Technical Annex

Hinkley Point C – Construction Modelling

Monitoring Results and Model Validation

March 2020

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1 Introduction

1.1 Overview

Air Quality and Dust monitoring is undertaken at various locations around the HPC Site in order to fulfil the following aims:

- Monitor the impact of construction emissions on local air quality;
- Validate the dispersion modelling;
- Use this information to action mitigation measures, if and where required; and
- Monitor the effectiveness of any mitigation measures implemented.

Monitoring has been undertaken around the HPC site for the following pollutants and measurement periods:

- Nitrogen dioxide by diffusion tube (NO_2) since 12 September 2019;
- Sulphur dioxide by diffusion tube (SO_2) since 12 September 2019; and
- Particulate matter automatic monitoring (TSP, PM_{10}, $PM_{2.5}$ and PM_1) since January 2016.

This report presents the monitoring methodology and results, which are then assessed against the relevant Air Quality Standards and Objectives. It then discusses the monitoring results relative to the pollutant concentrations predicted by the dispersion modelling exercise, with a view to validation of the dispersion model.

1.2 Background

During the construction phase at the HPC Site, there is potential for pollutants to be emitted from the construction plant operating at the Site, including diesel generators, powering construction plant, lighting towers and welfare units, and operation of Non-Road Mobile Machinery (NRMM). The emissions to air associated with operating this plant are the emissions from combustion, including (but not limited to), NO_x as NO_2, PM and SO_2. These pollutants also have stringent limits to assess against, hence why these pollutants have been monitored.

The monitoring locations have been distributed around the HPC Site to provide coverage relative to the site footprint – these are shown in Figure 1.1 and Figure 1.2.

Figure 1.1 – NO_2 and SO_2 Diffusion Tube Monitoring Locations around the HPC Site

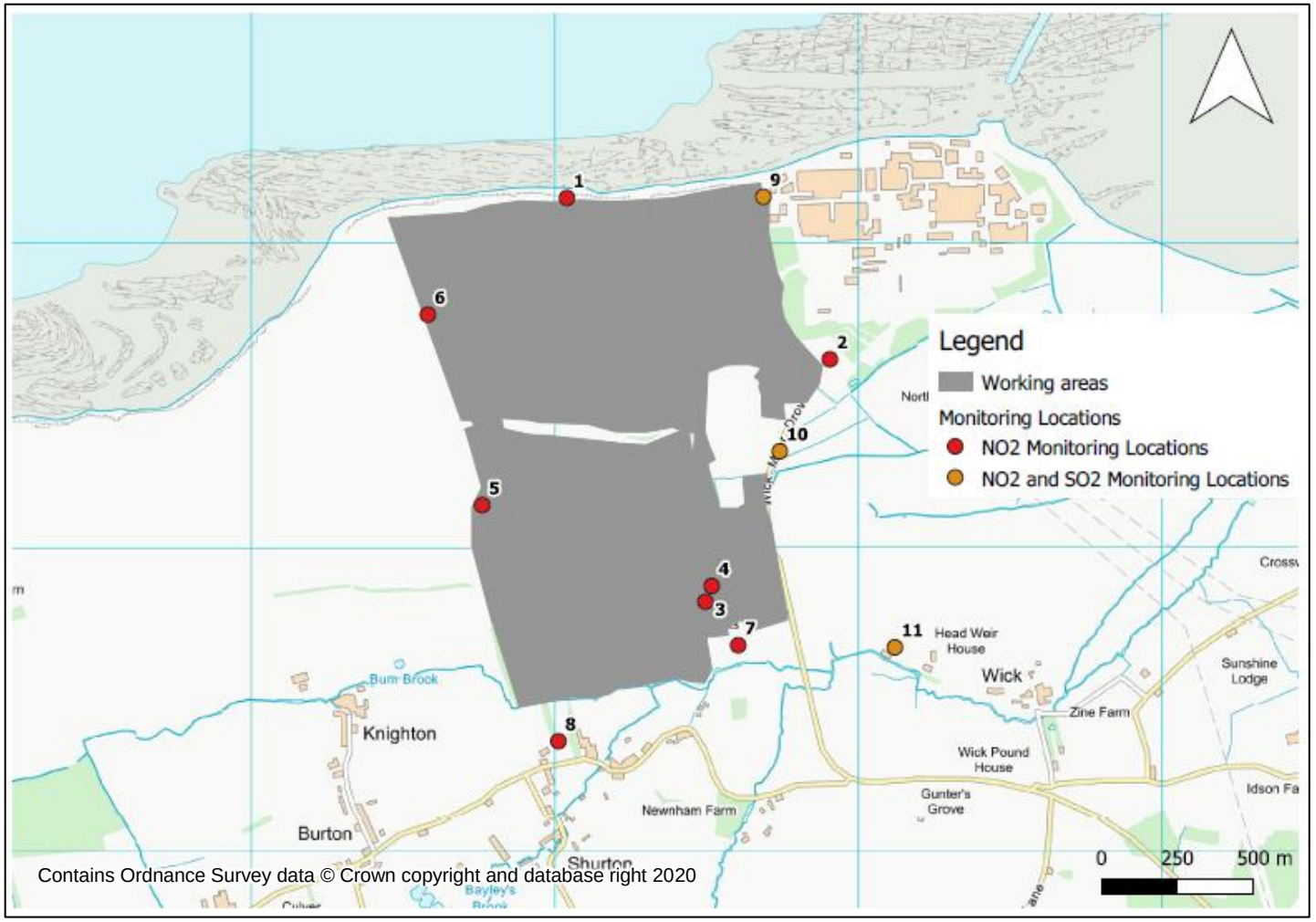


Figure 1.2 – Particulate Matter Monitoring Locations around the HPC Site

2 Criteria Appropriate to the Assessment

Monitoring has been undertaken for NO_x (as NO_2), PM and SO_2. The applicable limits values associated with each pollutant and their relevant averaging periods are provided in Table 2.1 below.

Table 2.1 – Applicable Air Quality Standards and Assessment Levels

Pollutant	AQS/EAL	Averaging Period	Value (µg m^{-3})
Human Receptors			
Nitrogen dioxide (NO_2)	AQS	Annual mean	40
	AQS	1-hour mean, not more than 18 exceedances a year (equivalent of 99.79 Percentile)	200
PM_{10}	AQS	Annual mean	40
	AQS	24-hour mean, not more than 35 exceedances per year (equivalent to 90.41 percentile)	50
$PM_{2.5}$	AQS	Annual mean	25
Sulphur dioxide (SO_2)	AQS	1-hour mean not to be exceeded more than 24 times a year (equivalent to 99.73 percentile)	350
	AQS	24-hour mean, not to be exceeded more than 3 times a year (equivalent to 99.18 percentile)	125
	AQS	15-min mean, not to be exceeded more than 35 times a year (equivalent to 99.9 percentile)	266
Ecological Receptors			
Oxides of Nitrogen (NO_x)	AQS	Annual Mean	30
	EAL	Daily Mean	75
Sulphur Dioxide (SO_2)	AQS	Annual Mean	20

3 Monitoring Methodology

3.1 NO_2 and SO_2

Palmes type diffusion tubes have been used around the HPC Site at 11 locations to monitor NO_2 concentrations and at 3 locations to monitor SO_2. The diffusion tubes are widely used throughout the UK as a simple method to monitor both long-term NO_2 and SO_2 concentrations, with exposure periods typically in the order of 4 or 5 weeks (i.e. for an annual mean monitoring survey, 12 x 4/5 week exposure periods are required). Each site used triplicate diffusion tubes.

The sampler is composed of an acrylic tube that is initially sealed at both ends. One end of the tube contains two stainless steel mesh discs coated with an absorbent material that reacts with the pollutant to produce a nitrate salt (for NO_2) and sulphate ions (for SO_2) which, after exposure, can be quantified. For NO_2, the total quantity of gas transferred along the tube is determined by chemical analysis, commonly using ultra-violet spectrometry, whilst ion chromatography is used to quantify the sulphate ions.

Gradko International, a UKAS accredited laboratory, were used to supply and analyse the diffusion tubes. Additional quality assurance is provided through Gradko's participation in the AIR-PT Scheme, which is designed to help laboratories meet the European Standard EN482[1]. For the latest round of results, AIR-PT Rounds 13 to 24[2], Gradko International scored 100% on all results. Further details on the QA/QC framework can be found through the Local Air Quality Management (LAQM) Helpdesk[3].

The diffusion tubes have been installed vertically, with the open end of the tube pointed downwards for the duration of the sampling period. They are installed on a bracket or plastic holder and mounted in a relevant location around the Site. Whilst tubes must be located in an area of free air circulation, equally it is important that they are not installed in areas of higher than usual air flow. The guiding principles contained within Defra's LAQM TG.16 guidance have been used where appropriate

The diffusion tube sampling periods are planned to align with the suggested UK National Diffusion Tube Calendar (Figure 3.1) in the interest of alignment with wider diffusion tube analysis across the UK.

[1] European Committee for Standardisation (CEN) Workplace Atmospheres, General requirements for the performance of procedures for the chemical measurement of chemical agents, EN482, Brussels, CEN 1994
[2] Summary of Laboratory Performance in AIR NO2 Proficiency Testing Scheme (April 2016 – February 2018), LAQM Helpdesk – March 2018
[3] https://laqm.defra.gov.uk/diffusion-tubes/qa-qc-framework.html

Figure 3.1 – Diffusion Tube Calendar 2019/2020

	Month	Start Date	Duration (weeks)
2018	*December*	*05 December*	*5*
2019	January	09 January	4
	February	06 February	4
	March	06 March	4
	April	03 April	4
	May	01 May	5
	June	05 June	4
	July	03 July	5
	August	07 August	4
	September	04 September	4
	October	02 October	5
	November	06 November	4
	December	04 December	5
2020	*January*	*08 January*	-

Month		Start Date	Duration (weeks)
2019	November	06-Nov	4
	December	04-Dec	5
2020	January	08-Jan	4
	February	05-Feb	4
	March	04-Mar	4
	April	01-Apr	4
	May	29-Apr	5
	June	03-Jun	4
	July	01-Jul	4
	August	29-Jul	5
	September	02-Sep	4
	October	30-Sep	5
	November	04-Nov	4
	December	02-Dec	5
2021	January	06-Jan	-

3.2 Particulate Matter

Continuous monitoring of particulate matter is currently undertaken at five locations, one location on the HPC Site itself (Balfour Beatty Monitor) and the remainder at off-site receptors.

The instruments are nephelometers, which are highly sensitive instruments for determining the light scattering properties of particulates. They measure Total Suspended Particulates (TSP), PM_{10}, $PM_{2.5}$ and PM_1 concentrations. They are relatively small units, contained within weatherproof housing and can be attached to a lamppost or any fixed hoarding.

The method employed by this kind of instrument, 'light scattering', uses a beam of light focused onto a measurement cell. Light striking a particle is scattered and reaches a photomultiplier tube, which produces an output proportional to the size of the particle. A pulse height analyser then counts the pulses and categorizes them into size ranges. Concentrations for a number of particle sizes are then reported with a concentration average calculated every 15 minutes. These data can then be averaged over 1-hour and 24-hour periods such that they can be compared against the appropriate assessment levels.

4 Monitoring Results

4.1 NO_2 (human receptors)

The monthly monitoring results for NO_2 are presented in Table 4.1. They represent the average results recorded by triplicate diffusion tubes at each site for each month. The results can also be visualised in Figure 4.1.

Table 4.1 – NO_2 Monthly Results

Monitoring Location	NO_2 Concentration (µg m^{-3})						Period Mean (µg m^{-3})	% Period Mean of AQS
	Sep 2019	Oct 2019	Nov 2019	Dec 2019	Jan 2020	Feb 2020		
1- Seawall West	33.2	33.5	39.2	26.8	32.7	-	33.1	83%
2 - Pixies Mound	15.6	14.6	17.9	15.2	19.8	-	16.6	42%
3 - Campus Fence	9.7	11.6	17.6	10.0	14.7	-	12.7	32%
4 - Campus Central	12.5	13.7	20.2	10.0	15.7	-	14.4	36%
5 - Coastal South	7.3	8.7	18.3	4.7	7.6	-	9.3	23%
6 - Coastal North	13.8	15.2	23.8	7.8	11.7	-	14.4	36%
7 - Doggets	5.0	8.2	13.7	6.7	10.6	-	8.8	22%
8 - Yellow Door	5.8	8.3	11.3	4.8	6.1	-	7.3	18%
9 - Seawall East	20.4	24.6	21.5	23.3	30.9	-	24.1	60%
10 - Wickmoor	11.7	13.7	18.1	11.0	20.3	-	15.0	37%
11 - Headweir	6.2	7.3	12.3	5.3	9.0	-	8.0	20%
AQS	**40**	**40**	**40**	**40**	**40**	**40**	**-**	**-**

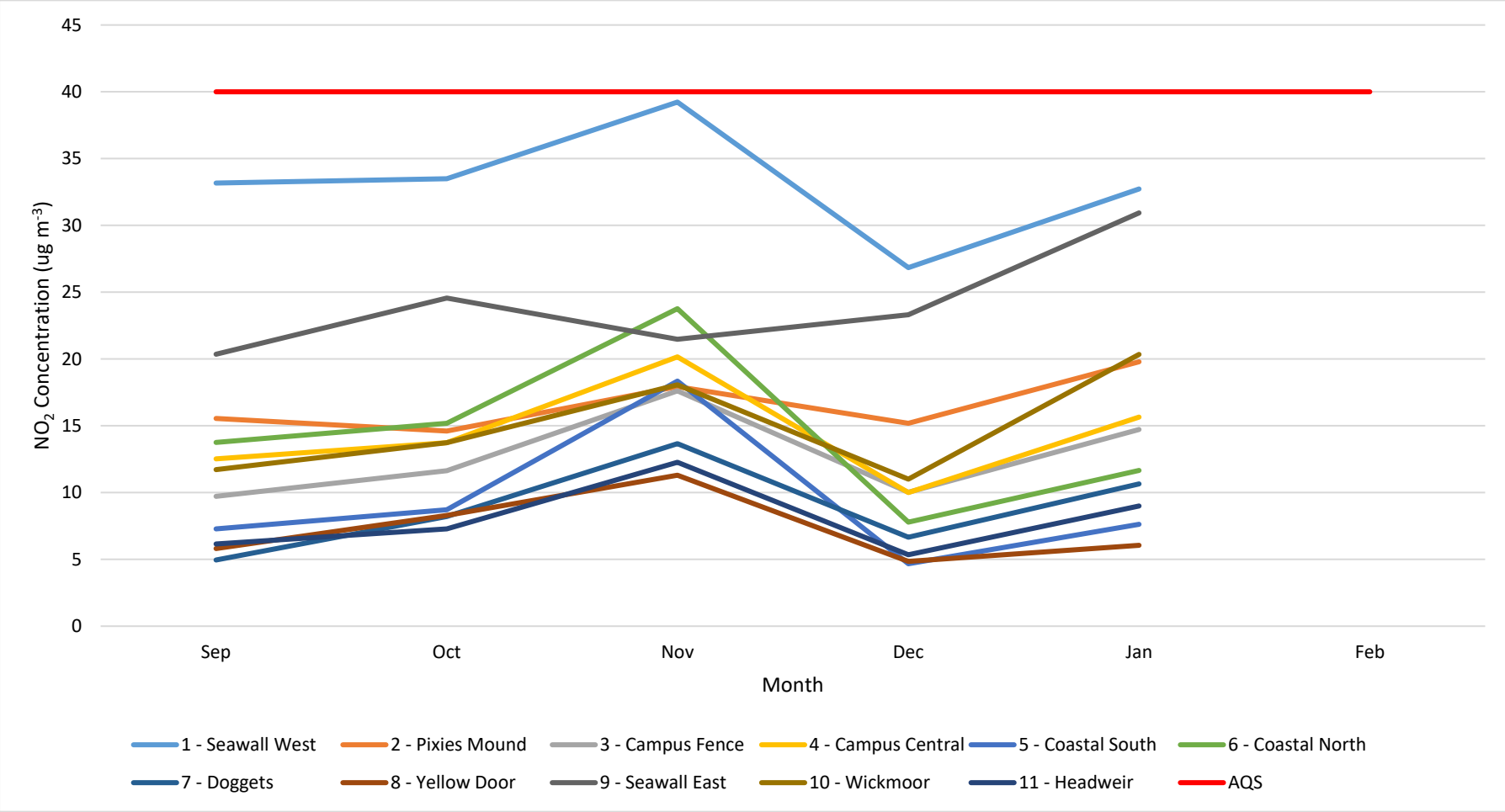
Note: there was missing data from sites 2, 4, 7 and 11 in September 2019 such that the averages for these sites for that month are based on an average of duplicate tubes.

The monitoring results collected around the HPC Site to-date indicate that concentrations of NO_2 are consistently below the annual mean AQS at all monitoring locations and there have been no exceedances.

There was a peak in concentration level at the majority of sites during November 2019, which can be seen in Figure 4.1. The Seawall West monitoring site, located to the north of the HPC Site and adjacent to the estuary, consistently records the highest concentrations of NO_2 at any of the monitoring sites, whilst concentrations recorded at Yellow Door, Headweir and Doggets are among the lowest.

It is understood that the monitoring will continue, such that compliance against the annual mean AQS can be confirmed once a full calendar year's-worth of data is collected.

Figure 4.1 – NO_2 Diffusion Tube Monitoring Results



4.2 SO_2

The average monthly monitoring results for SO_2 are presented in Table 4.2.

Table 4.2 – SO_2 Monthly Results

Monitoring Location	SO_2 Concentration (µg m^{-3})						Period Mean (µg m^{-3})	% Period Mean of AQS
	Sep	Oct	Nov	Dec	Jan	Feb		
9 – Seawall East	<1.5	<0.8	<0.9	0.4	<0.3	-	<0.8	<4%
10 – Wickmoor	<1.5	<0.8	<0.9	0.7	1.0	-	<1.0	<5%
11 – Headweir	<1.5	<0.8	<0.9	0.5	1.1	-	<1.0	<5%
AQS	**20**	**20**	**20**	**20**	**20**	**20**	**-**	**-**

Note: there was missing data from all sites in September 2019 such that the averages for sites 9 and 11 for that month are based on an average of duplicate tubes, whilst the average for site 10 is based on a single diffusion tube result for September.

The monitoring results collected around the HPC Site to-date indicate that concentrations of SO_2 are significantly below the annual mean AQS at all monitoring locations and there have been no exceedances. It should be noted that the annual mean AQS for SO_2 applies only at ecological receptors.

4.3 Particulate Matter

Particulate Matter is assessed against several metrics; the annual mean AQS and the 24-hour mean AQS for PM_{10} and the annual mean AQS for $PM_{2.5}$. The monitoring undertaken around the HPC Site comprises averaged 15-mintute monitoring, 1-hour monitoring and 24-hour monitoring. 15-minute and 1-hour averaged monitoring can be reviewed against annual mean metrics, whilst the 24-hour averaged data can be used to review against the 24-hour mean AQS. This technical note considers particulate matter data collected during 2019 only.

The monitoring data is shown in Table 4.3, Table 4.4 and Table 4.5.

Table 4.3 – 15-minute averaged PM_{10} and $PM_{2.5}$ Monitoring Results

Site	Average 15-min PM_{10} (µg m^{-3})	% Average 15-min PM_{10} of annual mean AQS	Average 15-min $PM_{2.5}$ (µg m^{-3})	% Average 15-min $PM_{2.5}$ of annual mean AQS	Data capture (%)
Balfour Beatty Monitor	41.6	103.9%	8.8	44.0%	99.9%

Table 4.4 – Hourly averaged PM_{10} and $PM_{2.5}$ Monitoring Results

Site	Average hourly PM_{10} (µg m^{-3})	% Average hourly PM_{10} of annual mean AQS	Average hourly $PM_{2.5}$ (µg m^{-3})	% Average hourly $PM_{2.5}$ of annual mean AQS	Data capture (%)
Headweir House	11.0	28%	6.6	26%	89%
Glebe House	6.7	17%	4.1	16%	87%
Yellowdoor	4.1	10%	3.8	15%	99%
New Doggets	6.8	17%	3.5	14%	68%

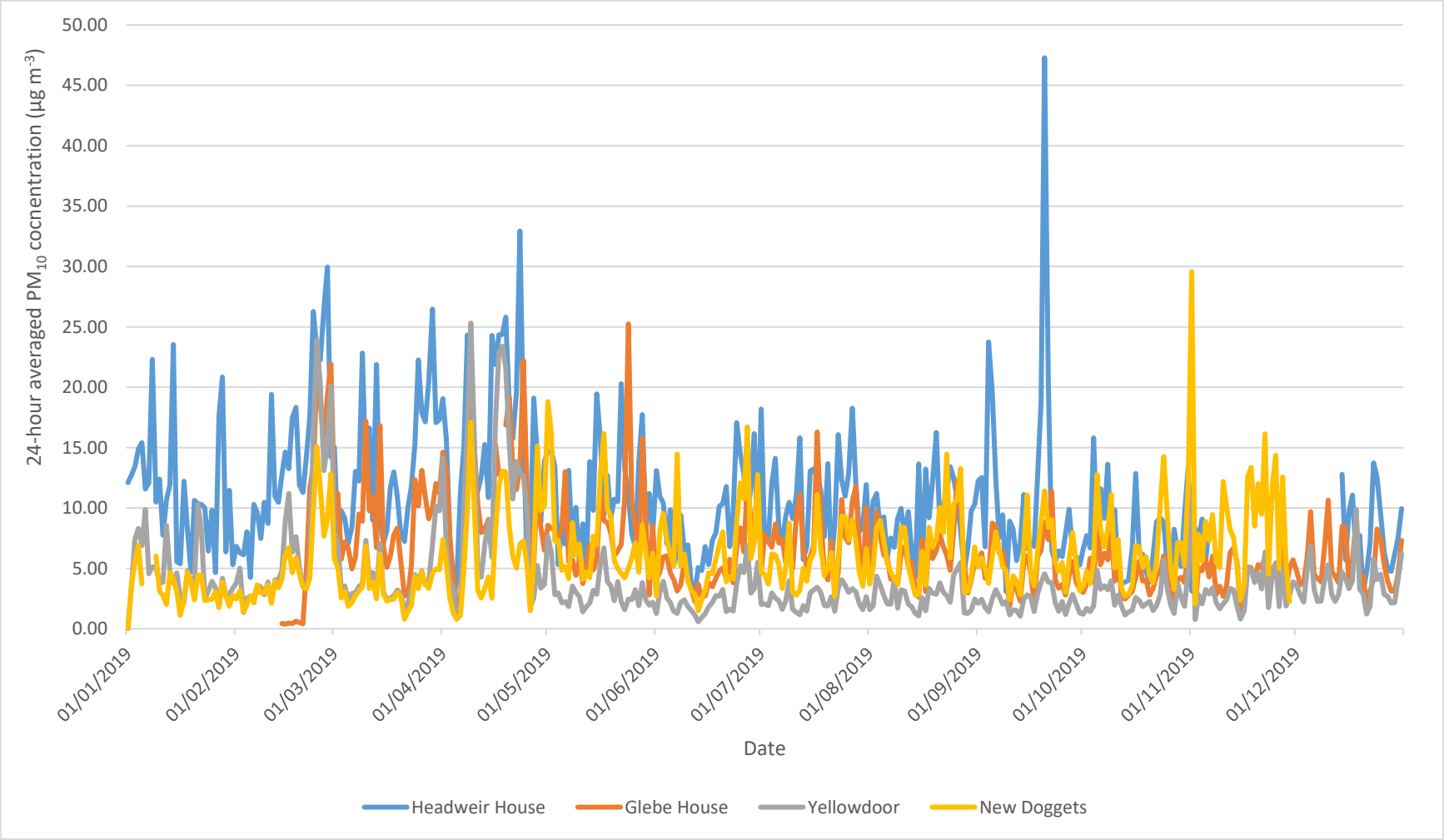
Table 4.5 – Daily averaged PM_{10} Monitoring Results

Site	Average 24-hourly PM_{10} (µg m^{-3})	% Average 24-hourly PM_{10} of AQS	Number of daily PM_{10} exceedances
Headweir House	11.0	22%	0
Glebe House	6.7	13%	0
Yellowdoor	4.1	8%	0
New Doggets	6.7	13%	0

For the majority of monitoring sites and averaging periods, the results are comfortably below the relevant AQS and have good data capture (>85%). The Balfour Beatty monitor, which records averaged 15-minute readings, indicates that there can be fluctuations in concentration of PM_{10} such that the annual mean AQS may be exceeded. However, this cannot be compared directly with the annual mean AQS and is an indicative measurement, since it is located within the HPC Site itself and not at a relevant receptor. There were no exceedances of the daily mean PM_{10} objective (24-hour periods with concentrations exceeding 50 µg m^{-3}).

A visualisation of the 24-hour averaged PM_{10} data through 2019, for the four off-site monitoring locations, is shown in Figure 4.2. The data at all monitoring sites shows similar peaks and troughs in the monitoring data over time, with larger fluctuations seen in the first half of 2019 relative to the second half of the year.

Figure 4.2 – 24-hour averaged PM_{10} monitoring data (2019)



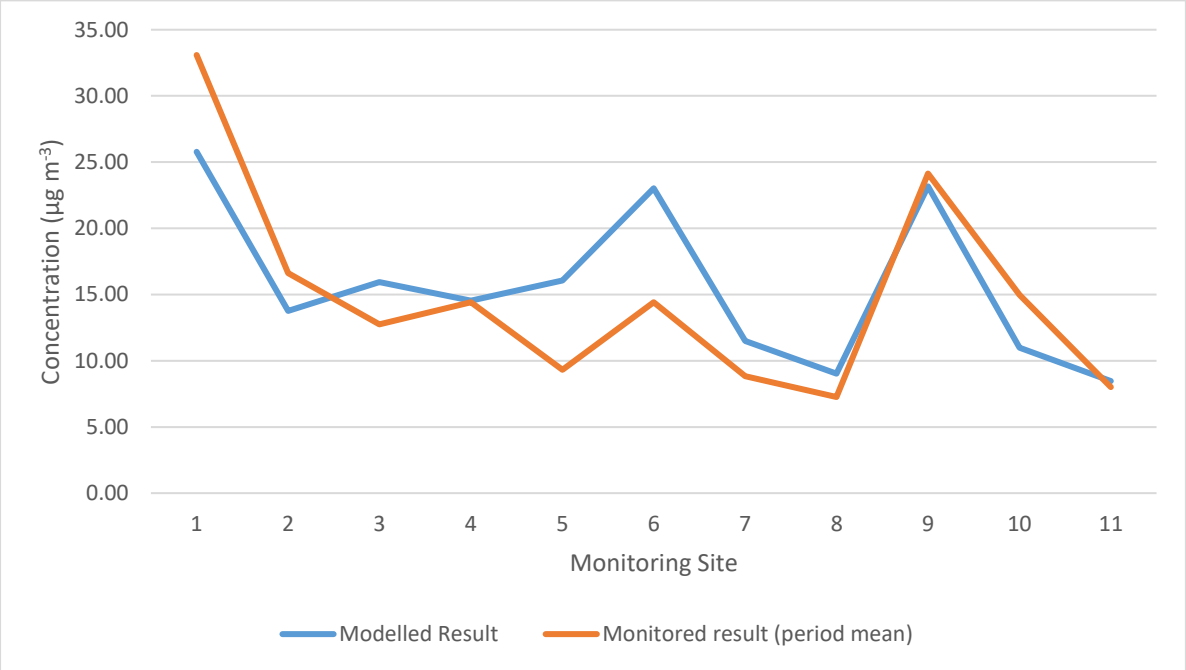
5 Model Validation

Model validation has been undertaken by comparing the model-predicted and monitored concentration results for NO_2. The model was run (as per the methodology set out in the main report) inclusive of the monitoring locations as receptor points. This allows for direct comparison of both datasets at specific locations, which is presented in Table 5.1. The highest result, when comparing the modelled and monitored results, is shaded green. The results can also be visualised in Figure 5.1.

Table 5.1 – Comparison of Modelled and Monitored Results

Receptor name/location	Modelled NO_2 PEC (µg m^{-3})	Period Mean Monitored Result (µg m^{-3})	% Difference (Modelled vs Monitored)
1- Seawall West	25.78	33.09	-28.4%
2 - Pixies Mound	13.76	16.61	-20.7%
3 - Campus Fence	15.94	12.74	20.0%
4 - Campus Central	14.53	14.41	0.8%
5 - Coastal South	16.06	9.33	41.9%
6 - Coastal North	23.03	14.43	37.4%
7 - Doggets	11.50	8.82	23.3%
8 - Yellow Door	9.03	7.26	19.6%
9 - Seawall East	23.17	24.13	-4.1%
10 - Wickmoor	10.98	14.97	-36.4%
11 - Headweir	8.47	8.01	5.4%

Figure 5.1 – Comparison of Modelled and Monitored Results



The results in Table 5.1 and Figure 5.1 demonstrate that the model performs well when compared with the monitoring results. At the majority of locations, the model over-predicts pollutant concentrations when compared with the monitored results; there are only four sites where the model is shown to be potentially under-predicting.

Looking at the percentage variation between the two datasets, the majority are within 25% of one other, which is particularly good when considering the extent of working assumptions that have been made in as part of the dispersion modelling exercise (see Appendix A of the main report).

Looking at Figure 5.1, it shows that the model is performing well with regard to the spatial distribution of high and low concentrations, with both the modelled and monitored data recording peak concentrations in the same locations. Overall, there is good correlation between the monitored and modelled data, such that it can be considered that the model performs well. This provides confidence that the expanded uncertainty associated with the model concentration predictions has been minimised.

Monitoring data will continue to be collected in order that a full 12-months' worth of data is collected, such that conclusions are made more robust.

6 Conclusions

Air Quality and Dust monitoring is undertaken at various locations around the HPC Site in order to, amongst other things, monitor the impact of construction emissions on local air quality and support model validation.

Monitoring has been undertaken around the HPC site for the following pollutants and measurement periods:

- Nitrogen dioxide by diffusion tube (NO_2) since 12 September 2019;
- Sulphur dioxide by diffusion tube (SO_2) since 12 September 2019; and
- Particulate matter automatic monitoring (TSP, PM_{10}, $PM_{2.5}$ and PM_1) since January 2016.

This report has presented the monitoring methodology and results of the monitoring campaign through 2019 - 2020.

Both NO_2 and SO_2 are monitored by diffusion tube at various locations around the site, whilst particulate matter is measured using automatic monitors.

All results for NO_2 to-date are below the annual mean AQS for NO_2, with the highest results being recorded at 1-Seawall West, and the corresponding period mean equating to 83% of the AQS. This monitoring location is situated adjacent to the north of the HPC Site and the Severn Estuary. This is not surprising given its close proximity to the construction activities on the HPC Site. The equivalent results for SO_2 are significantly below the annual mean AQS for SO_2, with results less than 5% of the AQS. Data capture has generally been good throughout the monitoring period so far.

For particulate matter, at the majority of monitoring sites and averaging periods, the results are comfortably below the relevant AQS and have good data capture (>85%). Additionally, there were no exceedances of the daily mean PM_{10} objective (24-hour periods with concentrations greater than 50 $\mu g\ m^{-3}$), except at the Balfour Beatty site, which, due to its location on the HPC Site, is not representative of nearby sensitive receptors.

With regard to model validation, a comparison was made against the period mean monitored NO_2 concentrations from the diffusion tubes, against the modelled data. The data show good correlation between the datasets, in that peak concentrations are found to occur at the same locations, and the majority of concentrations are within 25% of each other. This indicates that the model is performing well and that the assumptions made in the modelling are suitably representative of the actual emissions and dispersion associated with the HPC site.

It is understood that the monitoring will be continued at the HPC Site for the foreseeable future, such that compliance against the annual mean AQS can be confirmed once a full calendar year's-worth of data is collected.