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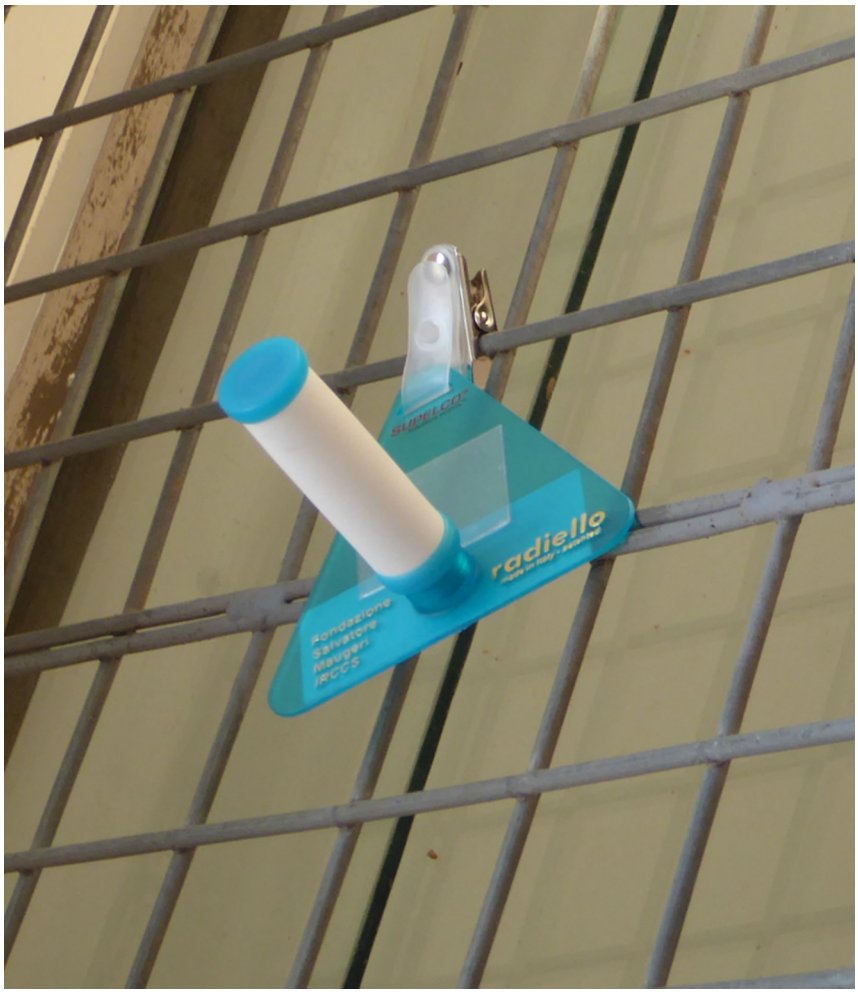

Air Quality Investigation Hopeland and Chinchilla December 2015

Queensland Government

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Summary

Following the discovery of certain gases associated with combustion by-products in sub-soil monitoring bores in the Hopeland area south-east of Chinchilla in February 2015, the Queensland Government conducted an initial air sampling program in the Hopeland and Chinchilla areas in March 2015 to determine if any of the sub-soil gases were present at levels of concern in ambient air. The March 2015 sampling did not find any evidence of sub-soil gases leading to unsafe level of air pollutants in the Hopeland community.

The Queensland Government undertook a second round of air monitoring at Hopeland and Chinchilla in December 2015 to assess if there had been any change in air pollutant levels since March 2015.

Measurement of volatile organic compound (VOC) concentrations in the ambient air was undertaken at eight locations in the Hopeland area and a background site in Chinchilla over the period 10 to 23 December 2015. At Hopeland, sampling was conducted at five residences and three open sites close to the locations of sub-soil gas monitoring bores which had previously returned high sub-soil VOC concentrations.

Only twelve individual VOCs were detected at one or more of the Hopeland sampling locations. The presence of ten of these VOCs could be linked to petroleum fuels (motor vehicle emissions and/or evaporation from fuel storages). Of the two remaining VOCs detected, the presence of carbon tetrachloride can be explained from past releases when it was widely used for refrigerant manufacture and as a cleaning agent and its long atmospheric half-life; while ethyl acetate is naturally produced from animal waste, plant volatiles and microbes.

Measured 13-day average concentrations for individual VOCs detected at the Hopeland monitoring sites in December 2015 were all well below the relevant long-term (annual) guideline values for protection of human health and wellbeing, and could be reasonably expected to have also complied with short-term (one hour or 24 hour) guidelines. On this basis, the ambient VOC levels measured in the Hopeland area in December 2015 would be unlikely to result in adverse health effects.

At the monitoring bore sampling sites situated in open locations further from residences, farm activities and vehicle movements, only five of the 12 VOCs were detected. A greater number of VOCs were detected at the background monitoring site in Chinchilla compared with sites in the Hopeland area. VOC concentrations were also generally higher at the background monitoring site in Chinchilla, most likely reflecting greater motor vehicle and organic solvent-based consumer products use in the town.

The ambient VOC concentrations measured in the Hopeland area in December 2015 showed little variation from those obtained during the March 2015 sampling program, indicating that the monitoring results for both periods reflect typical exposure levels experienced by the Hopeland community.

The December VOC measurement results support the conclusions drawn from the March 2015 sampling program that, if occurring, any surface emissions of sub-soil gases in the Hopeland area are gradual and any released gases are quickly diluted by surrounding air to very low levels.

Contents

Introduction

In February 2015 soil sampling in the Hopeland area south-east of Chinchilla by the Queensland Government identified the presence of certain gases, such as carbon monoxide, in the soil at depths below two metres. The gases present are by-products formed during combustion processes and are not associated with coal seam gas development. In response to these findings, the Department of Environment and Heritage Protection (EHP) initiated an air sampling program in March 2015 to investigate if the gases found in the soil could be detected at the surface or in the air, and to assist with an assessment of any potential risk to human health.

The Department of Science, Information Technology and Innovation (DSITI) was commissioned by EHP to conduct the March 2015 air monitoring investigation at residential dwellings in the Hopeland area and at community locations in Chinchilla. This monitoring, undertaken between 4 March and 25 March 2015, collected data on levels of carbon monoxide, hydrogen sulfide, volatile organic compounds (VOCs) and phenolic compounds.

The March 2015 monitoring did not find any evidence of subsoil gases leading to unsafe levels of air pollutants in the community. A report on these findings has been published[1].

DSITI was engaged by EHP to undertake a further round of air monitoring in the Hopeland area and Chinchilla in December 2015 to assess if there had been any change in air pollutant levels since March 2015.

This report summarises the findings of this repeat round of monitoring, conducted between 10 December and 23 December 2015.

Monitoring study design

The December 2015 monitoring program was restricted to measurement of volatile organic compounds (VOCs) only, as the March 2015 testing failed to detect any carbon monoxide or hydrogen sulphide in the ambient air at any of the monitoring locations. Monitoring of phenolic compounds was also not undertaken as the phenol concentrations measured in March 2015 were very low and displayed little variation across all the monitoring locations, indicating that natural sources such as animal wastes and decomposing organic material were likely to comprise the main source of these compounds. The December 2015 monitoring was limited to outdoor locations to minimise potential interference resulting from use of domestic products containing volatile organic compounds.

VOCs is a term given to a wide range of organic chemical compounds, some of which can pose a hazard to human health. VOCs are potential by-products of combustion processes. The VOC monitoring technique used in the December 2015 monitoring was capable of detecting the presence of 48 individual VOCs, including aliphatic hydrocarbons (such as hexane), aromatic hydrocarbons (such as benzene, toluene and xylenes), and oxygenated compounds (such as acetone and similar ketones). A full listing of the 48 individual VOCs can be found in the appendix to this report. The detection limits for the measurement technique were at least 100 times less than the respective air quality guideline value.

[1] Available from https://www.ehp.qld.gov.au/management/pdf/hopeland-chinchilla-air-monitoring-report.pdf.

Passive diffusive samplers were used to collect airborne VOCs on adsorbent material, followed by the extraction of the adsorbed compounds and analysis. The passive samplers operated by diffusion of gas molecules through a permeable membrane and subsequent capture by adsorbing material positioned inside the permeable membrane. Following sampling the passive samplers were sealed and sent for laboratory analysis. The average gas concentration over the sampling period was calculated from the mass of compound collected, the sampling time and the rate of diffusion of the compound through the permeable membrane. Analysis was carried out by SGS Leeder Consulting at their National Association of Testing Authorities (NATA) accredited laboratory in Melbourne.

Monitoring was conducted at five residential locations in the Hopeland area, and at a background site in Chinchilla. In addition, three open sites close to the locations of sub-soil gas monitoring bores at Hopeland which had previously returned high sub-soil VOC concentrations were included in the December 2015 round of monitoring. The passive VOC samplers were deployed for a period of 13 days (10 December to 23 December) at each monitoring location to maximise the collection of any airborne VOCs.

Health impacts assessment methodology

Assessment of possible health impacts was performed by comparing measured pollutant concentrations against the relevant objective for protection of human health listed in the Queensland Environmental Protection (Air) Policy 2008 (EPP Air), or another recognised ambient air quality guideline in the event that an EPP Air objective was not available. Three recognised sources of environmental and human health guidelines/criteria were used to cover the full range of compounds detected in the samples. These were, in order of priority, the Queensland Environmental Protection (Air) Policy 2008 (EPP Air) air quality objectives, the Texas Commission on Environmental Quality Air Monitoring Comparison Values (AMCVs) and the Texas Commission on Environmental Quality Effects Screening Levels (ESLs).

EPP Air objectives are set to protect environmental values including the protection of human health and wellbeing.

AMCVs are chemical-specific air concentrations set to protect human health and welfare. Exposure to an air concentration at or below the AMCVs is not likely to cause adverse health effects in the general public, including sensitive subgroups such as children, the elderly, pregnant women, and people with pre-existing health conditions.

ESLs are based on data concerning health effects. They are not ambient air standards. If predicted or measured airborne levels of a constituent do not exceed the screening level, adverse health or welfare would not be expected to result. If ambient levels of constituents in air exceed the screening level, it does not necessarily indicate a problem, but that a more in-depth review of potential health risk is necessary.

It should be noted that the VOC monitoring results are 13-day average concentrations and cannot be directly compared with guideline values that have shorter or longer averaging periods. For assessment purposes however, if the 13-day average VOC concentration measured is less than the long-term guideline value used to assess exposure impacts, then it can be reasonably assumed that the long-term guideline would be met. If the 13-day average VOC concentration is higher than the long-term guideline value it does not necessarily mean that the long-term guideline would not be met, but that compliance cannot be demonstrated based on the limited sampling period.

For short-term guidelines of one hour or 24 hours, a 13-day average concentration in excess of the guideline value would indicate non-compliance with the short-term guideline. However, if the 13-day average VOC concentration is less than the short-term guideline value it does not conclusively demonstrate that the short-term guideline was met due to the possibility of elevated one-hour or 24-hour episodes occurring during the 13-day sampling period. Despite this, in many cases it is still possible to show compliance with the short-term guideline by calculating the maximum possible short-term VOC concentration based on the worst-case situation that all the measured VOC collected on the sampler during the 13-day period occurred during a single short-term averaging period.

Results and discussion

Measurement results for VOCs detected in the December 2015 monitoring are summarised in Table 1, together with the corresponding results for outdoor VOC monitoring locations sampled in March 2015 and the relevant air quality guideline value(s).

Only twelve VOCs were detected at monitoring sites in the Hopeland area in December 2015, with the number of VOCs detected at individual Hopeland locations ranging from four to 11. By contrast, a total of 20 individual VOCs were detected at the background monitoring location in Chinchilla.

Nine of the VOCs detected at monitoring sites in the Hopeland area (benzene, *n*-decane, *n*-dodecane, *n*-hexane, 2-methylpentane, 3-methylpentane, toluene, *n*-undecane and xylene) are components of petroleum fuels and their presence in ambient air is often the result of motor vehicle emissions and/or evaporation from fuel storages. Another of the detected VOCs, cyclohexanone, is produced by oxidation in air of cyclohexane, which is also present in petroleum fuels. Of the remaining VOCs detected, carbon tetrachloride is long-lived in the atmosphere and is often present at low levels due to past releases when it was widely used for refrigerant manufacture and as a cleaning agent; and ethyl acetate is naturally produced from animal waste, plant volatiles and microbes.

Measured 13-day average concentrations for individual VOCs detected at the Hopeland monitoring sites were all well below the relevant long-term guideline values for protection of human health and wellbeing. By calculating the maximum possible VOC concentrations over the short-term guideline averaging period (one hour or 24 hours), it was possible to also confirm compliance with the short-term guideline values listed in Table 1 for all detected VOCs, with the exception of carbon tetrachloride and *n*-dodecane.

While compliance could not be conclusively demonstrated, it is considered unlikely that ambient concentrations of carbon tetrachloride and *n*-dodecane would have exceeded the short-term guideline values for the following reasons. In Australia the import, export and manufacture of carbon tetrachloride has been banned since 1996 under the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989*, except for very limited essential uses[2]. The presence of carbon tetrachloride in the atmosphere is the result of past releases when the chemical was in widespread use, and as such would be present at relatively constant background concentrations at or near to the 13-day average concentrations (this is supported by the consistency in carbon tetrachloride concentrations across all the monitoring sites, including the background site).

[2] For further information see https://www.environment.gov.au/protection/ozone/licences.

The presence of *n*-dodecane in the blank field sample means that actual ambient concentrations of *n*-dodecane would have been lower than the uncorrected concentrations reported. Calculations based on the mass on *n*-dodecane present in the field blank suggest that actual ambient concentrations of *n*-dodecane could have been as much as 80 per cent lower than the reported concentrations. At these concentrations *n*-dodecane levels would comply with the short-term guideline value.

Based on comparison against guideline values for protection of human health and wellbeing, it can be concluded that VOC levels measured in the Hopeland area in December 2015 would be unlikely to result in adverse health effects.

At the three Hopeland area monitoring bore sampling sites situated in open locations further from residences, farm activities and vehicle movements, only five of the 12 VOCs listed above were detected.

A greater number of VOCs were detected at the background monitoring site in Chinchilla compared to the sites in the Hopeland area. VOC concentrations were also generally higher at the Chinchilla background monitoring site, most likely reflecting proximity to a greater number of VOC emission sources, including motor vehicles and use of organic solvent-based consumer products.

Table 1 shows little variation in the VOC concentrations measured at outdoor monitoring sites in March 2015 and December 2015. This indicates that the VOC concentrations measured during both sampling periods reflect typical levels present in the air environment in the Hopeland area.

Table 1: Average volatile organic compounds (VOCs) concentrations measured at outdoor monitoring sites at Hopeland and Chinchilla over the 13-day period from 10 December 2015 to 23 December 2015.

Volatile Organic Compound	Hopeland sites				Chinchilla background site		Ambient Air Guideline/Criteria (Health)			
	December 2015 (five residential and three open sites)			March 2015	December 2015	March 2015	Averaging Period	Guideline type	Guideline Value (ppb)	Source
	Compound detected	Compound not detected	Concentration range (ppb)	Concentration range (ppb)	Concentration (ppb)	Concentration (ppb)				
Alkanes										
Cyclohexane	0	8	Not detected	Not detected	0.02	0.02	Annual	Health	100	Texas AMCV
							1 hour	Health	1,000	Texas AMCV
n-Decane	1	7	0.05	0.04	0.06	0.06	Annual	Health	175	Texas AMCV
							1 hour	Health	1,750	Texas AMCV
n-Dodecane[a]	8	0	0.49 to 0.85	4.59 to 5.45	0.85	3.59	Annual	Health	50	Texas ESL
							1 hour	Health	110	Texas ESL
n-Hexane	8	0	0.02 to 0.05	Not detected	0.12	0.08	Annual	Health	190	Texas AMCV
							1 hour	Health	1,800	Texas AMCV
Isooctane	0	8	Not detected	Not detected	0.03	Not detected	Annual	Health	75	Texas AMCV
							1 hour	Health	750	Texas AMCV
Methylcyclopentane	0	8	Not detected	Not detected	0.05	Not detected	Annual	Health	75	Texas AMCV
							1 hour	Health	750	Texas AMCV
2-Methylpentane	2	6	0.03 to 0.08	Not detected	0.24	Not detected	Annual	Health	85	Texas AMCV
							1 hour	Health	850	Texas AMCV
3-Methylpentane	1	7	0.03	Not detected	0.07	Not detected	Annual	Health	100	Texas AMCV
							1 hour	Health	1,000	Texas AMCV
n-Undecane	1	7	0.04	0.45 to 0.47	0.05	0.34	Annual	Health	55	Texas AMCV
							1 hour	Health	550	Texas AMCV

[a] Uncorrected concentrations as reported by the laboratory. The presence of *n*-dodecane in the field blank sample means that actual ambient concentrations of *n*-dodecane would have been lower than the reported values. Based on the mass on *n*-dodecane present in the field blank and the published diffusion rate for *n*-dodecane, actual ambient concentrations of *n* dodecane are estimated to be less than 20 per cent of the reported concentrations.

Table 1 (cont.)**:** Average volatile organic compounds (VOCs) concentrations measured at outdoor monitoring sites at Hopeland and Chinchilla over the 13-day period from 10 December 2015 to 23 December 2015.

Volatile Organic Compound	Hopeland sites				Chinchilla background site		Ambient Air Guideline/Criteria (Health)			
	December 2015 (five residential and three open sites)			March 2015	December 2015	March 2015	Averaging Period	Guideline type	Guideline Value (ppb)	Source
	Compound detected	Compound not detected	Concentration range (ppb)	Concentration range (ppb)	Concentration (ppb)	Concentration (ppb)				
Chloroalkanes										
Carbon tetrachloride	8	0	0.07 to 0.09	0.07 to 0.08	0.08	0.07	Annual	Health	2	Texas AMCV
							1 hour	Health	20	Texas AMCV
Aromatics										
Benzene	4	4	0.03	0.04	0.07	0.07	Annual	Health	3	EPP Air
1,4-Dichlorobenzene	0	8	Not detected	Not detected	0.43	1.51	Annual	Health	10	Texas ESL
							1 hour	Health	100	Texas ESL
Ethylbenzene	0	8	Not detected	Not detected	0.03	0.05	Annual	Health	450	Texas AMCV
							1 hour	Health	20,000	Texas AMCV
Toluene	6	2	0.02 to 0.16	0.08 to 0.09	0.27	0.85	Annual	Health	100	EPP Air
							24 hour	Health	1,000	EPP Air
1,2,4-Trimethylbenzene	0	8	Not detected	Not detected	0.05	0.02	Annual	Health	37	Texas AMCV
							1 hour	Health	3,000	Texas AMCV
Xylenes (total)	2	6	0.03	0.03 to 0.04	0.16	0.22	Annual	Health	200	EPP Air
							24 hour	Health	250	EPP Air
Carbonyls										
Cyclohexanone	1	7	0.03	Not detected	0.09	Not detected	Annual	Health	20	Texas ESL
							1 hour	Odour	120	Texas ESL
Ethyl acetate	8	0	0.02 to 0.03	0.06	0.03	Not detected	Annual	Health	400	Texas AMCV
							1 hour	Health	4,000	Texas AMCV

Conclusion

The second round of air monitoring conducted in the Hopeland and Chinchilla areas between 10 December and 23 December 2015 found that levels of VOCs in outdoor air were all below relevant air quality guidelines for protection of human health and wellbeing, mirroring the results of the initial March 2015 round of monitoring.

The December 2015 results show little change from the VOC concentrations measured in March 2015. Based on this, it is considered that the measured VOC concentrations are representative of typical levels to which the community is exposed.

Neither the March 2015 nor December 2015 monitoring programs found any evidence of subsoil gases leading to unsafe levels of air pollutants in the Hopeland community. Of note is the fact that VOC results for sites in the vicinity of sub-soil gas monitoring bores which had previously returned high underground VOC concentrations were among the lowest of all the sites sampled. This suggests that if any surface emissions of sub-soil gases are occurring, these emissions are gradual and any released gases are quickly diluted by surrounding air to very low levels.

Appendix

The full range of 48 VOCs capable of being detected by the sampling and analysis technique used in the December 2015 investigation is listed below. The 20 compounds shown in bold italic type were present at concentrations greater than the limit of reporting concentration.

Volatile Organic Compound	Limit of reporting (ppb)	Volatile Organic Compound	Limit of reporting (ppb)
Benzene	0.02	1-Methoxy-2-propyl acetate	0.02
Bromochloromethane	0.02	Methyl methacrylate	0.02
Butanol	0.02	Methylcyclohexane	0.02
2-Butoxyethanol	0.02	**Methylcyclopentane**	0.02
Butyl acetate	0.02	Methyl ethyl ketone	0.02
Carbon tetrachloride	0.01	Methyl isobutyl ketone	0.02
Chlorobenzene	0.02	**2-Methylpentane**	0.02
Cyclohexane	0.03	**3-Methylpentane**	0.02
Cyclohexanone	0.02	Methyl-tert-butyl ether	0.02
***n*-Decane**	0.02	Naphthalene	0.04
1,4-Dichlorobenzene	0.02	*n*-Nonane	0.02
1,2-Dichloroethane	0.02	*n*-Octane	0.02
1,2-Dichloropropane	0.02	*n*-Propylbenzene	0.02
***n*-Dodecane**	0.19	Styrene	0.02
Ethyl acetate	0.02	Tetrachloroethylene	0.01
Ethylbenzene	0.02	**Toluene**	0.02
2-Ethylhexanol	0.02	1,1,1-Trichloroethane	0.02
Ethyl-tert-butyl ether	0.02	Trichloroethylene	0.01
n-Heptane	0.02	Trichloromethane	0.01
***n*-Hexane**	0.02	**1,2,4-Trimethylbenzene**	0.02
Isobutanol	0.02	***n*-Undecane**	0.03
Isooctane	0.02	***m*-Xylene**	0.02
Isopropylbenzene	0.02	***o*-Xylene**	0.02
1-Methoxy-2-propanol	0.03	***p*-Xylene**	0.02

The limit of reporting is the minimum measurable VOC concentration achievable using the passive sampling and analysis technique.