



Health Risk Assessment of air quality monitoring results from March 2021: Walley's Quarry Landfill Site, Newcastle under Lyme

Regarding ongoing response to odours and health concerns associated with the site

Summary

The site is owned by RED industries, who operate the site as an active landfill which accepts non-hazardous waste e.g. household waste, and a cell which accepts stable non-reactive hazardous waste (gypsum and asbestos as found in construction waste). Activities at the site are regulated by the Environment Agency (EA) under an Environmental Permit first issued in 2016. In response to increased community concern of odours within Silverdale and the surrounding areas, the EA have installed four air quality Mobile Monitoring Facility (MMF) units which are to remain in place for at least 3 months to collect monitoring data to continuously assess air quality. The aim of this document is to interpret the EA's air quality monitoring data from the 4th to 31st March 2021 in relation to potential toxic or harmful effects to health.

Hydrogen sulphide (which smells of rotten eggs), particulate matter (solid and liquid particles suspended in air), nitrogen dioxide, and methane levels in air have been compared to appropriate health-based air quality standards or guidelines. Where the concentrations of pollutants in the air are lower than the health-based standards or guidelines, PHE's conclusion is that the risk to health is minimal.

The air quality monitoring shows that the World Health Organization's (WHO) odour annoyance (nuisance) guideline value was breached at both monitoring locations for some of the monitoring period (MMF2 22% and MMF9 38% of the time). The human nose is very sensitive to odours, and substances that can smell very unpleasant are commonly present at levels below which there is a direct harmful effect. However, odours can cause nuisance among the population and impact on wellbeing, leading to stress, anxiety and disturbed sleep. Some people may experience symptoms such as nausea, headaches or dizziness, as a response to odours even when the substances that cause those smells are themselves not directly harmful to physical health.

The WHO's 24-hour average guideline value for hydrogen sulphide was breached at MMF9 on two days during the monitoring period (7 & 8 March 2021). Exposure to concentrations of hydrogen sulphide above the WHO 24-hour guideline value does not necessarily mean eye irritation or other health effects will occur, but it reduces the margin of safety that is considered desirable to protect human health.

Based on the current data up to the end of March we would stress that any risk to long-term physical health is likely to be small, however we cannot completely exclude a risk to health from pollutants in the area. Short-term health effects may be experienced such as irritation to the eyes, nose and throat. Individuals with pre-existing respiratory conditions may be more susceptible to or at risk from to these effects.

Whilst this report concentrates on interpreting the Environment Agency's air quality monitoring data, PHE appreciates there are wider public health issues affecting residents around the site.

PHE recommends that measures continue to be taken by the site operators to reduce odours from the landfill site due to the impacts on the surrounding residents' wellbeing.

Main report

Scope

The EA has recently shared with Public Health England (PHE), an Interim Air Quality report based on initial monitoring data from the 4th-31st March 2021 (28 days). PHE - Centre for Radiation, Chemical and Environmental Hazards (CRCE) has reviewed the available hydrogen sulphide (H₂S), particulate matter (PM₁₀, PM_{2.5}), nitrogen dioxide (NO₂) and methane (CH₄) monitoring data, from MMF stations MMF2 and MMF9. The EA also monitored for benzene, toluene, ethylbenzene and xylene, during March 2021, however this data is not yet available for PHE to review.

MMF2 Location Silverdale road, Newcastle under Lyme

MMF9 Location Severn Trent Pumping Station off Galingale View, Newcastle under Lyme

Figure 1. Map showing the location of the two monitoring sites



Methodology

Air quality standards and assessment levels

The data provided to PHE have been compared to available health-based air quality guidelines and standards or assessment levels. There are a variety of health-based standards and assessment levels that have been derived by a number of organisations shown below:

- UK health-based guidance values
- UK air quality standards
- World Health Organization (WHO) air quality guidelines
- European air quality standards
- Other UK air quality assessment levels
- National air quality assessment levels other than UK (including US and Canadian air quality assessment levels)

Air quality monitoring results and discussion

Hydrogen Sulphide (H₂S) acute exposure

The health-based guidance values considered for the risk assessment for acute, intermediate and lifetime exposure are summarised in Table 1.

Table 1: Health based guidance values used in for this risk assessment

WHO air quality guidelines	ATSDR-MRL**	US EPA RfC***	OEHHA Chronic REL****
30-minute (average)* 7 µg/m ³ (5 ppb)	Intermediate (up to 1 year): 30 µg/m ³ (20 ppb)	For assessment of lifetime exposure	For assessment of lifetime exposure
24-hour (average) 150 µg/m ³ (107 ppb)	Based on lesions of the nasal olfactory epithelium in rats.	2 µg/m ³ (1 ppb)	10 µg/m ³ (7 ppb)
Based on eye irritation in humans.		Based on lesions of the nasal olfactory epithelium in rats.	Based on lesions of the nasal olfactory epithelium in rats.

*The WHO guideline value of 7 µg/m³ (5 ppb) over a 30-minute averaging period is a short-term odour value protective of odour annoyance¹.

** An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. They are derived for acute (>1, ≤14 days), intermediate (>14, <364 days), and chronic (365 days and longer) exposure durations².

*** An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime³.

**** The concentration level at or below which no adverse health effects are anticipated for a specified exposure duration is termed the reference exposure level (REL)⁴.

30 minute-average

The EA monitoring data shows a number of periods of exceedance of the WHO short-term odour annoyance value (7 µg/m³, 30-minute average): for 22% of the March 2021 monitoring period at MMF2; and 38% of the March 2021 monitoring period at MMF9. As such, there was potential for significant odour complaints to occur over this period.

24-hour average

The monitoring data has been converted to 24-hour averages for each of the monitoring days. At MMF2, 24-hour average values were significantly below the WHO 24-hour average guideline value of 150 µg/m³⁵. However, at MMF9, the 24-hour average guideline value was exceeded on two days during the monitoring period: 7 & 8 March 2021, the highest of which was 202 µg/m³.

Exposure to concentrations of hydrogen sulphide above the WHO 24-hour guideline value does not necessarily mean eye irritation or other health effects will occur, but it reduces the margin of safety that is considered desirable to protect health

Peak exposures

Table 2 US Environmental Protection Agency (US EPA) Acute Exposure Guideline Levels (AEGLs) for hydrogen sulphide

	10 min	30 min	60 min	4 hour	8 hour
AEGL-1[†]					
ppb	750	600	510	360	330
µg/m ³	(1045)	(836)	(711)	(502)	(460)
AEGL-2^{††}					
ppb	41000	32000	27000	20000	17000
µg/m ³	(57150)	(44600)	(37660)	(27880)	(23700)
AEGL-3^{†††}					
ppb	76000	59000	50000	37000	31000
µg/m ³	(105900)	(82240)	(69690)	(51570)	(43210)

† The level of the chemical in air at or above which the general population could experience notable discomfort.

†† The level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape.

††† The level of the chemical in air at or above which the general population could experience life-threatening health effects or death⁶.

Short-term peaks in hydrogen sulphide concentration have been compared against the US Environmental Protection Agency (US EPA) Acute Exposure Guideline Levels (AEGLs) (see Table 2).

AEGLs are expressed as specific concentrations of airborne chemicals at which health effects may occur and used to assess peaks of exposure. They are designed to protect the elderly and children, and other individuals who may be susceptible.

The March monitoring data from MMF2 and MMF9 were compared with AEGL-1 10-minute, 30-minute, 60-minute, 4-hour and 8-hour levels for hydrogen sulphide. AEGL-1 was exceeded across the AEGL time frames as set out in Table 3 in the Appendix. Figures 1 and 2 in the Appendix show hydrogen sulphide concentrations compared to AEGL-1, 10-minute and 8-hour time frames for MMF2 and MMF9 respectively.

Exposure to concentrations above the AEGL-1 values may cause notable discomfort, irritation or certain asymptomatic, non-sensory effects. However, the effects are not disabling, and are transient and reversible upon cessation of exposure.

See appendix for Table 3 which shows a breakdown of the specific timeframes of the exceedances at MMF9.

Intermediate exposure

To assess intermediate exposure to hydrogen sulphide during 2021, the calculated average daily exposure concentrations from the March 2021 data have been compared against the Agency for Toxic Substances and Disease Registry (ATSDR) Intermediate Minimal Risk Level (MRL) of 30 µg/m³, which applies to up to 1 year. The average daily hydrogen sulphide concentrations of 5.75 and 27.73 µg/m³ for MMF 2 and 9 respectively from 5th -31st March 2021, are below the ATSDR Intermediate MRL. As such, any risk to long-term physical health is likely to be small.

Long-term exposure

To assess long-term exposure to hydrogen sulphide the previous monitoring data from the 6/7/2017 to 14/2/2018 and 15/1/2019 to 25/6/2019 monitoring periods has been compared against the US EPA Reference Concentration (RfC) and the California Office of Environmental Health Hazard Assessment (OEHHA) Chronic Reference Exposure Level (REL) to assess longer-term exposure to hydrogen sulphide. For the 2017/18 monitoring period the average 24-hour concentration was 0.85 µg/m³ and for the 2019 the average 24-hour concentration was 0.95 µg/m³. These concentrations are below the US EPA and OEHHA values therefore there would not be expected to be any significant effects on health at these levels of exposure.

Hydrogen sulphide concentrations averaged across a 24-hour period

Figure 3 is a graph which shows average hydrogen sulphide concentrations against a 24-hour period. The complete data set from MMF9 has been averaged over a 24-hour period to illustrate trends in concentrations, peaks of hydrogen sulphide generally occur between 20:00 and 09:00.

Particulate matter UK air quality objectives

Table 4

Substance	UK limit values
PM ₁₀	50 µg/m ³ not to be exceeded more than 35 times a year 24-hour mean
	40 µg/m ³ Annual mean
PM _{2.5}	25 µg/m ³ Annual mean

PM₁₀: Average for MMF2 (04/03/2020 to 31/03/2021): 19 µg/m³
Average for MMF9 (04/03/2020 to 31/03/2021): 13.4 µg/m³

PM_{2.5}: Average for MMF2 (04/03/2020 to 31/03/2021): 9.8 µg/m³
Average for MMF9 (04/03/2020 to 31/03/2021): 9.1 µg/m³

These results are all well below the relevant annual air quality objectives.

Nitrogen dioxide UK air quality objectives

Table 5

Substance	UK limit values
NO ₂	200 µg/m ³ not to be exceeded more than 18 times a year 24-hour mean
	40 µg/m ³ Annual mean

Average for MMF2 (04/03/2020 to 31/03/2021): 15.8 µg/m³
Average for MMF9 (04/03/2020 to 31/03/2021): 11.4 µg/m³

These results are all well below the relevant annual air quality objectives.

Methane (CH₄)

Methane is generally considered to be an asphyxiant rather than a toxic gas. It is typically only a risk to health in high concentrations in enclosed spaces. There are no ambient air quality standards. However, levels greater than 80% methane may cause asphyxia (1% methane is equivalent to 6,556 mg/m³) and the Lower Explosive Limit (LEL) is 32,781 mg/m³.

The maximum concentration of methane recorded at MMF2 and MMF9 was 130.5 and 135.5 mg/m³ respectively which is significantly less than the values discussed above.

Benzene, Toluene, Ethylbenzene and Xylene (BTEX)

The EA is monitoring for BTEX contaminants, however this data has not yet been made available to PHE.

Conclusions

The monitoring results for particulate matter and nitrogen dioxide were below UK air quality objectives. Therefore, there would be negligible/minimal risks to health at these levels of exposure.

For the majority of the monitoring period the concentrations of hydrogen sulphide were below the WHO 24-hour health based-guideline value, AEGL values and the ATSDR MRL. However, the WHO value and the AEGLs values were exceeded over a 2-day period on 7th and 8th March. Exposure to concentrations above these values could potentially cause notable discomfort and irritation. Exceedances of these values does not necessarily mean health effects will occur, but it reduces the margin of safety that is generally considered to be desirable to protect health.

Based on the current data up to the end of March we would stress that any risk to long-term physical health is likely to be small, however we cannot completely exclude a risk to health from pollutants in the area. Short-term health effects may be experienced such as irritation to the eyes, nose and throat. Individuals with pre-existing respiratory conditions may be more susceptible to these effects.

The results for hydrogen sulphide continue to be above the odour threshold. Therefore, PHE recommends that all measures are taken to reduce the off-site odours from the landfill site, as it is acknowledged that odours can affect an individual's wellbeing.

PHE understands that further air quality monitoring is being undertaken by the Environment Agency and this report will be updated as appropriate when more data is available. The Environment Agency and multi-agency partners will also be assessing additional factors such as meteorological conditions, complaints, distance to receptors from the monitoring stations and indoor receptors. PHE will continue supporting the other agencies with this work.

Whilst this report concentrates on interpreting the Environment Agency's air quality monitoring data PHE appreciates there are wider public health issues affecting residents around the site.

PHE recommends that appropriate measures continue to be taken by the site operators to reduce odours from the landfill site due to the impacts on the surrounding residents' wellbeing.

References

- 1 World Health Organization (WHO) air quality guideline [Microsoft Word - 6.6-hydrogen sulfide.doc \(who.int\)](#)
- 2 U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological profile for Hydrogen Sulphide, 2006. <http://www.atsdr.cdc.gov/ToxProfiles/tp114.pdf>
- 3 U.S. Environmental Protection Agency Reference Concentration for Hydrogen Sulphide. https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nمبر=61
- 4 California Office of Environmental Health Hazard Assessment Chronic Reference Exposure Level for Hydrogen Sulphide. <https://oehha.ca.gov/chemicals/hydrogen-sulfide>
- 5 World Health Organization International Programme on Chemical Safety Concise International Chemical Assessments Document [cicad53.pdf \(who.int\)](#)
- 6 Hydrogen Sulphide Acute Exposure Guideline Levels (AEGs) [Acute Exposure Guideline Levels for Airborne Chemicals | US EPA](#)

Appendix

Figure 1

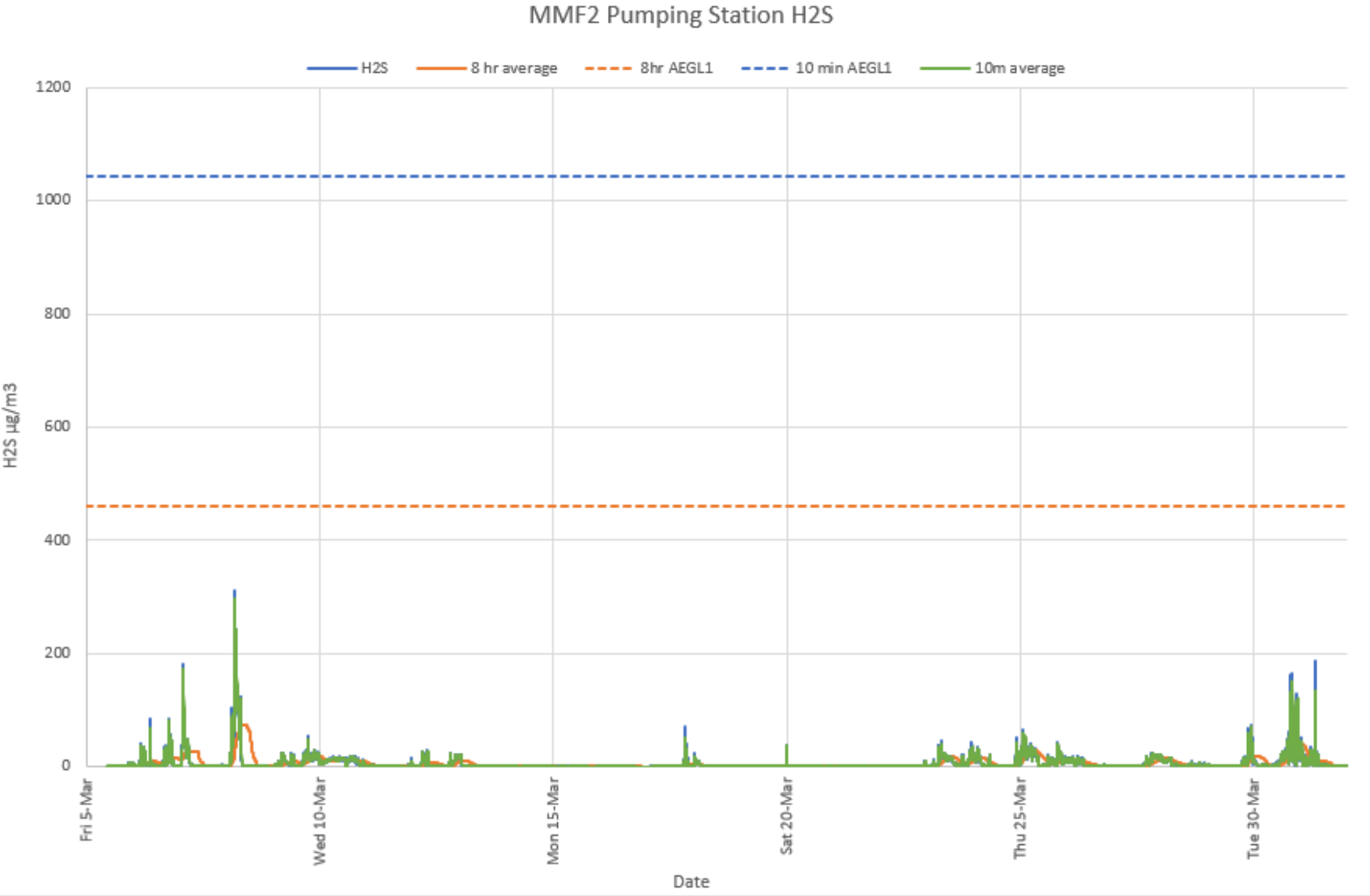


Figure 2

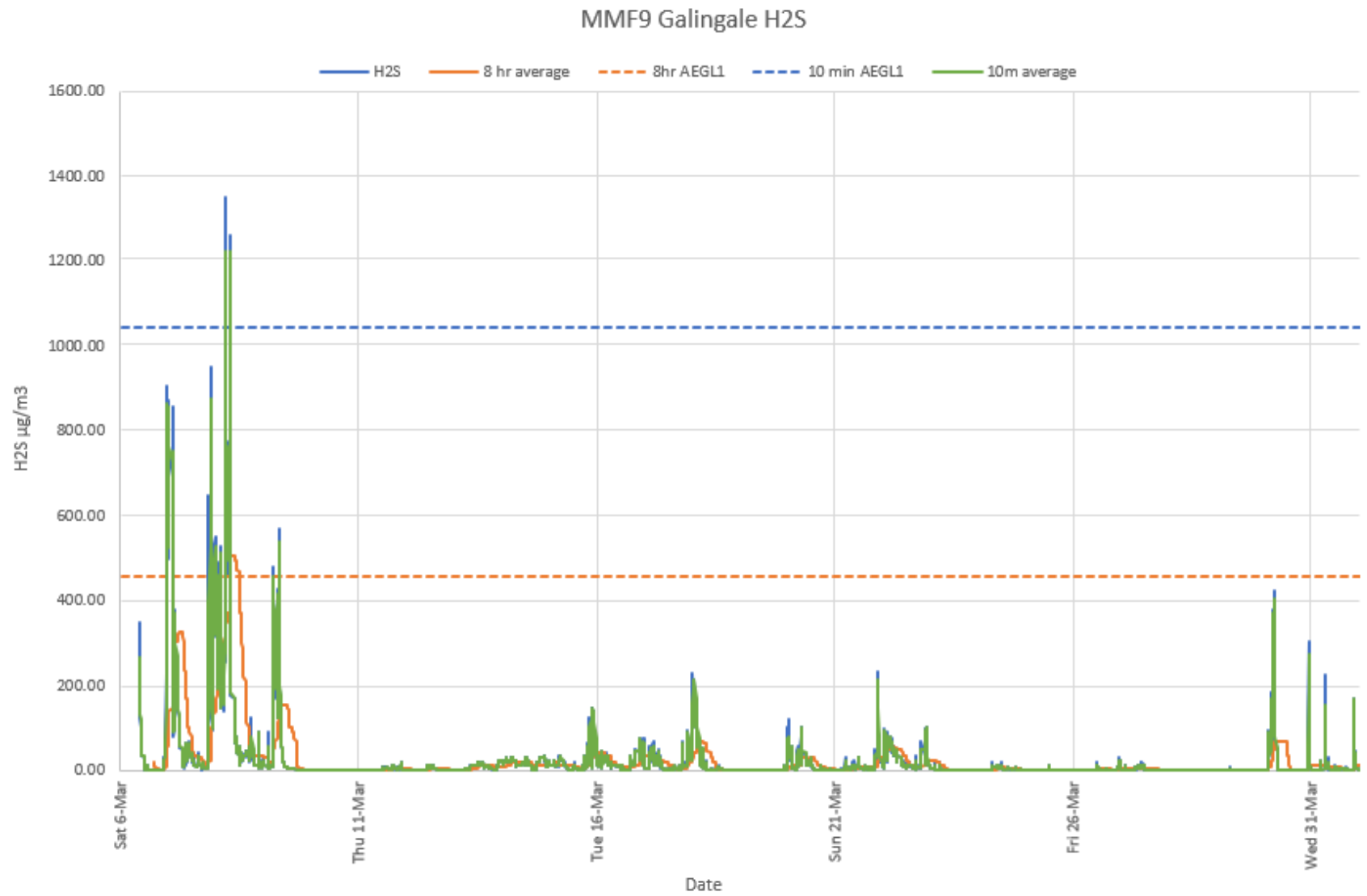


Table 3

	Acute Exposure Guideline Levels (AEGLs)				
	10 min	30 min	60 min	4 hour	8 hour
Timeframe of Exceedances	0615 - 0650hrs (7 th March)	0550 - 0655hrs (7 th March)	0415 - 0650hrs (7 th March)	0210 - 0550hrs (7 th March)	2245hrs (7 th March) – 0230hrs (8 th March)

Figure 3

