose a hazard to human health because they are small enough to pass through the filtration mechanisms in the upper respiratory tract and penetrate beyond the larynx to the lower airways. PM_{10} particles in urban areas can arise from combustion processes (e.g. motor vehicle engines, industrial boilers) and mechanical processes (e.g. rock crushing, windblown dust). PM_{10} measurements were made by drawing air through a size-selective inlet (to remove particles larger than 10µm) and depositing the PM_{10} particles on a pre-weighed 47mm diameter Teflon filter over a 24-hour period from midnight to midnight using a low volume sampler. After sampling, the filter was again weighed, with the difference in weight being the mass of PM_{10} particles collected. The PM_{10} mass concentration was calculated by dividing the mass of particles collected by the volume of air drawn through the sampler. Collection and analysis were carried out in accordance with Australian/New Zealand Standard AS/NZS 3580.9.9:2006 *Method 9.9: Determination of suspended particulate matter–PM_{10} low volume sampler–Gravimetric method* using a Partisol Model 2025 sequential air sampler. The sample collection was carried out by DERM staff and the gravimetric analysis was carried out by Queensland Government Safety in Mines, Testing and Research Station (Simtars). PM_{10} samples were collected at three-day intervals during the period of the monitoring investigation. Sample collection was carried out over a 24-hour period in order to compare results with the Queensland *Environmental Protection (Air) Policy 2008* (EPP Air) 24-hour air quality objective for PM_{10} particles.

Figure 1: Map showing location of the Arundel Hills monitoring site in relation to the Suntown Landfill site.



$PM_{2.5}$ is the term given to the fraction of total particles suspended in the air having diameters less than 2.5µm. There is an increasing body of evidence to suggest that, of the total PM_{10} fraction of airborne particles, the $PM_{2.5}$ particles may be the major area of concern with regard to adverse effects on human health. $PM_{2.5}$ particles in urban areas arise predominantly from combustion processes (e.g. motor vehicle engines, industrial boilers). $PM_{2.5}$ measurements were made by drawing air through a size-selective inlet (to remove particles larger than 2.5µm) and depositing the $PM_{2.5}$ particles on a pre-weighed 47mm diameter Teflon filter over a 24-hour period from midnight to midnight using a low volume sampler. After sampling, the filter was again weighed, with the difference in weight being the mass of $PM_{2.5}$ particles collected. The $PM_{2.5}$ mass concentration was calculated by dividing the mass of particles collected by the volume of air drawn through the sampler. Collection and analysis were carried out in accordance with Australian/New Zealand Standard AS/NZS 3580.9.10:2006 *Method 9.10: Determination of suspended particulate matter–$PM_{2.5}$ low volume sampler–Gravimetric method* using a Partisol Model 2025 sequential air sampler. The sample collection was carried out by DERM staff and the gravimetric analysis was carried out by Simtars. $PM_{2.5}$ samples were collected at three-day intervals during February 2010. Sample collection was carried out over a 24-hour period in order to compare results with the EPP Air 24-hour air quality objective for $PM_{2.5}$ particles.

Due to the nature of materials which may have been deposited over the lifetime of the landfill, dust emanating from landfill operations could potentially contain a number of contaminants including heavy metals and asbestos fibres. In this investigation metal levels present in the PM_{10} particle fraction were determined. In late March and early April 2010 the low volume sampler previously used for $PM_{2.5}$ sampling was converted to measure PM_{10} particles. Sample collection was conducted over a 7-day period, rather than the usual 24-hour period, in order to collect sufficient PM_{10} material for the heavy metals analysis. Analysis of the heavy metal content of the PM_{10} particles was performed using an inductively coupled plasma (ICP) spectroscopy method based on the United States Environmental Protection Agency Compendium Methods IO-3.1: *Selection, Preparation and Extraction of Filter Material* and IO-3.4: *Determination of Metals in Ambient Particulate Matter Using Inductively Coupled Plasma (ICP) Spectroscopy*. The sample collection was carried out by DERM staff and the analysis was carried out by the Queensland Government Natural Resource Sciences Laboratory.

Asbestos sampling was conducted by drawing a measured quantity of air through a membrane filter, followed by microscopic analysis of the particulate matter collected on the filter as prescribed in the National Occupational Health and Safety Commission *Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres*, Second Edition 2005. The sample collection was carried out by DERM staff and the analysis was conducted by Simtars. Asbestos samples were collected between 8:00am and 5:00pm on four weekdays.

VOC monitoring involved the use of a passive diffusion sampler to collect airborne VOCs on adsorbent material, followed by extraction of the adsorbed compounds and characterisation using capillary gas chromatography. The passive sampler worked by diffusion of gaseous molecules through a permeable membrane and subsequent capture by adsorbing material positioned inside the permeable membrane. The passive sampler was deployed at the monitoring site for one month (the maximum allowable sampling period) to maximise the detection of any VOCs present. Following collection the passive sampler was sealed and sent for laboratory analysis. The average VOC concentration over the sampling period was calculated from the VOC mass collected, the sampling time and the rate of diffusion of the VOC species through the permeable membrane. Deployment and retrieval of the passive sampler was carried out by DERM staff and the analysis was carried out by Gradko Environmental in the United Kingdom.

Aldehyde compound monitoring was performed using passive diffusion samplers to collect airborne aldehyde compounds by reaction with 2,4-dinitrophenylhydrazine (2,4-DNPH), followed by extraction and characterisation using reverse phase high pressure liquid chromatography. The passive sampler worked by diffusion of gaseous molecules through a permeable membrane and subsequent capture by reaction with 2,4-DNPH-coated material positioned inside the permeable membrane. The passive sampler was deployed at the monitoring site for one week (the maximum allowable sampling period) to maximise the detection of any aldehyde compounds present. Following collection the passive sampler was sealed and sent for laboratory analysis. The average aldehyde compound concentration over the sampling period was calculated from the aldehyde compound mass collected, the sampling time and the rate of diffusion of the aldehyde compound through the permeable membrane. Deployment and retrieval of the passive sampler was carried out by DERM staff and the analysis was carried out by Gradko Environmental in the United Kingdom.

To assist with the determination of the contribution of landfill operations to overall particle and associated pollutant levels, wind speed and direction measurements averaged over 30-minute periods were recorded at the Arundel Hills monitoring site. The wind sensor was located at a height of six metres above ground level. The wind direction range associated with winds blowing from the Suntown Landfill towards the Arundel Hills monitoring site was from 40^o to 150^o (NE to SSE).

The fact that the low volume and passive samplers could only provide a measure of daily or longer average pollutant concentrations meant that there were limitations to the analysis of the contribution from activities taking place at the Suntown Landfill. The contribution of Suntown Landfill activities to overall daily, weekly or monthly average concentrations measured at the monitoring site would be affected by a number of factors, including excavation and fill activities taking place on the landfill site during the sampling period, the duration of dust emissions, the magnitude of dust emissions, the amount of exposed ground, wind direction and speed, and dust suppression factors such as rain. The analysis contained in this report is only capable of describing the contribution of landfill operations to ambient pollutant concentrations at the monitoring site in general terms. It is not possible to quantify the contribution of short-term dust episodes that might have taken place on the landfill site during the investigation period.

Results and discussion

Meteorology

Wind direction was a critical factor in the measurement of the impacts from landfill operations at the monitoring site. For pollutants generated by operations occurring at the Suntown Landfill to impact the Arundel Hills monitoring site, the wind direction had to be within a range from 40 degrees to 150 degrees (north-east to south-south-east winds). A summary of the wind characteristics on sampling days is provided in Table 1.

The proportion of winds favourable for measurement of landfill impacts was above 50 percent on eleven of the fifteen PM_{10} sampling days and seven of the eight $PM_{2.5}$ sampling days. There were favourable winds for 58 percent and 32 percent of the sampling period when PM_{10} particles were collected for heavy metal analysis. For three of the four asbestos samples winds blew from the direction of the landfill for over 60 percent of the sampling period. During the month-long volatile organic compounds sampling period winds were from the direction of the landfill for 67 percent of the time. Favourable winds occurred for 60 percent and 31 percent of the sampling period for the two aldehydes samples. On the basis of this analysis, it can be concluded that the results obtained during the investigation period will have captured a significant proportion of any landfill site impacts.

Rainfall was another factor influencing the outcome of the investigation through possible dust suppression. Daily rainfall information was available from the nearest Bureau of Meteorology rainfall recording site at the Coombabah Water Treatment Plant (approximately three kilometres north of the monitoring site) and has been summarised in Table 1. There was frequent heavy rain during February 2010 which will have suppressed dust emissions from the landfill during this period. As a result, the monitoring was temporarily suspended from early March until late March when rainfall totals and frequency were considerably less and dust levels were more likely to reflect typical levels. The influence of rain on the levels of gaseous pollutants (volatile organic compounds and aldehydes) will be less than would be the case for particles.

Table 1. Wind and rainfall conditions during the Suntown Landfill investigation period from February to April 2010

Sampling period	**Wind**				**Rain** (mm)
	Proportion of winds from direction of landfill (%)	**Average wind speed** (m/s)	**Maximum wind speed** (m/s)	**Wind direction at time of maximum wind speed** (deg)	
PM_{10} sampling days, $PM_{2.5}$ sampling days (8 February to 1 March)					
8 February	100	1.3	4.4	84	37.0
11 February	79	1.4	3.7	70	0.0
14 February	23	0.9	2.6	42	0.5
17 February	56	1.0	2.5	170	58.0
20 February	71	1.7	4.3	86	9.6
23 February	65	0.9	3.7	68	0.0
26 February	52	1.7	4.6	90	2.6
1 March	67	0.6	3.2	89	23.4
25 March	79	0.7	2.8	82	0.0
28 March	60	1.3	4.3	65	4.6
31 March	19	0.3	1.4	44	0.0
5 April	65	1.1	4.1	90	0.0
8 April	4	0.5	1.4	297	0.0
11 April	10	0.6	3.9	15	0.0
14 April	52	1.4	3.1	92	0.0
PM_{10} heavy metals sampling periods					
25 March to 31 March	58	0.8	4.3	65	17.5
8 April to 14 April	32	0.8	3.9	53	1.5
Asbestos sampling days (8:00am to 5:00pm)					
25 March	100	1.6	2.8	82	0.0
30 March	61	1.4	3.5	61	0.0
8 April	0	1.0	1.4	297	0.0
13 April	100	1.6	2.2	116	1.4
Volatile organic compounds sampling period					
23 February to 24 March	67	1.3	4.2	86	274.4
Aldehydes sampling periods					
24 March to 31 March	60	0.9	4.3	65	17.5
7 April to 14 April	31	0.8	3.9	53	1.5

PM_{10}

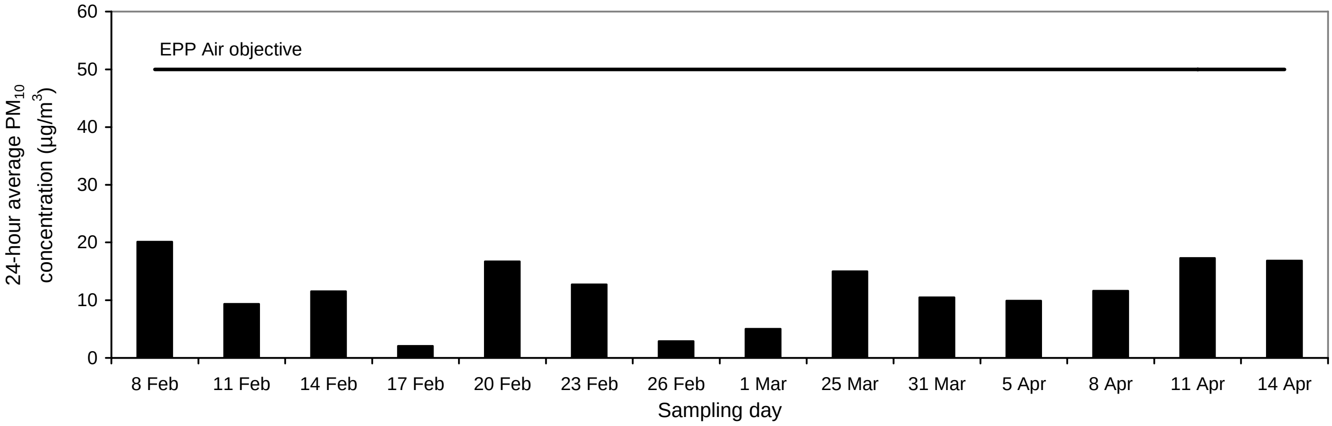
The 24-hour average PM_{10} monitoring results are summarised in Table 2 and displayed graphically in Figure 2. The EPP Air 24-hour air quality objective for PM_{10} particles is 50µg/m^3. No exceedences of the EPP Air objective were measured at the Arundel Hills monitoring site during the investigation period. The highest 24-hour average PM_{10} concentration was 20.1µg/m^3 (40 percent of the EPP Air objective).

Table 2: 24-hour average PM_{10} monitoring results, February to April 2010

Sampling period	**24-hour average PM_{10} concentration** (µg/m^3)	**Proportion of winds from direction of landfill** (%)	**Rainfall during sampling period** (mm)
8 February	20.1	100	37.0
11 February	9.3	79	0.0
14 February	11.5	23	0.5
17 February	2.1	56	58.0
20 February	16.7	71	9.6
23 February	12.7	65	0.0
26 February	2.9	52	2.6
1 March	5.0	67	23.4
25 March	15.0	79	0.0
31 March	10.5	19	0.0
5 April	9.9	65	0.0
8 April	11.6	4	0.0
11 April	17.3	10	0.0
14 April	16.9	52	0.0

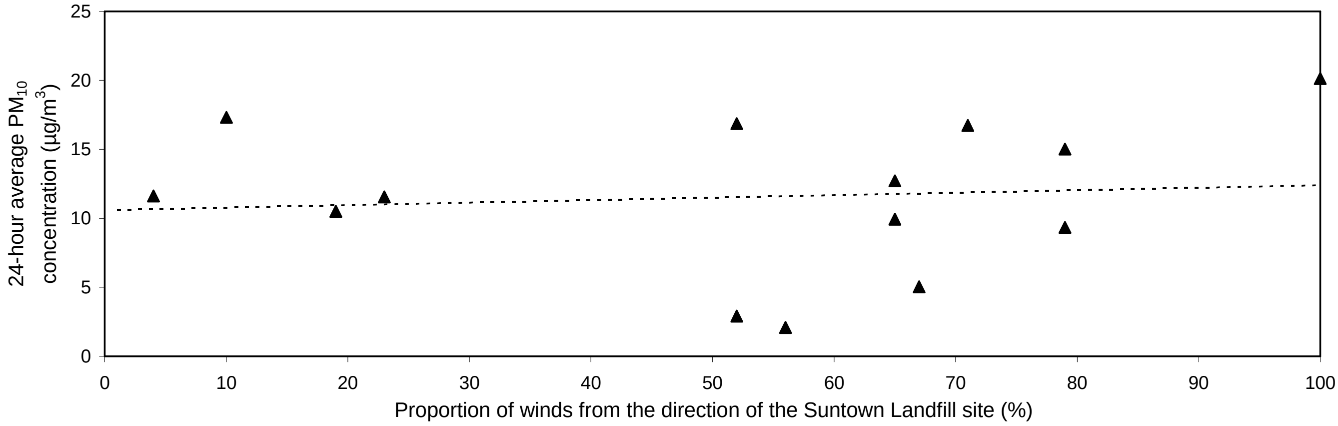
No result was available for the PM_{10} sample collected on 28 March due to a laboratory weighing error.
The *National Environment Protection (Ambient Air Quality) Measure 2008* standard for PM_{10} particles is a 24-hour average of 50µg/m^3.

Figure 2: 24-hour PM_{10} concentrations at the Arundel Hills monitoring site, February to April 2010



The relationship between 24-hour PM_{10} concentrations and the proportion of winds blowing from the direction of the Suntown Landfill site towards the Arundel Hills monitoring site during the sampling period is plotted in Figure 3. There is considerable variability between individual measurements. The overall trend (shown by the dotted line in Figure 3) shows only a very slight increase in PM_{10} concentration with increasing proportion of winds coming from the direction of the landfill site. This is likely to be due to the presence of other sources of PM_{10} particles (e.g. motor vehicle emissions) and suppression of dust emissions from the landfill site during the investigation period by frequent rain events. A proportion of overall dust particles impacting in the residential area immediately adjacent to the landfill site could also be larger than 10µm in diameter and not reflected in the PM_{10} monitoring results.

Figure 3: Relationship between 24-hour PM_{10} concentrations and proportion of winds from the direction of the Suntown Landfill site at the Arundel Hills monitoring site, February to April 2010



$PM_{2.5}$

$PM_{2.5}$ sampling was conducted during February 2010 only as the sampler was subsequently used for collection of samples for heavy metal analysis in March and April. The 24-hour average $PM_{2.5}$ monitoring results are summarised in Table 3 and displayed graphically in Figure 4. The EPP Air 24-hour air quality objective for $PM_{2.5}$ particles is 25µg/m^3. No exceedences of the EPP Air 24-hour objective were measured at the Arundel Hills monitoring site during the investigation period. The highest 24-hour average $PM_{2.5}$ concentration was 6.4µg/m^3 (26 percent of the EPP Air objective).

The average $PM_{2.5}$ concentration across all samples was 3.3µg/m^3. While the period of monitoring was insufficient to make a valid assessment of compliance with the EPP Air annual average objective value of 8µg/m^3, the average $PM_{2.5}$ concentration over the period of monitoring was less than half the objective value.

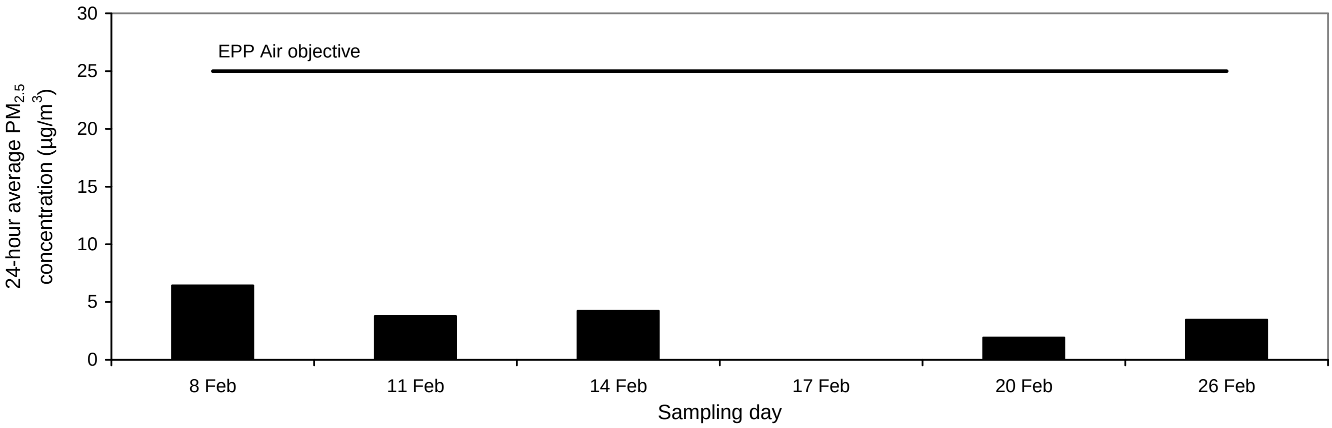
Table 3: 24-hour average $PM_{2.5}$ monitoring results, February to April 2010

Sampling period	**24-hour average $PM_{2.5}$ concentration** (µg/m^3)	**Proportion of winds from direction of landfill** (%)	**Rainfall during sampling period** (mm)
8 February	6.4	100	37.0
11 February	3.8	79	0.0
14 February	4.3	23	0.5
17 February	0.0	56	58.0
20 February	1.9	71	9.6
26 February	3.5	52	2.6

No results were available for the $PM_{2.5}$ samples collected on 23 February and 1 March due to laboratory weighing errors.

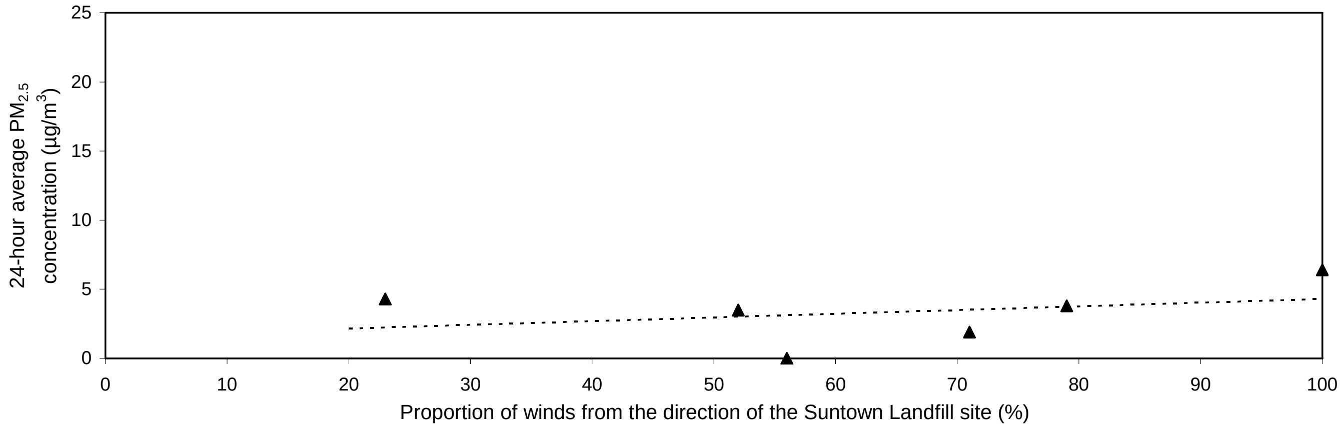
The *National Environment Protection (Ambient Air Quality) Measure 2008* advisory standards for $PM_{2.5}$ particles are an annual average of 8µg/m^3 and a 24-hour average of 25µg/m^3.

Figure 4: 24-hour $PM_{2.5}$ concentrations at the Arundel Hills monitoring site, February to April 2010



The relationship between 24-hour $PM_{2.5}$ concentrations and the proportion of winds blowing from the direction of the Suntown Landfill site towards the Arundel Hills monitoring site during the sampling period is plotted in Figure 5. There is considerable variability between individual measurements. The overall trend (shown by the dotted line in Figure 5) shows only a very slight increase in $PM_{2.5}$ concentration with increasing proportion of winds coming from the direction of the landfill site. As $PM_{2.5}$ particles are generally formed by combustion processes rather than mechanical processes such as earthworks or re-entrainment of soil particles from exposed ground during strong winds, it is not unexpected to find only a weak linkage between the frequency of winds coming from the landfill site and $PM_{2.5}$ concentrations at the monitoring site.

Figure 5: Relationship between 24-hour $PM_{2.5}$ concentrations and proportion of winds from the direction of the Suntown Landfill site at the Arundel Hills monitoring site, February 2010



Heavy metals

The EPP Air contains ambient air quality objectives for the following heavy metals – arsenic, cadmium, mercury, lead, manganese, nickel and vanadium. The air quality objective is expressed as an annual average concentration for all metals except vanadium, which has a 24-hour average objective. Evaluation of the risk posed to human health by heavy metals has been limited to those heavy metals listed in the EPP Air for which ambient air quality objectives exist.

To ensure sufficient particles were collected to undertake the metals analysis, the PM_{10} sampling instrument was operated continuously for a week. The 7-day average PM_{10} heavy metal monitoring results for the heavy metals listed in the EPP Air are summarised in Table 4. Table 4 also contains an indicative comparison between the average metal concentration measured during the investigation and the relevant EPP Air objective. The results for all metals measured by the analytical technique can be found in Table A1 in the Appendix.

Heavy metal levels in the PM_{10} particle fraction were found to be very low. Average concentrations were typically only one or two percent of the relevant EPP Air objective value. While the period of monitoring was insufficient to make a valid assessment of compliance with annual average EPP Air objectives, these results strongly suggest that heavy metal levels would be well below the relevant objective and not pose a risk to human health.

The heavy metals detected in monitoring at the Arundel Hills site are often found in urban air. The heavy metal concentrations found in this investigation are at the lower end of the concentration range typically measured in Australian urban areas (Environment Australia Technical Report No. 3, *Review of data on heavy metals in ambient air in Australia*, May 2002).

Winds blew from the direction of the Suntown Landfill site towards the monitoring site for 58 percent of the time during the March sampling run, but only 32 percent of the time during the April sampling time. Heavy metal levels were slightly higher during the March sampling run than during the April sampling run, suggesting that particles coming from the direction of the landfill site contain a higher level of heavy metals. However, this observation needs to be viewed within the context of the very low overall heavy metal concentrations (less than one percent of the EPP Air objective value for most heavy metals). Even if dust from the landfill site is a source of heavy metals, the heavy metal content of particles measured in this investigation indicates that heavy metal levels will still comply with EPP Air objectives even at significantly higher overall dust levels.

Table 4: 7-day average PM_{10} heavy metal monitoring results, March and April 2010

Heavy metal	Sampling period	7-day average concentration (µg/m^3)	Average concentration (µg/m^3)	Fraction of the EPP Air objective value
Arsenic	25 March to 31 March	0.0027	0.0022	0.367
	8 April to 14 April	0.0016		
Cadmium	25 March to 31 March	0.00002	0.00003	0.006
	8 April to 14 April	0.00004		
Lead	25 March to 31 March	0.0018	0.0012	0.002
	8 April to 14 April	0.0006		
Manganese	25 March to 31 March	0.0025	0.0018	0.011
	8 April to 14 April	0.0011		
Mercury	25 March to 31 March	Not detected	Not detected	–
	8 April to 14 April	Not detected		
Nickel	25 March to 31 March	0.0009	0.0005	0.025
	8 April to 14 April	0.0002		
Vanadium	25 March to 31 March	Not detected	Not detected	–
	8 April to 14 April	Not detected		

The Queensland *Environmental Protection (Air) Policy 2008* air quality objective for arsenic is an annual average of 0.006µg/m^3.
The Queensland *Environmental Protection (Air) Policy 2008* air quality objective for cadmium is an annual average of 0.005µg/m^3.
The Queensland *Environmental Protection (Air) Policy 2008* air quality objective for lead is an annual average of 0.5µg/m^3.
The Queensland *Environmental Protection (Air) Policy 2008* air quality objective for manganese is an annual average of 0.16µg/m^3.
The Queensland *Environmental Protection (Air) Policy 2008* air quality objective for mercury is an annual average of 1.1µg/m^3.
The Queensland *Environmental Protection (Air) Policy 2008* air quality objective for nickel is an annual average of 0.02µg/m^3.
The Queensland *Environmental Protection (Air) Policy 2008* air quality objective for vanadium is a 24-hour average of 0.5µg/m^3.

Airborne asbestos fibres

Airborne asbestos fibre sampling was conducted at the Arundel Hills monitoring site on four days in late March and early April 2010. Asbestos samples were collected over a nine hour period from 8:00am to 5:00pm each day when the landfill was operating. The number of asbestos fibres present in the particulate material collected on the filter was determined by microscopic analysis.

The asbestos monitoring results are summarised in Table 5, along with details of relevant meteorological conditions at the time of sampling.

The proportion of winds blowing from the direction of the landfill site was high on all sampling days except 8 April. No asbestos sample was found to have a fibre count above the limit of reporting of the microscopic analysis method (0.01 fibres/ml). There was no evidence that landfill operations were resulting in unsafe levels of asbestos in ambient air at the Arundel Hills monitoring site.

Table 5: 9-hour average airborne asbestos fibre monitoring results, March and April 2010

Sampling day (8:00am to 5:00pm)	**Asbestos fibre concentration** (fibres/ml)	**Proportion of winds from direction of landfill** (%)	**Rainfall during sampling period** (mm)
25 March	Less than 0.01	100	0.0
30 March	Less than 0.01	61	0.0
8 April	Less than 0.01	0	0.0
13 April	Less than 0.01	100	1.4

The National Occupational Health and Safety Commission's National Exposure Standard for asbestos (all forms) in occupational environments is 0.1 fibres/ml.

The Workplace Health and Safety Queensland 'clearance' level following asbestos removal works (i.e. the area is considered safe for normal use) is when the measured level of airborne asbestos fibres is below 0.01 fibres/ml.

Volatile organic compounds

Volatile organic compounds (VOCs) monitoring was undertaken using a passive diffusion sampler deployed at the monitoring site for a period of one month. This method of monitoring was chosen as it provided a simple means of surveying the range and indicative levels of VOCs present in ambient air to determine if any VOC pollutant was present at levels which could potentially pose a risk to human health.

Only 21 VOC species were present at levels above the minimum measurable concentration of 0.0001ppm during the period monitoring was carried out. The compounds detected included seven aromatic VOC species (ethylbenzene, naphthalene, N,N-dimethylbenzamide, styrene, toluene, 1,2,4-trimethylbenzene and xylene) and nine higher alkane hydrocarbon species. VOC levels were found to be very low. Ethylbenzene was detected at the highest concentration (0.00543ppm), then xylene (0.00467ppm), followed by five alkane hydrocarbon compounds present at concentrations between 0.00090ppm and 0.00338ppm. The remaining VOCs detected were present at concentrations below 0.0007ppm. Measurement results for all the VOC species detected are included in Table A2 in the Appendix.

The EPP Air contains ambient air quality objectives for the following volatile organic compounds (VOCs) – 1,2-dichloroethane, 1,3-butadiene, benzene, dichloromethane, styrene, tetrachloroethylene, toluene, vinyl chloride monomer and xylene. For most of the VOCs the EPP Air air quality objective is expressed as an annual average concentration.

Evaluation of the risk posed to human health has been limited to those VOCs listed in the EPP Air for which ambient air quality objectives exist. Of the compounds listed in the EPP Air, only styrene, toluene and xylene were detected in sampling at the Arundel Hills monitoring site. Measured ambient concentrations of detected VOCs listed in the EPP Air are summarised in Table 6, together with an indicative comparison between the VOC concentration measured during the investigation and the relevant EPP Air objective value.

Table 6: Monthly average volatile organic compound monitoring results, 23 February to 24 March 2010

Volatile organic compound	Monthly average concentration (ppm)	Fraction of the EPP Air air quality objective value
Styrene	0.00067	0.011
Toluene	0.00053	0.005 (annual), 0.001 (24-hour)
Xylene	0.00467	0.023 (annual), 0.019 (24-hour)

The Queensland *Environmental Protection (Air) Policy 2008* air quality objective for styrene is a 7-day average of 0.06ppm.

The Queensland *Environmental Protection (Air) Policy 2008* air quality objectives for toluene are an annual average of 0.1ppm and a 24-hour average of 1ppm.

The Queensland *Environmental Protection (Air) Policy 2008* air quality objectives for xylene are an annual average of 0.2ppm and a 24-hour average of 0.25ppm.

Average styrene, toluene and xylene concentrations were typically only one or two percent of the relevant EPP Air objective value. While the period of monitoring was insufficient to make a valid assessment of compliance with annual average EPP Air objectives for toluene and xylene, these results strongly suggest that VOC levels would be well below the relevant annual average objective. Compliance with the EPP Air 24-hour and 7-day objectives can be demonstrated by calculating the highest concentration possible given the unlikely event that all the VOC sampled over the month was collected in one day or one week. These calculations result in a maximum possible 7-day styrene concentration of 0.003ppm (five percent of the EPP Air objective), a maximum possible 24-hour toluene concentration of 0.017ppm (two percent of the EPP Air objective) and a maximum possible 24-hour xylene concentration of 0.149ppm (60 percent of the EPP Air objective). This comparison of ambient concentrations against the relevant air quality objective indicates that levels of styrene, toluene and xylene measured during the investigation period do not pose a risk to human health.

The VOCs detected in monitoring at the Arundel Hills site are commonly found in urban air. The National Pollutant Inventory (*www.npi.gov.au*) identifies motor vehicles as a significant diffuse source to the atmosphere in south-east Queensland of many of the detected VOCs. Levels of toluene and xylene at the Arundel Hills monitoring site are similar to levels measured at DERM's suburban monitoring site at Springwood.

Winds blew from the direction of the Suntown Landfill site towards the monitoring site for 67 percent of the total sampling period. On this basis, it is likely that any emissions from landfill operations will have been captured by the monitoring. It does not appear that landfill operations are contributing significantly to ambient VOC levels in adjacent residential areas.

Aldehyde compounds

Aldehyde compound monitoring was undertaken on two occasions using a passive diffusion sampler deployed at the monitoring site for a period of one week. This method of monitoring was chosen as it provided a simple means of surveying the range and indicative levels of aldehyde compounds present in ambient air to determine if any aldehyde pollutant was present at levels which could potentially pose a risk to human health.

Only five aldehyde compounds were present at levels above the minimum measurable concentration of 0.0001ppm during the period monitoring was carried out. The compounds detected were formaldehyde, acetaldehyde, acrolein/acetone, crotonaldehyde and butyraldehyde. Measured aldehyde compound levels were low. Formaldehyde was detected at the highest concentration (0.00128ppm), followed by acetaldehyde (0.00040ppm). Measurement results for all aldehyde compounds are included in Table A3 in Appendix 2.

Evaluation of the risk posed to human health has been limited to those aldehyde compounds listed in the EPP Air for which ambient air quality objectives exist. The EPP Air contains an ambient air quality objective for formaldehyde only, expressed as a 24-hour average. Ambient concentration results for formaldehyde are summarised in Table 7, together with an indicative comparison between the average formaldehyde concentration measured during the investigation and the EPP Air objective value. Compliance with the EPP Air 24-hour objective can be demonstrated by calculating the highest 24-hour concentration possible given the unlikely event that all the formaldehyde sampled over the week was collected in one day. These calculations result in a maximum possible 24-hour formaldehyde concentration of 0.009ppm (22 percent of the EPP Air objective). Based on this comparison of ambient formaldehyde concentrations against the relevant air quality objective indicates that formaldehyde levels measured during the investigation period do not pose a risk to human health.

Table 7: 7-day average formaldehyde monitoring results, March and April 2010

Aldehyde	**Sampling period**	**7-day average concentration** (ppm)	**Average concentration** (ppm)	**Fraction of the EPP Air objective value**
Formaldehyde	24 March to 31 March	0.00097	0.00113	0.028
	7 April to 14 April	0.00128		
The Queensland *Environmental Protection (Air) Policy 2008* air quality objective for formaldehyde is a 24-hour average of 0.04ppm.				

The aldehyde compounds detected in monitoring at the Arundel Hills site are commonly found in urban air. The National Pollutant Inventory (*www.npi.gov.au*) identifies motor vehicles as a significant diffuse source of formaldehyde, acetaldehyde and acetone to the atmosphere in south-east Queensland.

Winds blew from the direction of the Suntown Landfill site towards the monitoring site for 60 percent of the total sampling period in March and 31 percent of the total sampling period in April. Formaldehyde and acetaldehyde levels were higher in the April sample, however a greater range of aldehyde compounds was detected in the March sample. These results indicate that there are a range of sources contributing to overall ambient aldehyde compound levels.

Conclusions

Ambient pollutant concentrations measured at the Arundel Hills residential community adjacent to the Suntown Landfill site between February and April 2010 were low. PM_{10}, $PM_{2.5}$, heavy metal, VOC and aldehyde compound levels complied with the EPP Air 24-hour and 7-day air quality objectives for the entire investigation period. Based on the low measured concentrations, compliance with EPP Air annual average objectives would also be likely. No airborne asbestos fibres were detected in ambient air at the monitoring site.

While the monitoring results for gaseous pollutants (VOCs and aldehyde compounds) is likely to be indicative of typical levels, the incidence of frequent heavy rainfall events during February and March meant that ambient particle levels experienced in the community adjacent to the Suntown Landfill site during the investigation period were not representative of conditions giving rise to complaints by Arundel Hills residents Airborne particle concentrations experienced in the community during drier periods are likely to be higher than those measured during the investigation period.

It is possible that heavy metal and asbestos levels could also be higher under more typical ambient particle levels. Even so, the very low levels of these pollutants measured during the investigation period means that it is highly likely that compliance with criteria for protection of human health will still be achieved under more typical ambient particle concentrations.

The landfill site does not appear to be a major contributor to VOC and aldehyde compound concentrations at the Arundel Hills monitoring site. The contribution of the landfill site to particle, heavy metal and asbestos concentrations in the adjacent community could not be adequately determined due to dust suppression resulting from high rainfall events during the investigation period.

Appendix

Monitoring results for metals, volatile organic compounds and aldehyde compounds

Table A1: 7-day average PM_{10} metals concentrations, March and April 2010

Metal	**7-day average concentration** (µg/m^3)		**Average concentration** (µg/m^3)
	25 March to 31 March	8 April to 14 April	
Aluminium	0.053	0.032	0.043
Antimony	0.0004	0.0005	0.0005
Arsenic	0.0027	0.0016	0.0022
Barium	0.0029	0.0030	0.0030
Beryllium	Not detected	Not detected	Not detected
Cadmium	0.00002	0.00004	0.00003
Chromium	0.0005	0.0002	0.0004
Cobalt	0.00005	0.00003	0.00004
Copper	0.0038	0.0024	0.00031
Iron	0.101	0.068	0.084
Lead	0.0018	0.0006	0.0012
Manganese	0.0025	0.0011	0.0018
Mercury	Not detected	Not detected	Not detected
Nickel	0.0009	0.0002	0.0005
Selenium	Not detected	Not detected	Not detected
Titanium	0.0023	0.0012	0.0018
Thallium	Not detected	Not detected	Not detected
Vanadium	Not detected	Not detected	Not detected
Zinc	0.006	0.005	0.006

Table A2: Monthly average volatile organic compound concentrations, 23 February to 24 March 2010

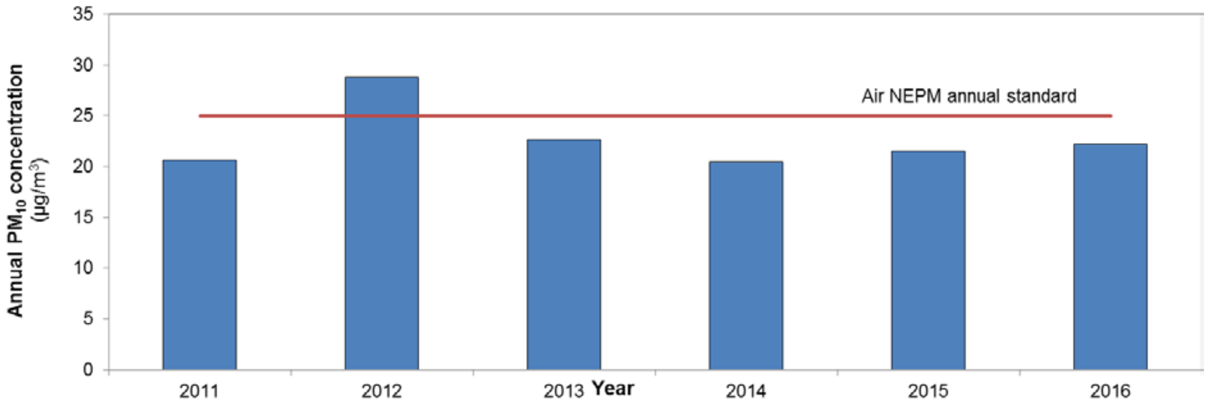
Volatile organic compound	**Monthly average concentration** (ppm)
Ethylbenzene	0.00543
p-Xylene	0.00354
3-Methylpentane	0.00338
2-Methylbutane	0.00235
2-Methylpentane	0.00229
o-Xylene	0.00113
Methylcyclopentane	0.00108
Hexane	0.00090
Styrene	0.00067
Acetone	0.00056
2-Ethyl-1-hexanol	0.00056
Toluene	0.00053
Methyl isobutyl ketone	0.00041
Dodecane	0.00036
Cyclohexane	0.00033
Undecane	0.00030
N-N-Dimethylbenzamide	0.00028
Naphthalene	0.00027
1R-alpha-Pinene	0.00024
1,2,4-Trimethylbenzene	0.00022
Tridecane	0.00014
The detected VOC species are listed in order of decreasing concentration. All other VOC species were present at concentrations below 0.00010ppm (the minimum measurable concentration possible with the sampling and analysis methods used).	

Table A3: 7-day average aldehyde concentrations, March and April 2010

Metal	**7-day average concentration** (ppm)		**Average concentration** (ppm)
	24 March to 31 March	7 April to 14 April	
Formaldehyde	0.00097	0.00128	0.00113
Acetaldehyde	0.00034	0.00040	0.00037
Acrolein / Acetone	0.00028	0.00020	0.00024
Propionaldehyde	Not detected	Not detected	Not detected
Crotonaldehyde	0.00014	Not detected	0.00007
Butyraldehyde	0.00011	Not detected	0.00006
Benzaldehyde	Not detected	Not detected	Not detected
Valeraldehyde	Not detected	Not detected	Not detected
Isovaleraldehyde	Not detected	Not detected	Not detected
Tolualdehyde	Not detected	Not detected	Not detected
Hexaldehyde	Not detected	Not detected	Not detected

Assessment of Particle Concentrations measured at the Moranbah station 2011 – 2016

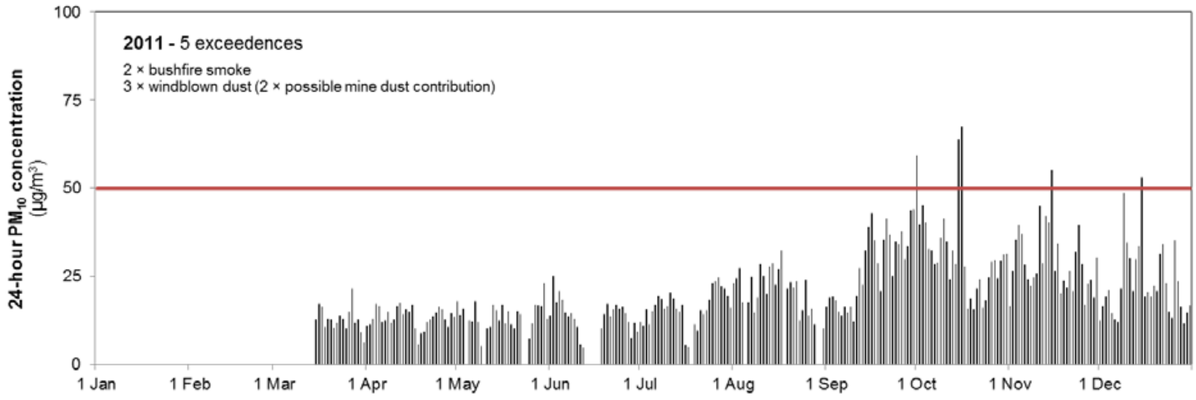
Moranbah – Annual PM_{10} concentrations

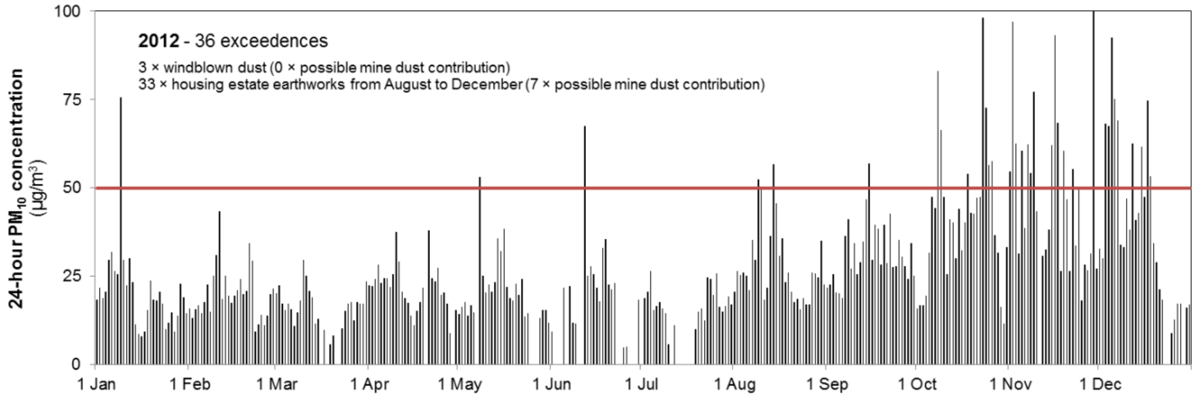


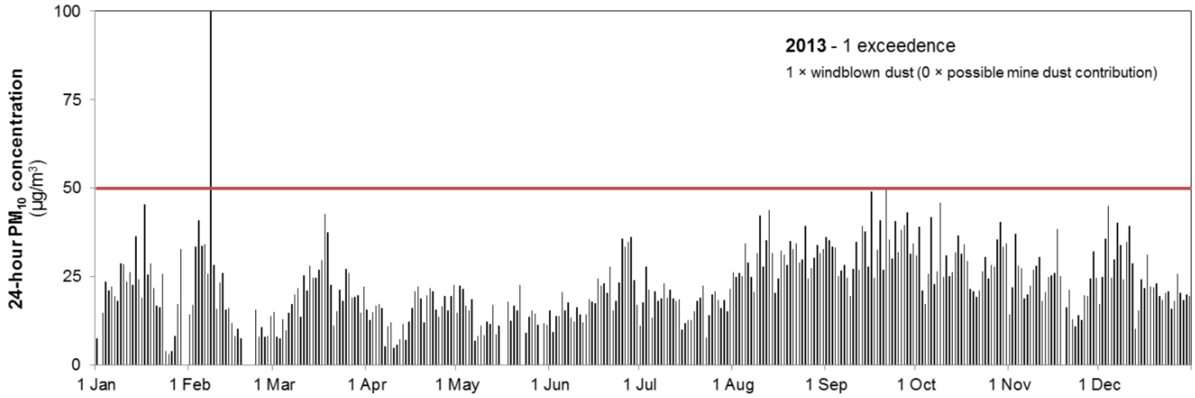
Year	**Annual PM_{10} concentration** (µg/m^3)
2011	20.6
2012	28.8
2013	22.7
2014	20.5
2015	21.5
2016	22.2

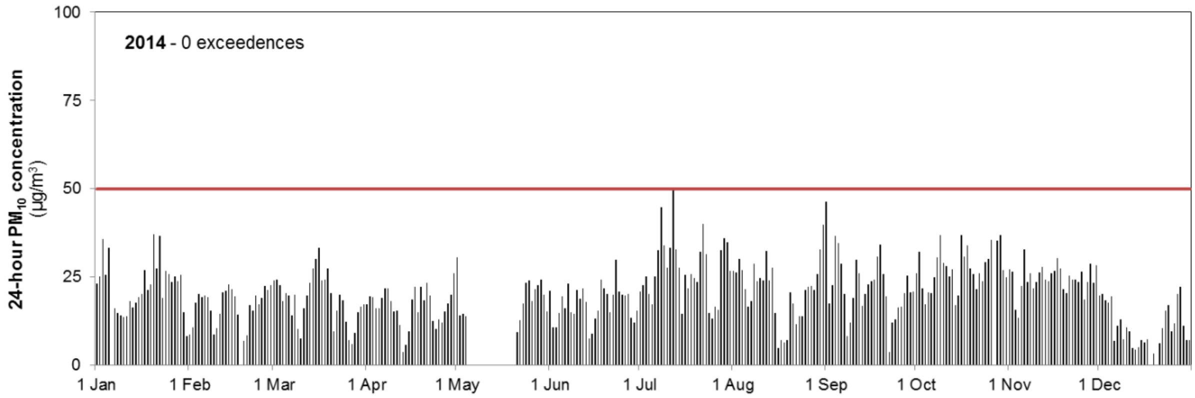
Note: 2012 annual average PM_{10} concentration impacted by housing estate development earthworks adjacent to the monitoring site.

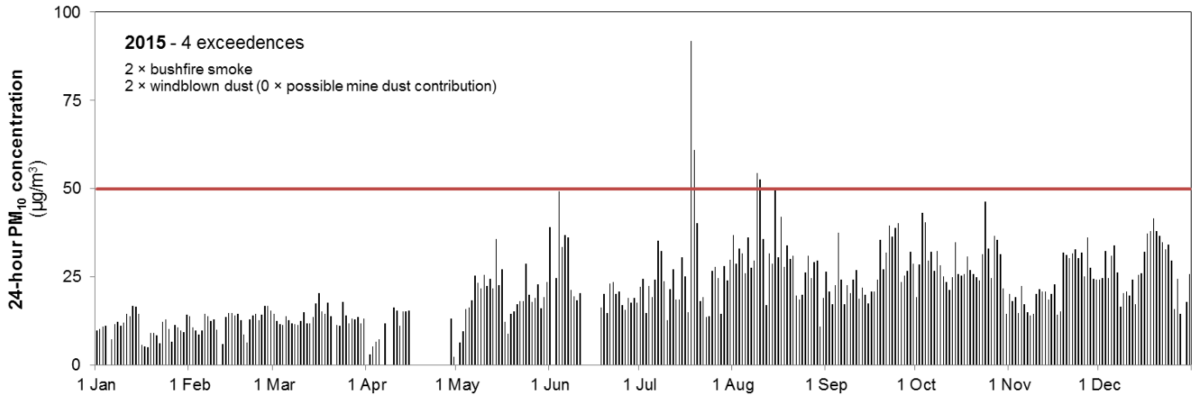
Moranbah – 24-hour PM_{10} concentrations

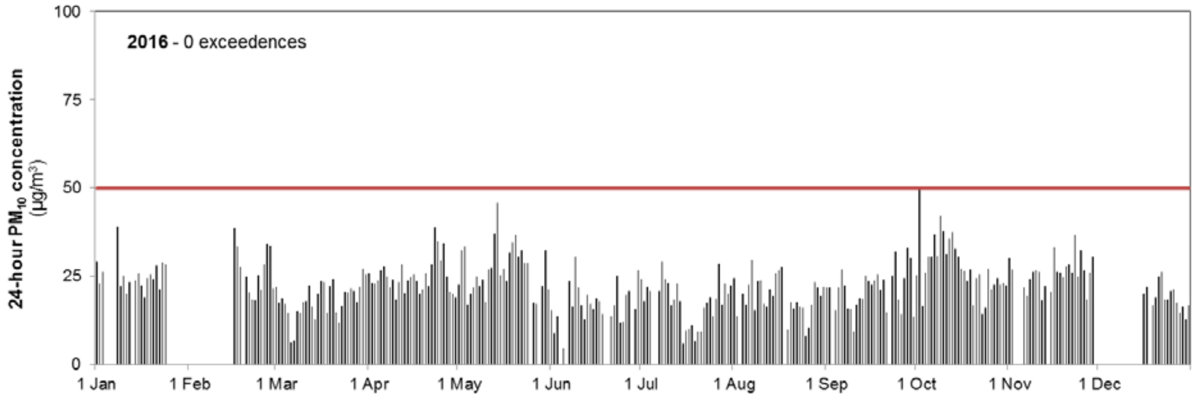












Year	Causes of 24-hour PM_{10} exceedences
2011	• 2 × bushfire smoke • 3 × windblown dust (2 × possible mine dust contribution)
2012	• 3 × windblown dust (0 × possible mine dust contribution) • 33 × housing development earthworks (7 × possible mine dust impacts)
2013	• 1 × windblown dust (0 × possible mine dust contribution)
2014	Nil
2015	• 2 × bushfire smoke • 2 × windblown dust (0 × possible mine dust contribution)
2016	Nil