

Preston New Road - Continuous Monitoring Update

8th April 2019 to 21st April 2019



Image from Google Maps 2018

Prepared for:

Cuadrilla Bowland Ltd.



Document Control Page

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1 Outline of Monitoring

Cuadrilla Bowland Ltd has appointed GGS to conduct continuous ambient air quality monitoring at the Preston New Road (PNR) wellsite before, during and after the hydraulic fracturing and well testing operations.

GGS has been undertaking continuous air quality monitoring at the PNR wellsite since early 2018. Continuous ambient methane monitoring commenced in February 2018. Continuous ambient monitoring of certain additional air quality parameters commenced in May 2018.

These monitoring requirements were codified in Cuadrilla Bowland's Environmental Management and Monitoring Plan (EMMP) (Version 5.1, May 2018) as required by pre-operational condition 2 of the site's environmental permit (EPR/AB3101MW/V004). The EMMP was approved by the Environment Agency on 18th May 2018 (CAR/UP3434VF/0306642).

A commitment to provide regular updates on the results gathered by this monitoring is included within the site's EMMP. This continuous monitoring update (CMU) report forms the latest regular update since the start of hydraulic fracturing operations, which commenced during week commencing 8th October 2018.

This CMU summarises the continuous monitoring results recorded between 8th April and 21st April 2019

The parameters covered by this report are as detailed within the site's EMMP, and are summarised in Table 1 below.

Preston New Road – Continuous Monitoring Update
8th April 2019 to 21st April 2019

Table 1. Required Ambient Air Quality Parameters.

Parameters	Monitoring frequency
Methane (CH ₄)	Continuous monitoring (10-minute average)
Nitrogen dioxide (NO ₂)	Continuous monitoring (10 minutely sampling)
PM ₁₀	Continuous monitoring (10 minutely sampling)
Total Volatile Organic Compounds (TVOC)	Continuous monitoring (10 minutely sampling)

2 Site Monitoring Location

A continuous monitoring station has been established at the site in order to capture the prevailing down-wind concentrations for the required air quality parameters. Figure 1 below illustrates the location of the monitoring station.

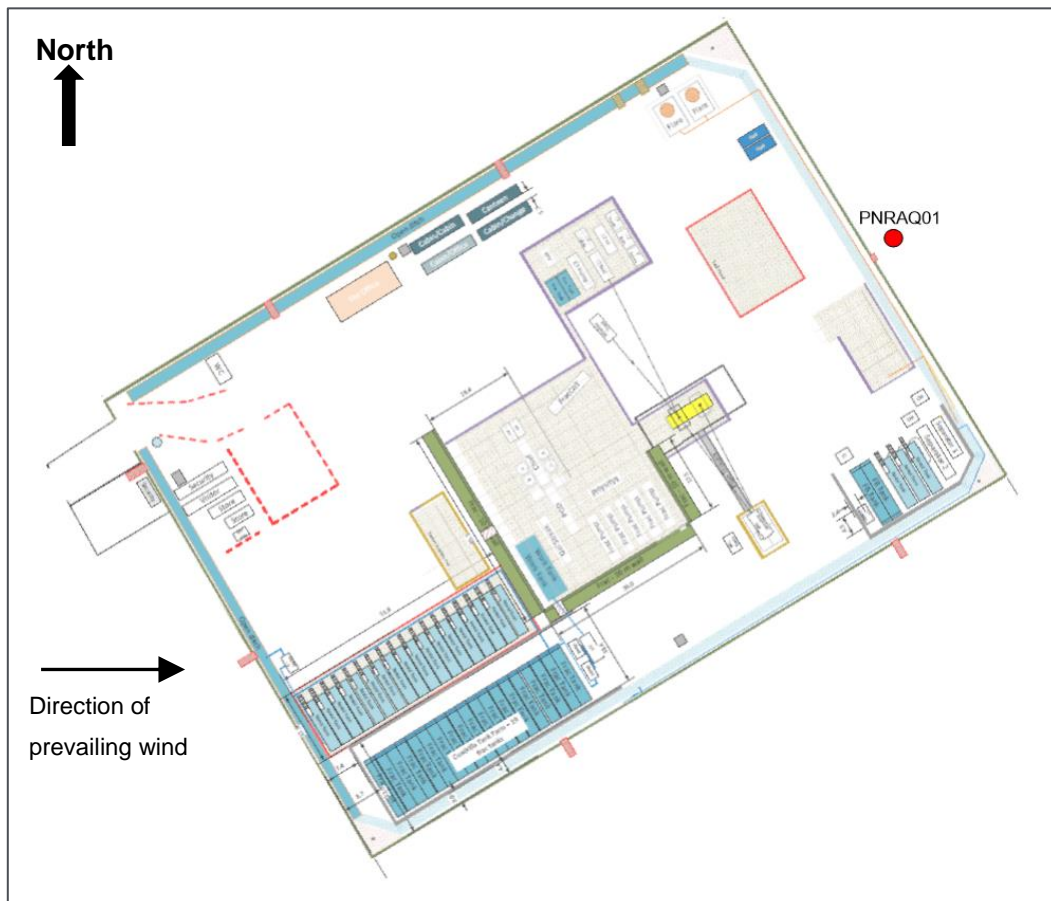


Figure 1. Location of prevailing down-wind ambient air quality monitoring station shown by red dot (PNRAQ01). Drawing adapted from the site 'as-built' plan.

3 Continuous Monitoring Update

3.1 Background

GGs has been undertaking continuous air quality monitoring for all reported parameters at the PNR wellsite since mid-2018. The instruments used and monitoring specification are as detailed within the site's EMMP (Section 8).

Where available, the monitoring results have been compared against the applicable Daily Air Quality Index (DAQI) as defined by Defra¹. DAQIs exist for both nitrogen dioxide and particulate matter (specifically PM₁₀). DAQIs present the level of air pollution at a given location, along with actions to take where pollutant levels are elevated. Each set of monitoring results have been presented alongside the relevant DAQI bands to indicate the overall level of air quality at the monitoring location, which is immediately down prevailing wind of the onsite activities.

3.2 Methane (CH₄)

Methane is naturally occurring in the environment and arises from organic rich soils and ruminant cattle. It is typically present in the atmosphere at approximately 2 ppmv, but this can vary due to local influences. It is also the principle constituent of the target gas to be produced from the geological formations that are proposed to be hydraulically fractured.

3.2.1 Methodology

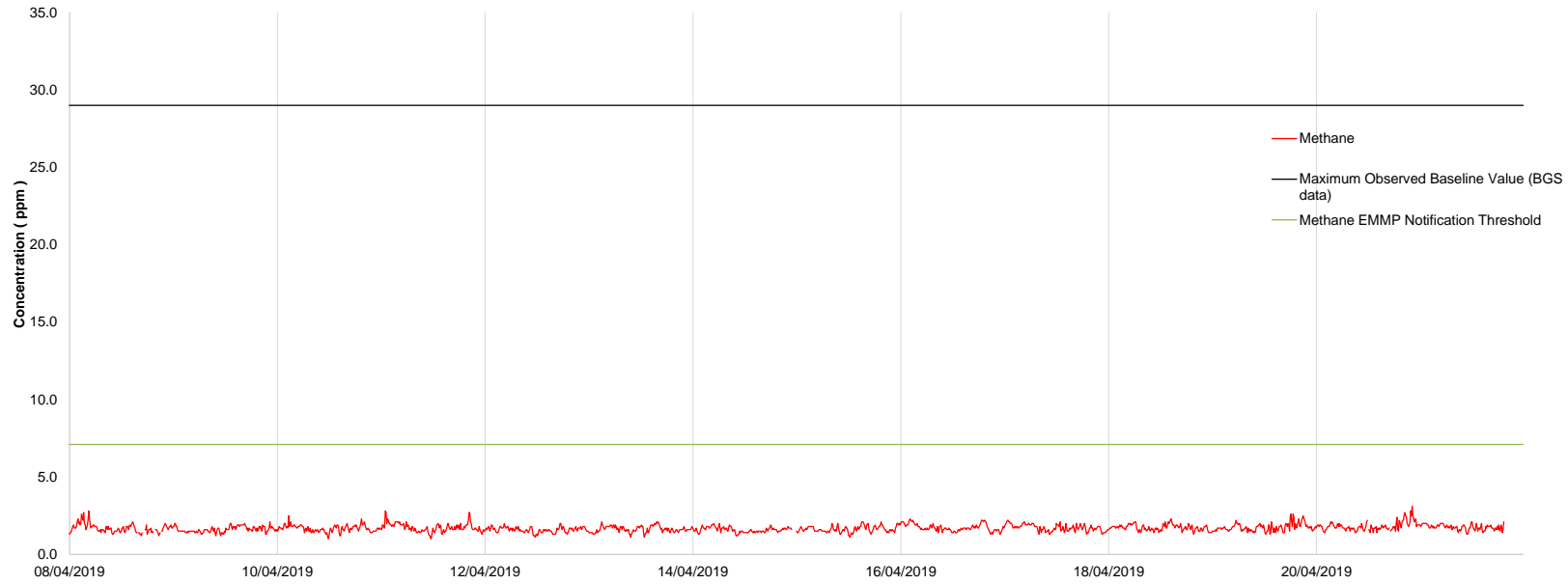
Continuous monitoring of methane at PNRAQ01 began in February 2018. Data is presented below from the 8th April to 21st April 2019. In line with the commitment within the site's EMMP the data is presented as a 10 minute average. No Daily Air Quality Index (DAQI) exists for methane.

¹ Daily Air Quality Index, Defra 2018[<https://uk-air.defra.gov.uk/air-pollution/daqj>], accessed October 2018.

3.2.2 Results

A summary of the continuous monitoring results are presented in the graph on the following page. A maximum and minimum table is also presented. The observed results are graphed against both the threshold at which the site's EMMP requires the Environment Agency to be notified, and the maximum level observed during baseline conditions, that is, prior to site construction. The baseline data is based on results collected by the British Geological Survey at a monitoring location approximately 450m from the site.

The latest methane monitoring results are in line with the baseline results observed at the site.

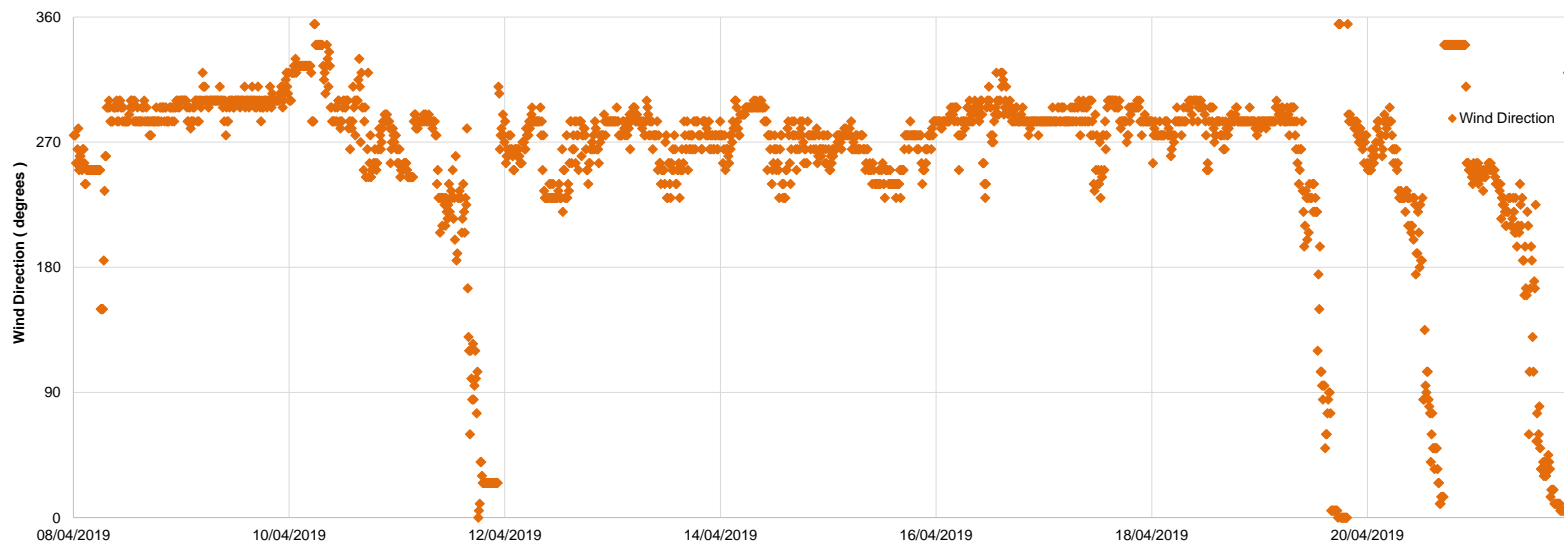


Title:
Preston New Road Methane - 8th April to 21st April 2019

Project:
GG51628 Preston New Road

Client:
Cuadrilla Bowland Ltd

Minimum / Maximum Table		
Parameter	Minimum	Maximum
CH ₄ (ppm)	1.0	3.1



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3.3 Nitrogen Dioxide (NO₂)

Trace concentrations of nitrogen dioxide occur naturally in the atmosphere from volcanic sources and lightning strikes. It is also a product of combustion and is present in vehicle exhaust fumes and cigarette smoke. Nitrogen dioxide concentrations in the atmosphere are highly variable, both temporally and spatially.

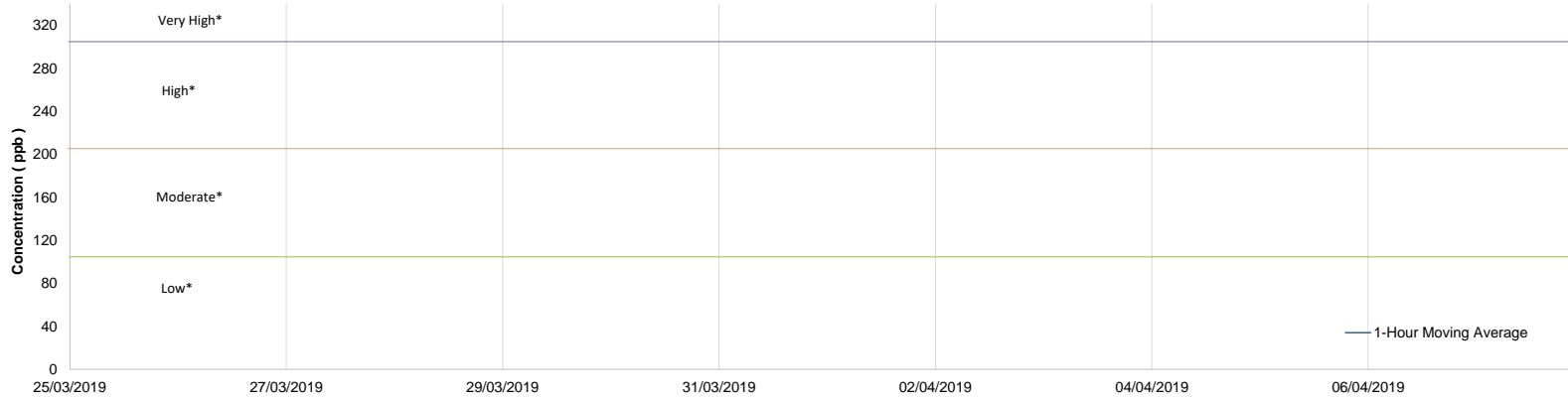
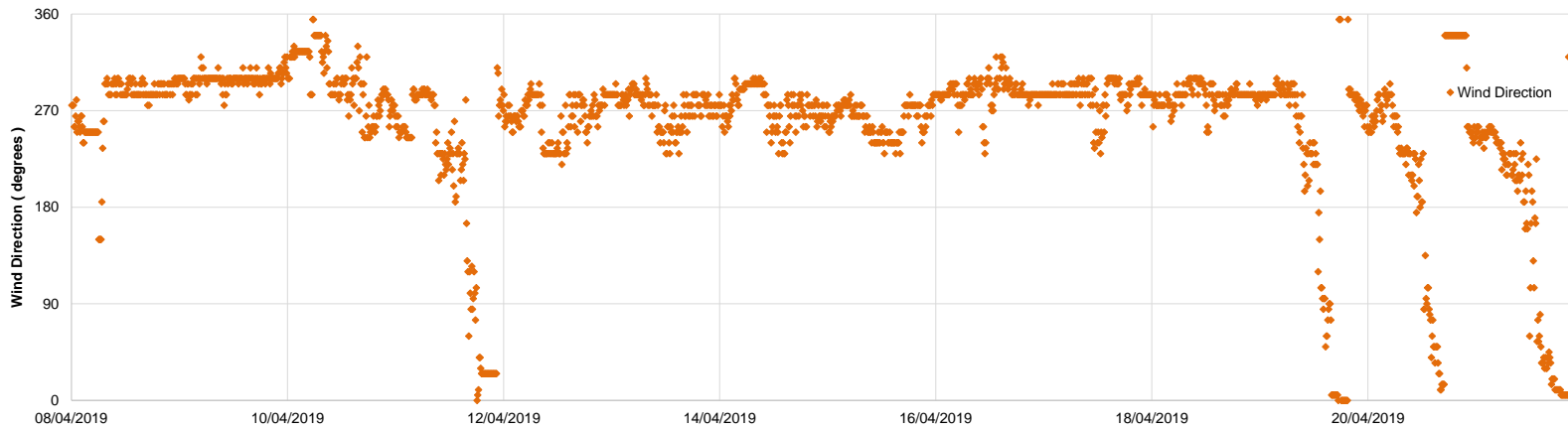
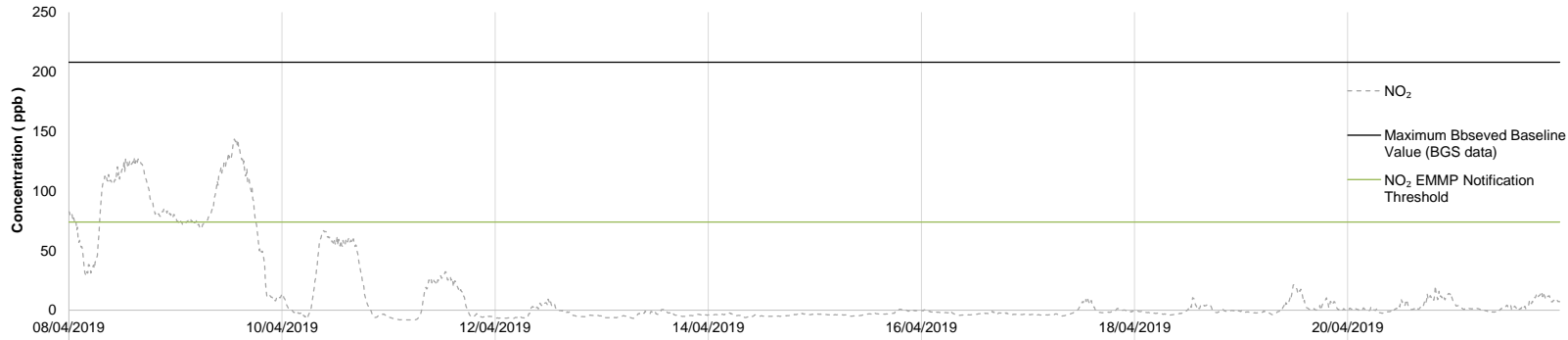
3.3.1 Methodology

Continuous monitoring of nitrogen dioxide at PNRAQ01 began in May 2018 and results are recorded every 10 minutes. Data is presented below from the 8th April 2019 to 21st April 2019. The graph on the following page presents the observed results in comparison to the DAQI air quality bands set out by DEFRA, where results are reported as an hourly mean concentration.

3.3.2 Results

A summary of the continuous monitoring results are presented in the graph on the next page. A maximum and minimum table is also presented. The observed results are graphed against both the threshold at which the site's EMMP requires the Environment Agency to be notified, and the maximum level observed during baseline conditions, that is, prior to site construction. The baseline data is based on results collected by the British Geological Survey at a monitoring location approximately 450m from the site.

The latest nitrogen dioxide results are not in line with expected results for the activity undertaken at the site and the surrounding environment. GGS are investigating the veracity of the observed readings as alternative monitoring stations in the area have not shown a corresponding increase in nitrogen dioxide levels. Elevations above the notification threshold have occurred on a number of occasions. As required by the EMMP, this was notified to the Environment Agency within 24 hours. An explanation of the anomalous nitrogen dioxide results is contained in Section 3.3.3 below.



Experts in Continuous Monitoring

Title:

Preston New Road NO₂ - 8th April to 21st April 2019

Project:

GG1628 Preston New Road

Client:

Cuadrilla Bowland Ltd

Minimum / Maximum Table		
Parameter	Minimum	Maximum
NO ₂ (ppb)	-8.1	143.6

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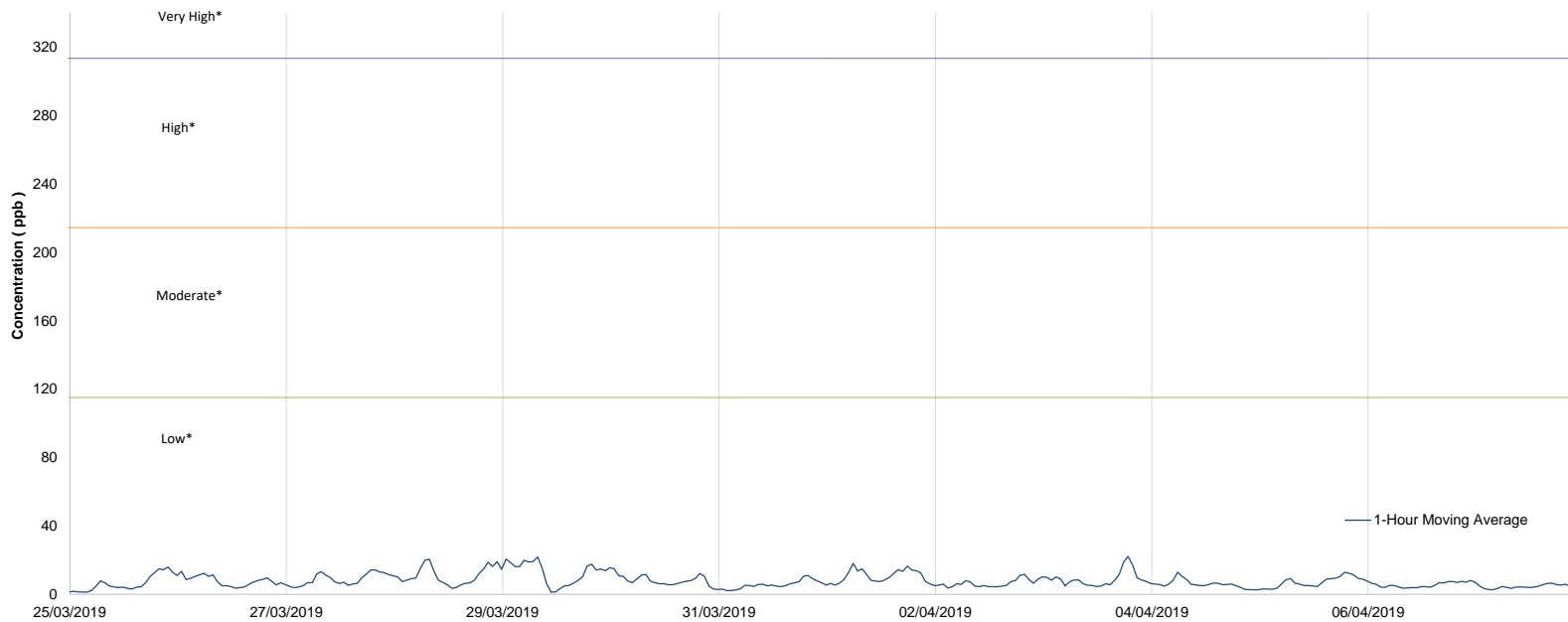
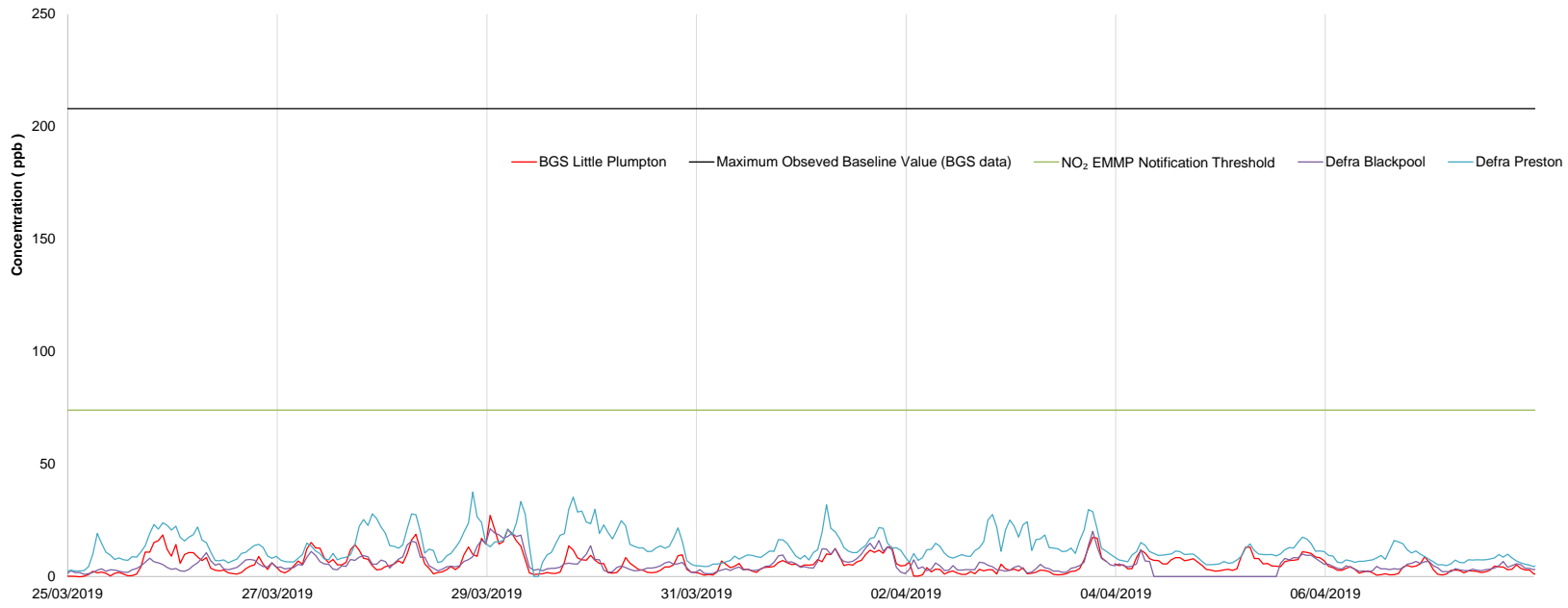
* Boundaries are set by the DEFRA Daily Air Quality Index (DAQI) for Nitrogen Dioxide using a hourly mean concentration. Boundary limit concentrations are converted from µg/m³ using a conversion factor of 1 ppb : 1.9125 µg/m³

3.3.3 Review of recent nitrogen dioxide results

During the period commencing March 19th 2019, a series of anomalous nitrogen dioxide results were observed at the Preston New Road site. Sustained elevated nitrogen dioxide concentrations were recorded between 19th March and 1st April. Following a short period of instrument downtime, a series of widely varying peaks and troughs in nitrogen dioxide concentrations were observed. The peaks during this period included very high levels approaching the maximum observed during the baseline period before the site's construction. These widely varying levels continued until 11th April, after which the reported results returned more typical results, albeit including a number of negative results. Nitrogen dioxide results appeared to stabilise at typical values from 20th April onwards.

Upon reviewing alternative nearby nitrogen dioxide monitoring sources during this period, it is evident that the results measured at the site were not genuine. Three alternative monitoring stations record nitrogen dioxide concentrations in the surrounding area, including one located close to the Preston New Road site. These three monitoring stations all show a consistent pattern of typical results throughout this period, which do not replicate the anomalous results observed from the onsite monitoring station. These results, including an indicative regional DAQI trend based on the average of all three stations, are presented in the graph on the following page.

During this period, GGS undertook a number of investigatory actions and interventions to understand and correct the anomalous nitrogen dioxide results observed. These actions included repeated dialogue with the manufacturer of the instrument involved. Following this investigation, GGS have concluded that changes undertaken to the software and algorithms which process the data from the nitrogen dioxide instrument were the cause of results observed. These issues have now stabilised, and the reported results have returned to typical levels which are representative of the air quality surrounding the Preston New Road site. GGS will continue to monitor a range of air quality parameters throughout operations at the site, and where necessary, will undertake any measures required to verify the results collected to provide confidence in the monitoring being undertaken.



Title:
Fylde regional NO₂ - 10th March to 21st April 2019

Project:
GGS1628 Preston New Road

Client:
Cuadrilla Bowland Ltd

Minimum / Maximum Table		
Parameter	Minimum	Maximum
NO ₂ (ppb)	0.0	27.2

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* Boundaries are set by the DEFRA Daily Air Quality Index (DAQI) for Nitrogen Dioxide using a hourly mean concentration. Boundary limit concentrations are converted from µg/m³ using a conversion factor of 1 ppb : 1.9125 µg/m³

3.4 Particulate Matter 10 (PM₁₀)

Airborne particulate matter is made up of a collection of materials of various sizes that range from a few nanometres in diameter to around 100 microns (100 µm). It consists of a wide range of material from both natural and anthropogenic sources and includes sea salt, soil dust and the products of combustion. PM₁₀ is defined as particulate matter 10 micrometres or less in diameter. PM₁₀ concentrations in the atmosphere are highly variable, both temporally and spatially.

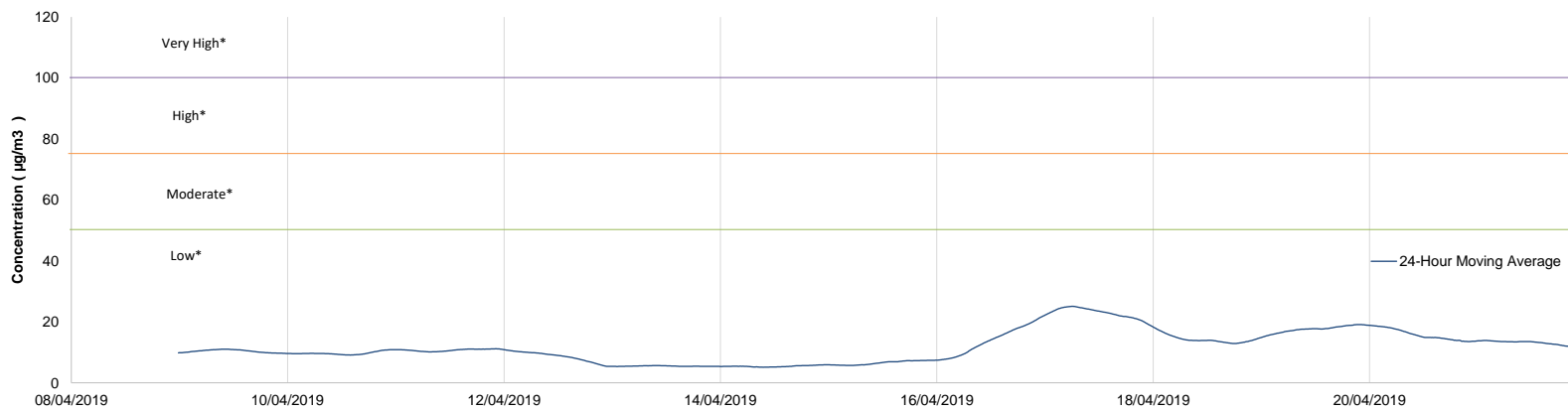
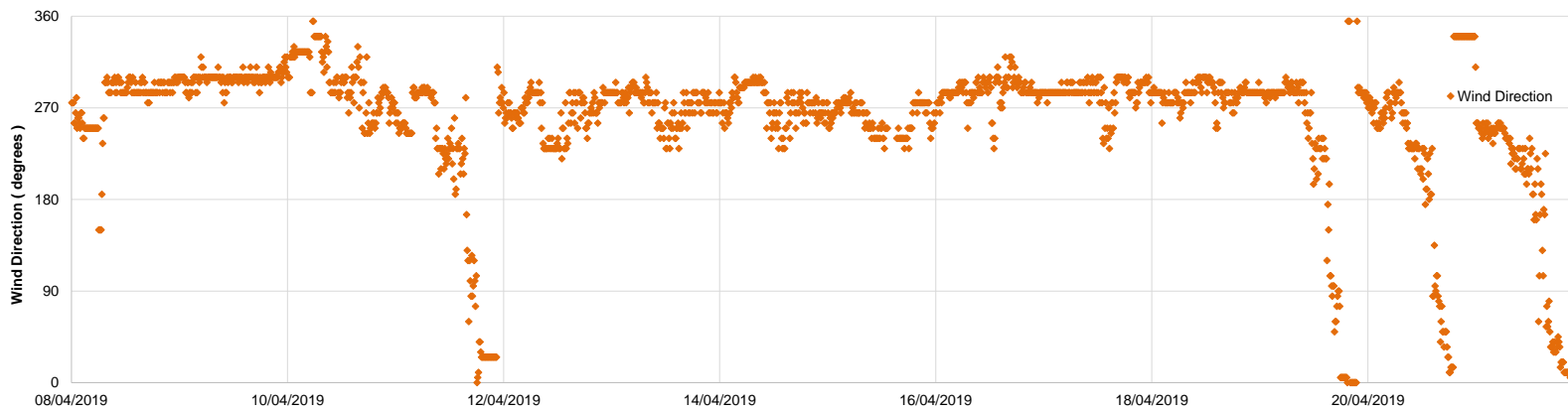
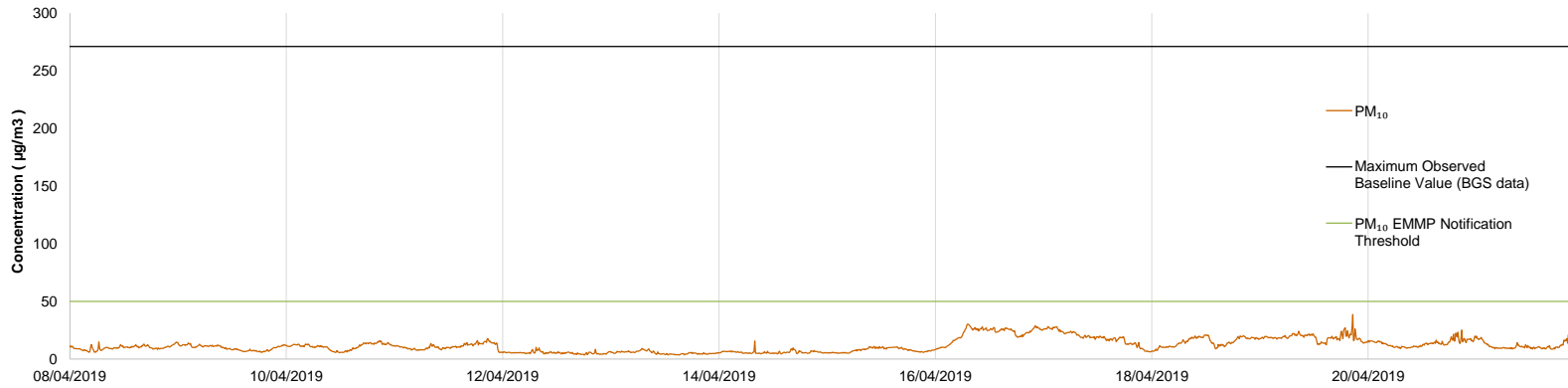
3.4.1 Methodology

Continuous monitoring of particulate matter at PNRAQ01 began in May 2018 and results are recorded every 10 minutes. Data is presented below from the 8th April to 21st April 2019. The graph on the following page presents the observed results in comparison to the Daily Air Quality Index (DAQI) air quality bands set out by DEFRA, where results are reported as a 24 hourly mean concentration.

3.4.2 Results

A summary of the continuous monitoring results are presented in the graph on the next page. A maximum and minimum table is also presented. The observed results are graphed against both the threshold at which the site's EMMP requires the Environment Agency to be notified, and the maximum level observed during baseline conditions, that is, prior to site construction. The baseline data is based on results collected by the British Geological Survey at a monitoring location approximately 450m from the site.

The latest particulate matter results are in line with expected results for the activity undertaken at the site and the surrounding environment. The 24 hour mean concentration remained within the 'low' band as defined by the DAQI throughout the period.



* Boundaries are set by the DEFRA Daily Air Quality Index (DAQI) for PM10 using a moving average over 24 hours.

Title:
Preston New Road PM₁₀ - 8th April to 21st April 2019

Project:
GGS1628 Preston New Road

Client:
Cuadrilla Bowland Ltd

Minimum / Maximum Table		
Parameter	Minimum	Maximum
PM ₁₀ (µg/m ³)	3.4	38.6

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3.5 Total Volatile Organic Compounds (TVOCs)

Volatile organic compounds (VOCs) are a wide range of substances with low boiling points that evaporate from solids or liquids. They occur both naturally and as products used in industrial processes. VOCs are also released by combustion activities and hydrocarbon-based substances. VOCs are generally absent in ambient air unless in close proximity to a source.

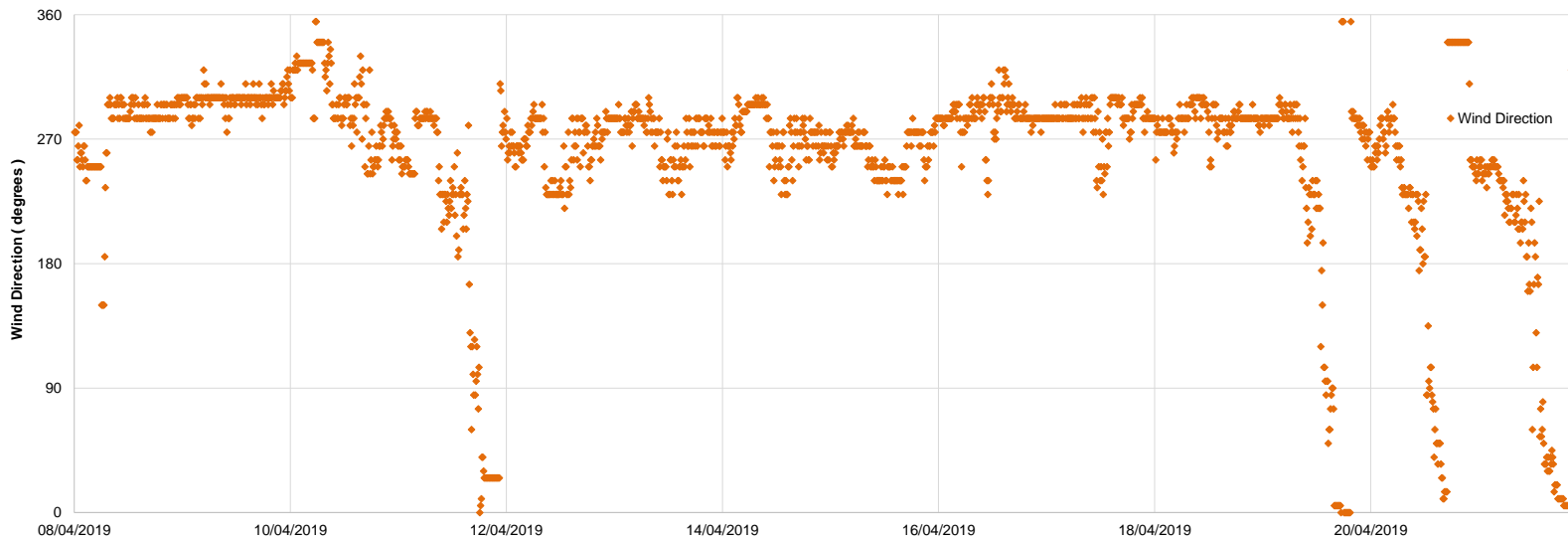
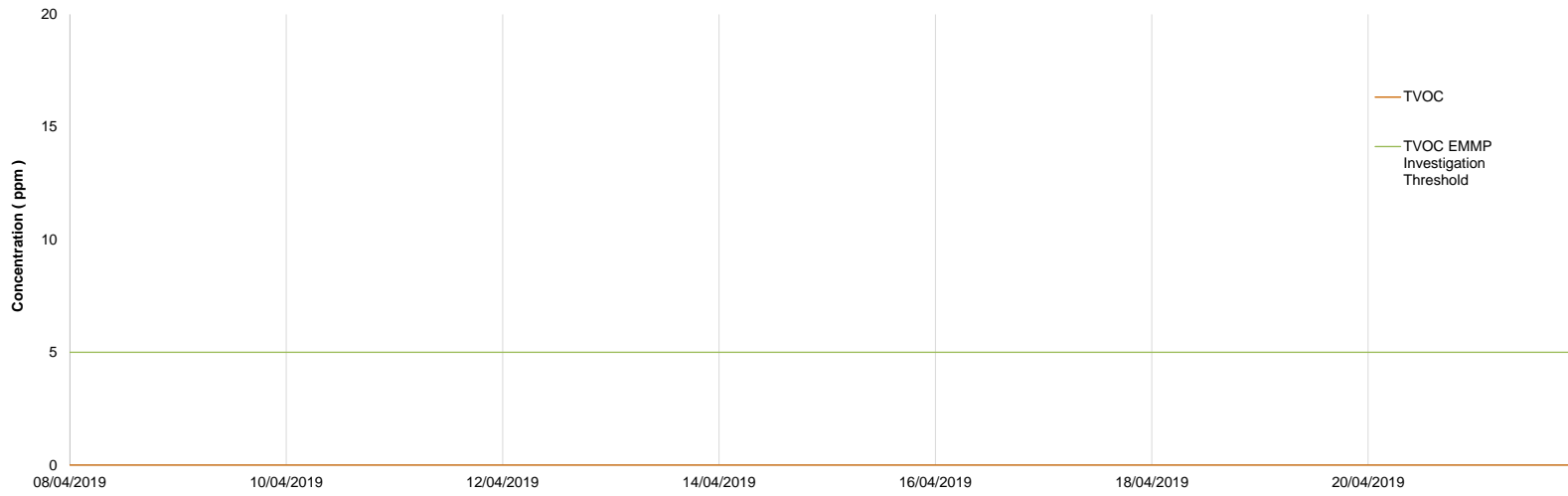
3.5.1 Methodology

Continuous monitoring of total VOCs (TVOCs) began in May 2018 and results are recorded every 10 minutes. Data is presented below from the 8th April 2019 to 21st April 2019. No DAQI exists for the TVOC parameter.

3.5.2 Results

A summary of the continuous monitoring results are presented in the graph on the next page. A maximum and minimum table is also presented. The observed results are graphed against the threshold at which the site's EMMP requires Cuadrilla to investigate potential causes. No directly equivalent parameter was measured by the British Geological Survey during the baseline period.

The latest monitoring results are in line with results observed at the site prior to hydraulic fracturing commencing.



Title:
Preston New Road TVOC - 8th April to 21st April 2019

Project:
GGS1628 Preston New Road

Client:
Cuadrilla Bowland Ltd

Minimum / Maximum Table		
Parameter	Minimum	Maximum
TVOC (ppm)	0	0

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4 Quality Control & Assurance

All monitoring equipment operated by GGS is maintained in accordance with the manufacturer's guidelines. Annual services and calibrations are undertaken when required and routine visual inspections of the equipment are undertaken prior to deployment and during regular site visits by GGS staff.

GGS operates an Integrated Management System (IMS) that is accredited by QMS International plc as complying with the following international standards:

- BS EN ISO 9001:2015 (Quality Management System);
- ISO 14001:2015 (Environmental Management System), and;
- ISO 45001:2018 (Health and Safety Management System).

All of GGS' continuous monitoring and sampling is carried out to procedures that are subject to an annual audit.

5 Ongoing Monitoring Regime

Ambient air monitoring will continue throughout the duration of site operations as required by the EMMP.

In addition, if significant concentrations, as determined with reference to baseline monitoring carried out prior to well stimulation operations and as agreed with the Environment Agency, are observed then the Environment Agency will be notified and the source of the elevation will be investigated.