Application to vary a bespoke installation environmental permit

Supporting Information

September 2023

RADNOR
It's in our nature

Issue Record

Client: Radnor Hills Mineral Water Company Ltd.

Project: Application to vary a bespoke installation permit - Supporting Documentation

Version: Issued

PREPARED BY

Dan Sandrof Consulting
Colburn,
Upton Bishop,
Herefordshire
HR9 7UE
Email d.sandrof@btinternet.com

Signature:

Name: Daniel Sandrof

Position: Environmental Consultant

Date: 20th September 2023

Contents

Appendices

Introduction

This document provides supporting information for an environmental permit application to vary a bespoke installation permit (ref. EPR/AB3697CN) operated by Radnor Hills Mineral Water Company Ltd. The purpose of the variation is to add a new stationary Medium Combustion Plant (MCP) as a Directly Associated Activity (DAA) and to amend Table S3.1 of the environmental permit.

Reason for the proposed changes

Radnor Hills Mineral Water Company Ltd. (Radnor Hills) intends to operate a new steam-raising boiler to replace three existing boilers. Upon commissioning of the new boiler, the three existing boilers shall become standby boilers and are expected to only operate under specific circumstances e.g. breakdown/servicing, and may be removed from site in due course.

The new boiler is high efficiency boiler. It will be installed with a 'Economiser' which is a type of flue gas heat exchanger to pre-heat the boiler feedwater as a fuel efficiency measure. The installation of the new boiler is part of Radnor Hills' infrastructure upgrade programme.

Table S3.1 of the existing Environmental Permit describes emission point A5 as an oil-fired boiler, which was the case when the Permit was originally granted. Since then, this boiler has been replaced with an LPG-fired boiler.

About the new MCP boiler

There are currently five boilers located at the installation, all of which are operated for the purposes of steam generation that is used in various activities within the production process.
The boilers are identified in the Permit as Directly Associated Activities and are identified in Table S3.1 in the Permit as point-sources of emission to air and are subject to emissions monitoring requirements accordingly.

The new boiler will be a stationary unit and has a rated net thermal input capacity of 4.11 MWth. It is classified as a Medium Combustion Plant (MCP) accordingly. As such, it is required to meet the requirements of the MCP Directive. The MCP is not a Part B activity as its capacity is below the threshold. The boiler will run on LPG and result is emissions to air.

The new MCP will meet the requirements of a standard facility in all respects other than the fact that the installation it serves is located within the distance threshold of two Sites of Special Scientific Interest (SSSI), which are the River Teme and Brampton Bryan Park. As such cannot be considered a standard facility.

As the boiler is a DAA serving a Environmental Permitting Regulations Schedule 1 activity, the operation of the boiler will be subject to Best Available Techniques (BAT). The BAT conclusions are those for the Food, Drink and Milk Industries, under Directive 2010/75/EU, which have been subject to assessment by Radnor Hills and NRW previously. The requirement to review and maintain the requirements of BAT is achieved by Radnor Hills through their EMS.

Location

The new MCP boiler will be installed at grid reference SO 334 272 as shown in Figure 3.2 of the Air Quality Assessment provided in Appendix A.

Environmental Management System

Radnor Hills operates an Environmental Management System (EMS). The system complies with ISO 14001:2015, and while it has not been certified by a UKAS-accredited auditing body it is subject to external audit routinely. The EMS provides the framework by which Radnor Hills manages the environmental impact of its site, operations and value chain where possible. It is an evolving system as aspects of site operations change.

The new boiler will form part of the existing management system. The new boiler is essentially a replacement unit and therefore does not represent a new risk that requires managing beyond what is already addressed in the EMS current. However, it has been necessary to consider the potential risks to air quality presented by the new boiler. This has been addressed in the Environmental Risk Assessment discussed below.

The boiler shall form part of the environmental management and monitoring programme applied at through Radnor Hills' EMS (EMS-007 Monitoring Emissions Procedure) and other than including an additional point-source emission to air monitoring point in the existing monitoring programme does not necessitate any other changes to the existing the management system.

Environmental Risk Assessment

The emissions to air that will be generated by the new MCP boiler has been assessed using the H1 screening methodology.

An H1 screening assessment was undertaken for Oxides of Nitrogen (NOx) emissions from the new boiler, using the H1 screening tool. The assessment determined that the impact on long-term concentrations could be screened out from requiring a detailed assessment. However, the short-term impacts for both human health and habitat sites indicated that a detailed assessment was required. Accordingly, a quantitative Air Quality Assessment (AQA) has been prepared by Gair Consulting Ltd. and is provided in Appendix A for reference.

The AQA finds that the impact of the new boiler emissions on human health and sensitive habitat sites would be not significant.

Environmental monitoring and emission measurement point

The new boiler has been assigned the emission point reference - A6. This emission point shall be monitored annually for Oxides of Nitrogen, and Sulphur Dioxide, should that be a requirement of the Permit, along with the monitoring requirements for the other boilers that shall remain operational. The measuring methodology and procedures that shall be applied by Radnor Hills are set out in EMS-007 (see Appendix B).

Sampling location

The new boiler has not yet been fully installed, but the regulatory requirements of the sampling location used to measure point source emissions to air as given in Technical Guidance Note M1 (Monitoring) has been considered and shall be applied in the construction of the emission ports in the emission stack as part of the boiler's installation and commissioning works.

Duty and standby boiler arrangements

As described above, when the new boiler becomes operational, three of the existing boilers shall become standby boilers. The new arrangement is summarised below.

Table 1. Summary of boiler arrangements

Environmental Permit monitoring point reference	Associated production process	Operational status
A1	RV3	Duty
A2	RV6	Standby
A3	Syrup Room	Standby
A4	Tetra Pac Room	Standby
A5	RV8	Duty
A6	RV5	Duty

Operating hours

Appendix 8 of application form C3 requires the applicant to confirm that the MCP will not operate for more than the number of hours specified in article 6(3) or article 6(8) of the MCPD. The new MCP boiler is expected to operate for more than 500 hours per annum, however its operation will negate the requirement for three of the existing boilers to operate above this number of hours.

Table 1. Summary of boiler operating hours

EP monitoring point reference	Associated production process/adjacent building	Expected to operate longer than 500 hours per annum
A1	RV3	Yes
A2	RV6	No
A3	Syrup Room	No
A4	Tetra Pak	No
A5	RV8	Yes
A6	RV5	Yes

Accordingly, the monitoring point references A2, A3 and A5 are confirmed as exempt under article 6(3) or article 6(8) of the MCPD.

OPRA

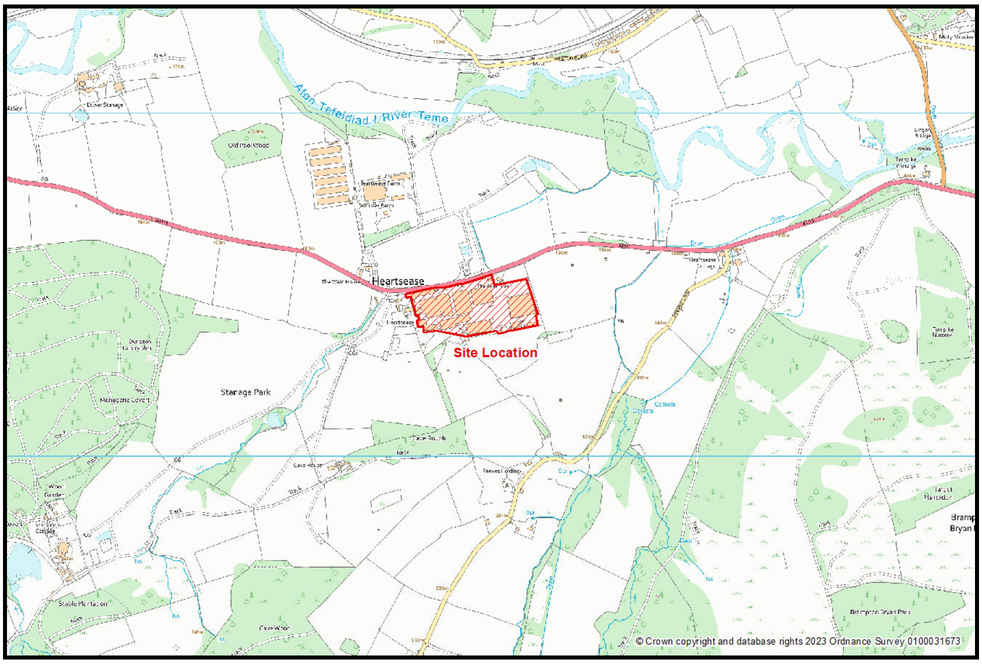
In accordance with Question 2 of Form F1, the most recent OPRA spreadsheet is provided as part of this application in electronic format.

Appendices

Appendix A – Air Quality Assessment

RADNOR HILLS:

AIR QUALITY ASSESSMENT – NEW BOILER EMISSIONS



September 2023

Report Reference: C74-P03-R02

Gair Consulting Ltd
Independent Air Quality & Odour Specialists

CONTENTS

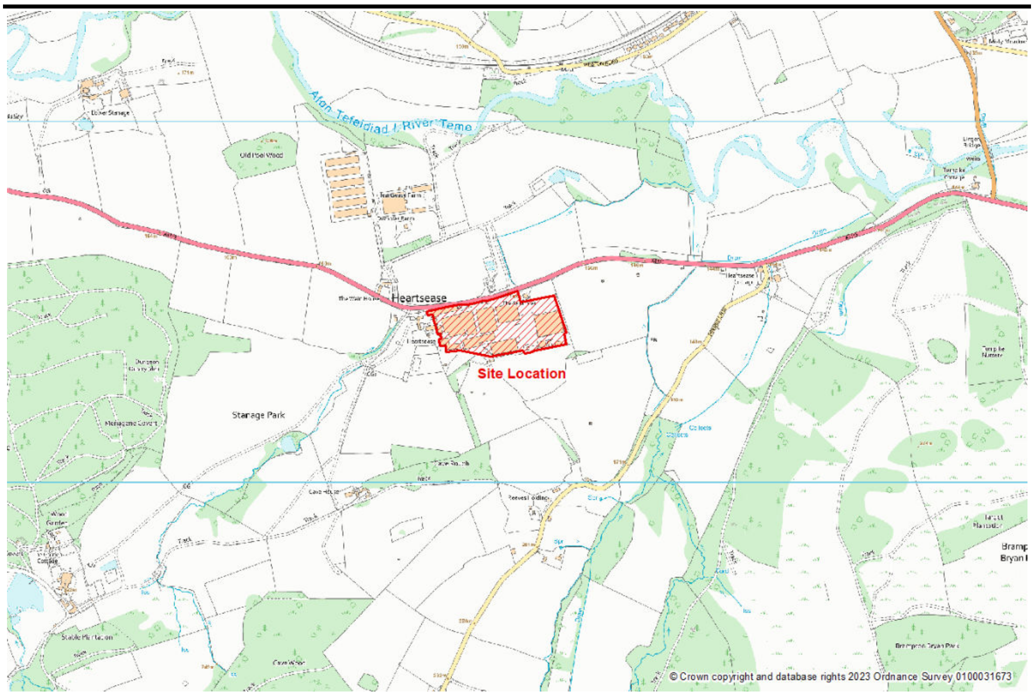
1 INTRODUCTION

1.1 PURPOSE OF THE ASSESSMENT

Gair Consulting Ltd has been commissioned by Radnor Hills Mineral Water Company Limited to undertake an assessment of potential local air quality impacts associated with the addition of a new boiler at Heartsease Farm, Knighton, Powys. The assessment supports an application to vary the permit for the installation.

The site is located adjacent to the A4113 to the west of Brampton Bryan (refer *Figure 1.1*). The site is located within the administrative area of Powys County Council but close to the border with Shropshire Council to the north and the County of Herefordshire to the east. The installation is regulated by Natural Resources Wales (NRW) under the Environmental Permitting (England & Wales) Regulations 2016.

FIGURE 1.1 SITE LOCATION



The installation is a soft drinks production facility and has been operational since 1996. There are a number of combustion plant that generate steam for the process and these are a directly associated activity. Currently, there are five boilers included within the permit (EPR/AB3697CN). The purpose of the assessment is to support the variation to the permit for the additional boiler.

The new boiler has a larger capacity (4.11 MW_{th}) than the currently permitted boilers. Therefore, some of the existing boilers will become standby boilers and will only operate when the new boiler or other duty boilers are under maintenance or repair. The assessment has considered the impact of the existing boilers, the new boiler alone and the proposed future operation of boilers at the installation.

The existing and new boilers would be fired on liquefied petroleum gas (LPG) which is assumed to be a 'gaseous fuel other than natural gas'. The principal emissions of concern from the boiler units would be the oxides of nitrogen (NO_x). In addition, an emission limit for sulphur dioxide (SO_2) is also specified in the regulations. Emissions of NO_x and SO_2 have the potential to affect human health and habitat sites from exposure to airborne NO_x and SO_2, nutrient nitrogen deposition of NO_x and acidification impacts from NO_x and SO_2.

As a worst-case, it is assumed that the boilers would operate continuously. Emissions data for the existing boilers has been obtained from monitoring data. Information on the new boiler is based on information provided by the manufacturer.

1.2 SCOPE OF THE ASSESSMENT

The emissions of NO_x and SO_2 from the boilers have the potential to affect human health. Therefore, these have been included in the air quality assessment. Emissions of NO_x and SO_2 also have the potential to affect habitats sites. There are two Sites of Special Scientific Interest (SSSI) within 2 km of the installation site. Therefore, the impact of emissions from the boiler units on sensitive habitats has also been considered.

1.3 STRUCTURE OF THE REPORT

The remainder of this report is presented as follows:

- *Section 2* presents an assessment of baseline conditions for the air quality assessment.
- *Section 3* provides a description of the assessment methodology for the air quality assessment.
- *Section 4* presents an assessment of the operational impact of emissions on human health and local air quality.
- *Section 5* presents an assessment of the operational impact of emissions on sensitive habitat sites.
- *Section 6* summarises and concludes the air quality assessment.

2 BASELINE CONDITIONS

2.1 INTRODUCTION

This section of the report defines the baseline environment for the assessment and provides the following:

- a discussion of appropriate ambient air quality assessment criteria;
- a review of background monitoring data for the local area;
- a description of local conditions that will affect the dispersion and dilution of emissions arising from the proposed development.

In relation to impacts on humans, the pollutants of interest emitted from the generating units are NO_x and SO_2.

2.2 ASSESSMENT CRITERIA

2.2.1 Oxides of Nitrogen

The oxides of nitrogen comprise principally of nitric oxide (NO) and nitrogen dioxide (NO_2). The oxides of nitrogen (NOx) in combustion processes may be formed from the oxidation of nitrogen in the fuel or from the reaction of nitrogen and oxygen at high temperatures. The majority of NOx is emitted from combustion processes as NO (typically over 90%), a relatively innocuous substance that rapidly oxidises to NO_2 in ambient air. Health based standards for NOx generally relate to NO_2.

Directive (2008/50/EC of the European Parliament and of the Council of 21st May 2008, on ambient air quality and cleaner air for Europe) was adopted in June 2008. The Directive streamlines the European Union's air quality legislation by replacing four of the five existing Air Quality Directives within a single, integrated instrument.

Directive 2008/50/EC retains the existing air quality standards for NO_2, but provides greater clarity on where to assess air quality, so that the focus is on areas of potential public exposure. The Directive has been transposed into the UK Air Quality Standards Regulations 2010, which came into force on the 11^{th} June 2010.

Air quality limits and objectives for the NO_2 in the UK are summarised in *Table* 2.1

TABLE 2.1 AIR QUALITY ASSESSMENT LEVELS

Pollutant	Averaging Period	AQAL ($\mu g\ m^{-3}$)	Comments
Nitrogen dioxide (NO_2)	Annual mean	40	UK AQO and EU limit value
	1-hour mean	200	UK AQO and EU limit value, not to be exceeded more than 18 times per annum, equivalent to the 99.8th percentile of 1-hour means

2.2.2 Sulphur Dioxide

Air quality limits and objectives for SO_2 in the UK are summarised in *Table 2.2*.

TABLE 2.2 AIR QUALITY OBJECTIVES AND LIMIT VALUES FOR SULPHUR DIOXIDE

Pollutant	Averaging Period	AQAL ($\mu g\ m^{-3}$)	Comments
Sulphur dioxide (SO_2)	15-minute mean	266	UK AQO, not to be exceeded more than 35 times a year (a)
	1-hour mean	350	UK AQO and EU limit value, not to be exceeded more than 24 times a year (b)
	24-hour mean	125	UK AQO and EU limit value, not to be exceeded more than 3 times a year (c)

(a) This corresponds to the 99.9th percentile of 15-minute means
(b) This corresponds to the 99.7th percentile of 1-hour means
(c) This corresponds to the 99.2nd percentile of 24-hour means

The 15-minute mean concentration is considered to be the most stringent. Furthermore, the 15-minute and 1-hour limit values are inconsistent, as a limit value for a shorter exposure period would normally be a higher concentration compared to a longer exposure time period. The 15 minute concentration is lower than the 1 hour concentration such that the 15 minute concentration is much more likely to exceed the AQO compared to the longer averaging periods.

2.2.3 Critical Levels for the Oxides of Nitrogen and Sulphur Dioxide

Critical levels are thresholds of airborne pollutant concentrations above which damage may be sustained to sensitive plants and animals. High concentrations of pollutants in ambient air directly cause harm to leaves and needles of forests and other plant communities.

The 2008 Air Quality Directive set limit values for the protection of vegetation and ecosystems and these have been adopted by the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (July 2007), but are not currently set in Regulations. The current critical levels, limit values and objectives for NO_x and SO_2 are summarised in *Table 2.3*.

TABLE 2.3 CRITICAL LEVELS, LIMIT VALUES AND OBJECTIVES FOR THE PROTECTION OF VEGETATION AND ECOSYSTEMS

Pollutant	Description	Averaging Period	Concentration ($\mu g\ m^{3}$)
Nitrogen Oxides			
EU Directive on Ambient Air Quality / 2010 Air Quality Standards Regulations	Critical Level / Limit Value	Annual mean	30
Environment Agency Risk Assessment Guidance	Critical Level	Daily mean	75
Sulphur Dioxide			
Environment Agency risk assessment guidance	Critical Level for ecosystems dominated by lichens and bryophytes	Annual mean	10
	Critical Level for all other ecosystems	Annual mean	20

The deposition of pollutants to soils and plant surfaces can also adversely affect habitat sites and critical loads are provided for assessing the impact of nitrogen deposition and acidification. These are site and habitat specific and are discussed in more detail in *Section 5.1.3*.

2.3 LOCAL CONDITIONS

2.3.1 The Dispersion and Dilution of Emissions

For meteorological data to be suitable for dispersion modelling purposes a number of meteorological parameters need to be measured, on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature. There are only a limited number of sites where the required meteorological measurements are made. In the UK, all of these sites are quality controlled by the Met Office.

The most important climatological parameters governing the atmospheric dispersion of pollutants are as follows:

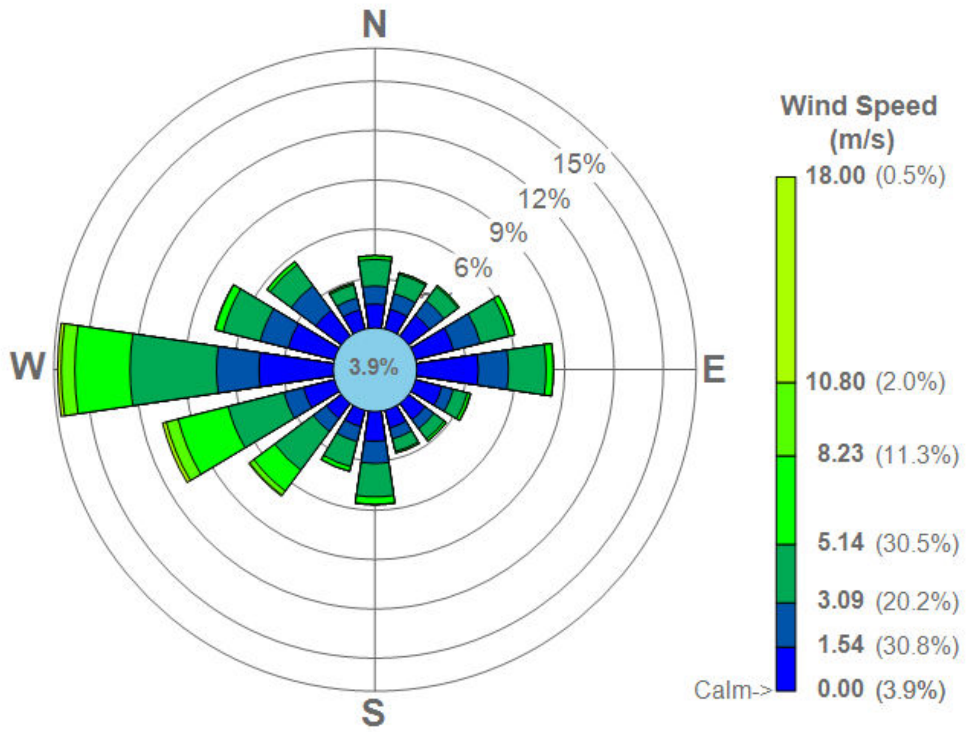
- **Wind direction** determines the broad transport of the emission and the sector of the compass into which the emission is dispersed.
- **Wind speed** will affect low-level emissions by increasing the initial dilution of pollutants in the emission.
- **Atmospheric stability** is a measure of the turbulence, particularly of the vertical motions present.

2.3.2 Local Wind Climate

Met Office observing stations are limited and the nearest station to the site with full data suitable for dispersion modelling is located at Shobdon Airfield, approximately 12 km to the south-southeast the site. Five years of meteorological data for this observing station have been obtained (2016 to 2020) and a wind rose for the five years is presented in *Figure 2.1*.

The predominant wind direction is from the west (16.8%) and calm winds occur for 3.9% of the time.

FIGURE 2.1 WIND ROSE FOR SHOBDON AIRFIELD FOR 2016 TO 2020



2.4 BACKGROUND AIR QUALITY

2.4.1 Local Authority Review and Assessment

Local authorities are required to periodically review and assess the current and future quality of air in their areas. Where it is determined that an air quality objective is not likely to be met within the relevant time period, the authority must designate an Air Quality Management Area (AQMA) and produce a local action plan. Powys County Council does not currently have any AQMA. The nearest AQMA to the installation site is located in Leominster and is 20 km to the southeast of the site. Therefore, emissions from the installation will not have an impact on any nearby AQMA.

The installation site is located within the Powys County Council (PCC) administrative area. The most recent air quality management and review report available from PCC is the 2022 Air Quality Progress Report [1]. PCC do not undertake continuous monitoring and in 2021 only had two diffusion tube monitoring sites. These are both located in Brecon and would not be characteristic of air quality at the installation site.

2.4.2 Background Pollutant Concentrations

Nitrogen Dioxide

Annual mean NO_2 background concentrations for 2023 have been obtained from the Defra UK Background Air Pollution Maps. The latest background maps were issued in August 2020 and are based on 2018 monitoring data. The 2023 mapped annual mean NO_2 background concentration for the installation site and surrounding area is 3.5 $\mu g\ m^{-3}$, 9% of the air quality objective. This is the maximum for the nine 1 km^2 grid squares surrounding the site. The maximum concentration is used to avoid underestimating the contribution from other local sources. Therefore, this concentration is considered a reasonable baseline NO_2 concentration for the assessment.

Sulphur Dioxide

The Defra mapped background SO_2 concentrations for the area have been obtained for 2001 and the maximum for the nine 1 km^2 grids surrounding the site is 1.4 $\mu g\ m^{-3}$. Concentrations of SO_2 are presented for 2001, which is the most recent mapped data available and represents a worst-case for the area. Therefore, for the purposes of the assessment an annual mean SO_2 concentration of 1.4 $\mu g\ m^{-3}$ has been assumed.

1 2022 Air Quality Progress for Powys County Council (November 2022)

3 ASSESSMENT METHODOLOGY

3.1 INTRODUCTION

Emissions to air from the boilers have been modelled using the UK Atmospheric Dispersion Modelling System (ADMS Version 6.0) and a five year meteorological data set from Shobdon Airfield (2016 to 2020). Predicted concentrations are compared with air quality standards and objectives set for the protection of human health and critical levels/loads for the protection of habitat sites.

3.2 SENSITIVE RECEPTORS

The air quality assessment has considered the impact of emissions from the boilers at a number of discrete receptors. The locations of these receptors are provided in *Figure 3.1* and described in *Table 3.1*. The nearest receptors surrounding the installation in all directions have been selected for the assessment.

FIGURE 3.1 LOCATIONS OF POTENTIALLY SENSITIVE RECEPTORS CONSIDERED FOR THE AIR QUALITY ASSESSMENT

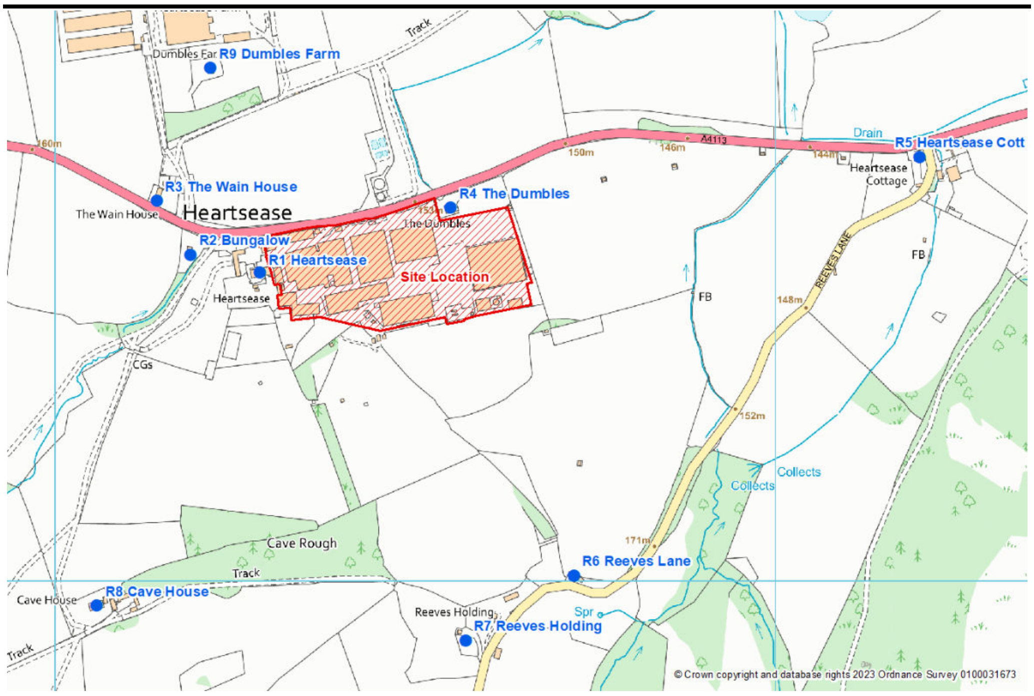


TABLE 3.1 DESCRIPTION OF SENSITIVE RECEPTORS FOR THE AIR QUALITY ASSESSMENT

Ref.	Name (a)	Type	Grid Reference	
			Easting	Northing
R1	Heartsease	Residential	334285	272427
R2	Bungalow	Residential	334189	272452
R3	The Wain House	Residential	334142	272526
R4	The Dumbles	Residential	334550	272517
R5	Heartsease Cott	Residential	335201	272587
R6	Reeves Lane	Residential	334721	272007
R7	Reeves Holding	Residential	334571	271917
R8	Cave House	Residential	334059	271966
R9	Dumbles Farm	Residential	334216	272710

3.3 SENSITIVE HABITAT SITES

The Environment Agency's Risk Assessment guidance [2], as adopted by NRW, states that the impact of emissions to air on vegetation and ecosystems should be assessed for the following habitat sites within 10 km of the source:

- Special Areas of Conservation (SACs) and candidate SACs (cSACs) designated under the EC Habitats Directive;
- Special Protection Areas (SPAs) and potential SPAs designated under the EC Birds Directive; and
- Ramsar Sites designated under the Convention on Wetlands of International Importance.

Within 2 km of the source:

- Sites of Special Scientific Interest (SSSI) established by the 1981 Wildlife and Countryside Act;
- National Nature Reserves (NNR);
- Local Nature Reserves (LNR);
- local wildlife sites (LWS); and
- ancient woodland.

However, for medium combustion plant (MCP), separate guidance is provided by NRW. For a rated thermal input of 2 to 5 MW_{th} (gas other than natural gas)

2 https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit

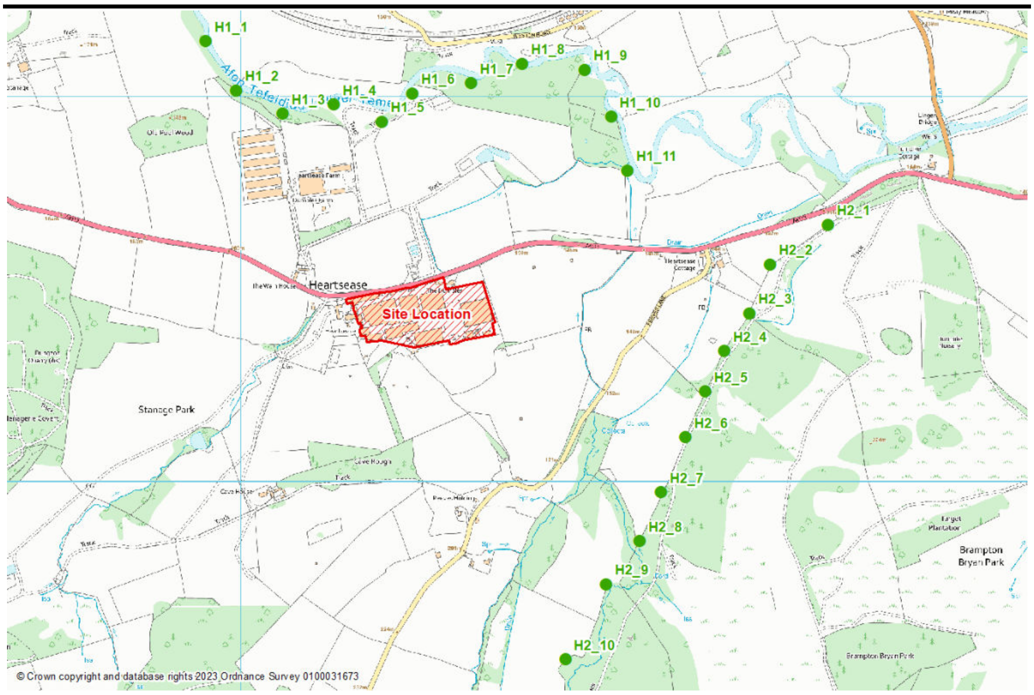
this is 1.5 km from the site for SSSI and 1.5 km for European habitat sites (SACs, SPAs and Ramsar sites). There are two SSSIs within 1.5 km of the installation.

For all habitat sites, the assessment has considered airborne concentrations, nutrient nitrogen deposition and acidification impacts. Details and the locations of the sites are provided in *Table 3.2* and *Figure 3.2*.

TABLE 3.2 DESCRIPTION OF HABITATS CONSIDERED FOR THE AIR QUALITY ASSESSMENT

Ref.	Name	Sensitive Habitat
H1	River Teme SSSI	Various habitats, fish, crustacean, invertebrate, mammals (otter) and molluscs
H2	Brampton Bryan Park SSSI	Dwarf shrub heath and dry heaths

FIGURE 3.2 LOCATION OF HABITAT RECEPTORS CONSIDERED FOR THE AIR QUALITY ASSESSMENT



Due to the extent of the two habitats, these have been represented in the model by a number of receptor locations to enable the maximum impact to be predicted. Results are presented for the highest predicted impact and are representative of the worst-case.

3.4 DISPERSION MODELLING OF EMISSIONS

3.4.1 The Dispersion Model

The potential impact of emissions from the boilers has been assessed using a dispersion model to predict airborne ground level concentrations of pollutants emitted from the generating unit stacks.

The operational impact of the installation emissions has been assessed using the ADMS dispersion model. ADMS allows for the modelling of dispersion under convective meteorological conditions using a skewed Gaussian concentration distribution. It is able to simulate the effects of terrain and building downwash simultaneously. It can also calculate concentrations for direct comparison with air quality standards or guidelines. It is used extensively in the UK for assessing the air quality impacts of industrial and other polluting processes.

3.4.2 Building Downwash

Structures associated with the operation of the installation may affect the dispersion of emissions from the boiler stacks. Building downwash affects occur where buildings are greater than one third of the stack height. Details of building structures that have been included in the dispersion model to allow for building downwash affects are presented in *Table 3.3*.

TABLE 3.3 BUILDINGS INCLUDED IN THE DISPERSION MODEL

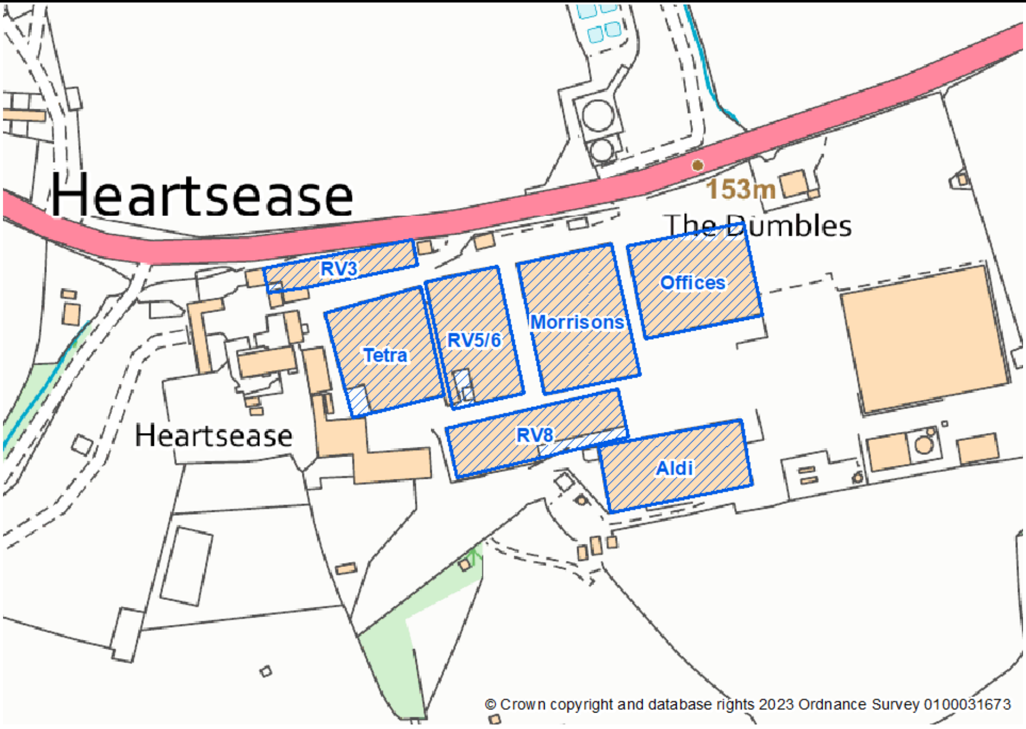
Building	Assumed Height (m)	Assumed X Length (m)	Assumed Y Width (m)	Assumed Angle (°)
Building RV5/6	7.5	65	37	166
Morrisons	8.0	66	48	166
Building RV8	8.0	25	87	166
Aldi	9.5	33	72	166
Tetra	5.5	56	50	166
Building RV3	4.0	16	75	166
Offices	7.0	47	60	166

Buildings within the model can only described as square, rectangular or circular. Therefore, the dimensions provided are representative of the main building structure given these limitations. The assumed footprint of each building is provided in *Figure 3.3*.

3.4.3 Grid Size

In addition to assessing the impact of emissions on the discrete receptors identified in *Section 3.2*, the maximum predicted off-site concentration is also determined. Predicted concentrations are calculated across a 2 km by 2 km grid with a 10 m grid resolution.

FIGURE 3.3 BUILDING FOOTPRINTS ASSUMED FOR THE DISPERSION MODELLING



3.4.4 Significance Criteria

Human Health

The Environment Agency's risk assessment guidance, as adopted by NRW, specifies criteria to enable the potential significance of an impact to be determined[3]. For the process contribution (PC), the impact is deemed not significant if the annual mean PC is less than 1% of the environmental assessment level (EAL) and the short term PC is less than 10% of the EAL. If either of these criteria is exceeded, they are potentially significant and it is then necessary to consider the total predicted environmental concentration (PEC, which is the PC plus the ambient background concentration).

For the annual mean, if the PEC is below 70% of the assessment criterion then it is considered unlikely that an exceedance of the limit will occur and there should be no adverse impact. For short term concentrations, more detailed assessments are required where the short term PC is greater than 20% of the short term standard minus twice the long term background concentration.

Habitat Sites - SSSI

The Environment Agency's risk assessment guidance[3] specifies criteria to enable the potential significance of an impact to be determined. For the process contribution (PC), the impact is deemed not significant if the annual mean PC

3 https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit

is less than 1% of the critical level (or air quality objective) and the short term PC is less than 10% of the critical level (or air quality objective). If either of these criteria is exceeded, they are not necessarily significant however, it is then necessary to consider the total predicted environmental concentration or deposition (PC plus the background contribution) as discussed above.

3.4.5 Emission Parameters

Details of the emission parameters for the six boiler units are provided in *Table 3.4* and *Table 3.5* and the location of the stacks for each is provided in *Figure 3.4*.

TABLE 3.4 SUMMARY OF THE STACK EMISSIONS DATA FOR DISPERSION MODELLING (EMISSIONS A2, A3 AND A4)

Parameter	A2 RV6 (b)	A3 Syrup (b)	A4 Tetra (b)
Capacity (kW)	2300	570	1254
Stack height (m)	3	5	4
Stack diameter (m)	0.38	0.25	0.38
Temperature of emission (^oC)	177	145	205
Actual flow rate ($m^3\ s^{-1}$)	0.71	0.65	0.98
Emission velocity at stack exit ($m\ s^{-1}$)	6.3	13.2	8.6
Moisture content (%v/v)	9.1	4.0	3.4
Oxygen content (%v/v dry)	10.3	17.6	17.4
Normalised flow rate ($Nm^3\ s^{-1}$) (a)	0.24	0.079	0.11
NO_x ($mg\ Nm^{-3}$)	260	180	232
NO_x ($g\ s^{-1}$)	0.062	0.014	0.026
SO_2 ($mg\ Nm^{-3}$)	35	35	35
SO_2 ($g\ s^{-1}$)	0.0083	0.0028	0.0039

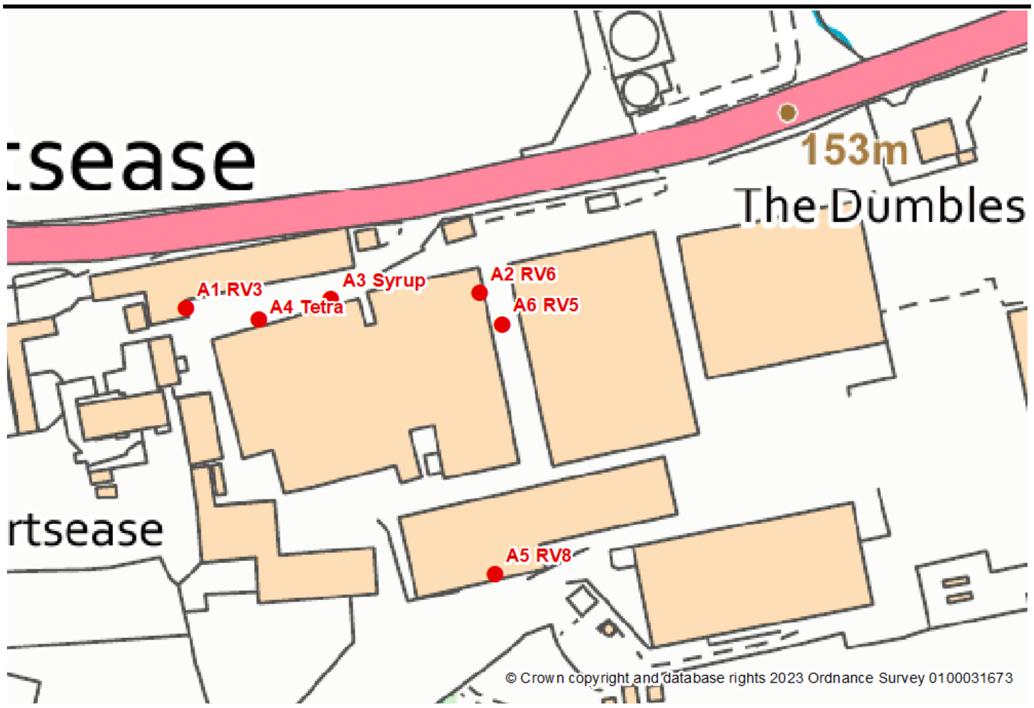
(a) Reference conditions of 273K, 1 atmosphere, dry and 3% oxygen
(b) Emissions data based on monitoring carried out by ESG in January 2017

TABLE 3.5 SUMMARY OF THE STACK EMISSIONS DATA FOR DISPERSION MODELLING (EMISSIONS A1, A5 AND A6)

Parameter	A1 RV3 (b)	A5 RV8 (b)	A6 RV5 (d)
Capacity (kW)	1252	1200	4110
Stack height (m)	4	7.5	9.5
Stack diameter (m)	0.36	0.38	0.61
Temperature of emission (°C)	177 (c)	177 (c)	130
Actual flow rate ($m^3 s^{-1}$)	0.92	0.92	1.94
Emission velocity at stack exit ($m s^{-1}$)	9.1	8.1	6.6
Moisture content (%v/v)	-	-	- (e)
Oxygen content (%v/v dry)	-	-	4
Normalised flow rate ($Nm^3 s^{-1}$) (a)	0.11	0.11	1.24
NO_x ($mg Nm^{-3}$)	232	232	200
NO_x ($g s^{-1}$)	0.026	0.026	0.248
SO_2 ($mg Nm^{-3}$)	35	35	35
SO_2 ($g s^{-1}$)	0.0039	0.0039	0.0434

(a) Reference conditions of 273K, 1 atmosphere, dry and 3% oxygen
(b) No emissions monitoring data available, assumed to be the same as for A4 as capacities are similar
(c) Temperature assumed to be the average of A2 to A4
(d) Obtained from boiler manufacturer
(e) Not corrected for moisture

FIGURE 3.4 LOCATION OF EMISSION SOURCES



3.4.6 Meteorological Data

Dispersion modelling has been carried out for five years of hourly sequential data from the Shobdon Airfield meteorological station (2016 to 2020). The model utilises hourly meteorological data to define conditions for the dispersion of emissions, transport and diffusion. Predicted concentrations are estimated for each year and the maximum concentration at each receptor is provided. Therefore, predicted concentrations represent the worst-case for the five-year period.

3.4.7 Topography

The presence of elevated terrain can significantly affect the dispersion of pollutants in a number of ways. For stack emissions, the presence of elevated terrain reduces the distance between the plume centre line and the ground level, thereby increasing ground level concentrations. Elevated terrain can also increase turbulence and, hence, plume mixing with the effect of increasing concentrations near to an elevated source and reducing concentrations further away.

The area surrounding the facility is hilly with the installation site located within a valley. Therefore, topographical data has been included within the model.

4 PREDICTED OPERATIONAL IMPACT ON HUMAN HEALTH

4.1 INTRODUCTION

The predicted impact of emissions to air from the various emission sources at the installation site is presented. Results are presented as the maximum predicted across the dispersion modelling domain. In addition, predicted concentrations for the discrete receptors are provided.

For each averaging period (e.g. annual mean, maximum hourly mean etc.), the result presented is the maximum for the five years of meteorological data used for dispersion modelling purposes.

A number of assumptions have been made to characterise the various emission sources and the surrounding environment into which these emissions are emitted. Worst-case assumptions have been adopted to avoid underestimating the predicted impact of emissions on air quality. In particular, it is assumed that the facility operates continuously, and results are presented for the worst-case meteorological year.

Predicted concentrations are provided for the following operational scenarios:

- existing boilers (A1 to A5);
- new boiler (A6); and
- future operational scenario (A1, A5 and A6) with the remaining boilers on standby (A2, A3 and A4) and assumed not to be operating.

4.2 PREDICTED IMPACT ON HUMAN HEALTH

4.2.1 Existing Permitted Emissions

Nitrogen Dioxide

Predicted annual and hourly mean ground level concentrations of NO_2 arising as a result of emissions from the existing permitted boilers (A1 to A5) are presented in *Table 4.1* and *Table 4.2*, respectively. Maximum predicted concentrations are provided along with predicted concentrations for the identified receptor locations. The significance of the impacts is assessed with regard to the significance criteria for environmental permitting as provided by the Environment Agency in their risk assessment guidance. The results are presented for the process contribution (PC) and the predicted environmental concentration (PEC) which is the PC plus the background concentration.

Guidance issued by the Environment Agency's Air Quality Assessment and Modelling Unit (AQMAU) [4] indicates that an initial screening approach would be to assume that 100% of annual average and 50% of peak hourly average concentrations of NO_x are in the form of NO_2. For a more detailed worst-case assessment such as this, the guidance recommends a conversion rate of 70% and 35% for annual and hourly concentrations respectively.

TABLE 4.1 PREDICTED ANNUAL MEAN GROUND LEVEL CONCENTRATIONS OF NO_2 AT SENSITIVE RECEPTORS – EXISTING PERMITTED SOURCES

Ref	Receptor	Annual Mean PC ($\mu g\ m^{-3}$) (a)	Annual Mean PC as %age of AQS	Annual Mean PEC as %age of AQS (b)	Impact Descriptor
Max	Maximum predicted	59.7	149%	158%	AQO doesn't apply
R1	Heartsease	3.8	9.4%	18.1%	AQO met
R2	Bungalow	1.4	3.4%	12.1%	AQO met
R3	The Wain House	0.71	1.8%	10.5%	AQO met
R4	The Dumbles	4.0	10.0%	18.7%	AQO met
R5	Heartsease Cott	0.37	0.9%	9.7%	Not significant
R6	Reeves Lane	0.30	0.8%	9.5%	Not significant
R7	Reeves Holding	0.19	0.5%	9.2%	Not significant
R8	Cave House	0.18	0.5%	9.2%	Not significant
R9	Dumbles Farm	0.19	0.5%	9.2%	Not significant
(a) As a worst-case, assumes 70% conversion of NO to NO_2					

As a maximum at any location, the contribution of the facility to annual mean concentrations is 59.7 $\mu g\ m^{-3}$ and is 149% of the air quality objective (AQO) of 40 $\mu g\ m^{-3}$. This represents worst-case conditions as discussed in *Section 4.1*. The location of the maximum predicted concentration occurs within the installation site (refer *Figure 4.1*) where the AQO would not apply. The highest predicted concentration at sensitive receptors is 4.0 $\mu g\ m^{-3}$ and is 10% of the AQO. However, combined with the background concentration of 3.5 $\mu g\ m^{-3}$ the PEC would be well below 70% of the AQO. Therefore, it is unlikely that the AQO would be exceeded.

For the short-term objective (99.8th percentile of hourly means), the maximum predicted impact of the facility is 90.8% of the AQO but as the maximum occurs within the site (refer *Figure 4.2*) the AQO would not apply. For the majority of sensitive receptors, the predicted impact is less than 10% of the AQO and would be assessed as not significant. At receptors R1 and R4, the predicted concentration exceeds 10% of the AQO and are also greater than 20% of the difference between the AQO and the background (38.6 $\mu g\ m^{-3}$). Therefore, the impact at these two receptors is potentially significant.

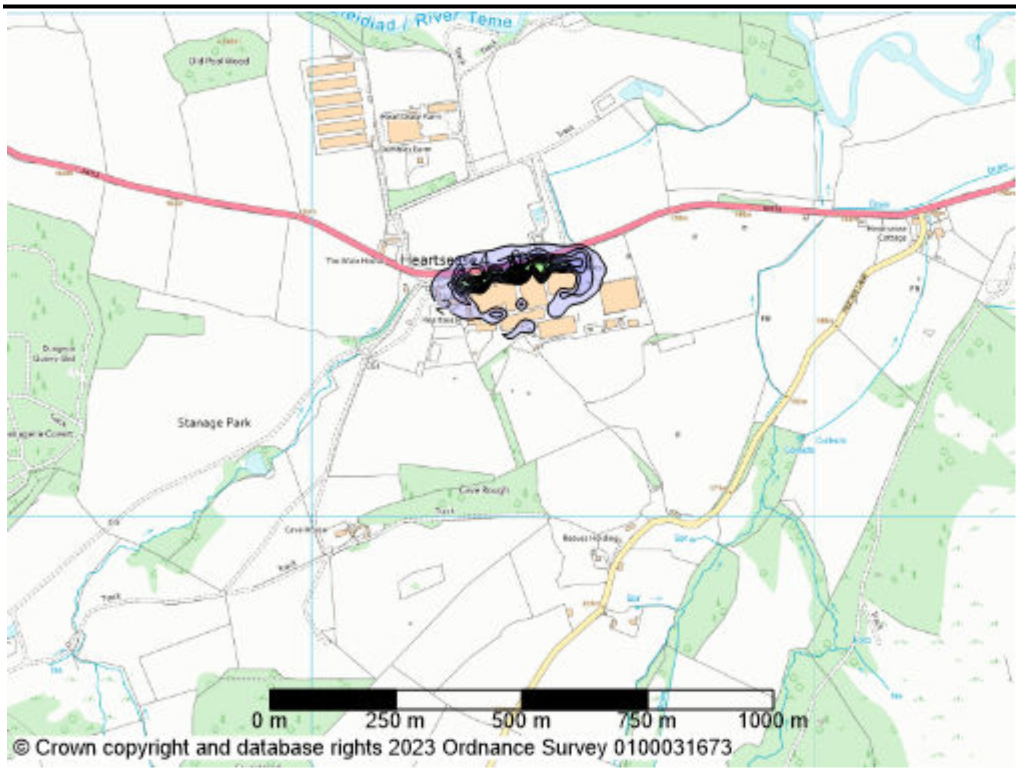
4 Conversion Ratios for NO_x and NO_2, Air Quality Modelling and Assessment Unit, Environment Agency

Predicted annual mean and predicted hourly mean (as the 99.8th percentile) ground level concentrations are also presented as contour plots in *Figure 4.1* and *Figure 4.2*, respectively. These are presented for the 2020 meteorological data which gives rise to the highest predicted concentrations.

TABLE 4.2 PREDICTED 99.8TH PERCENTILE OF HOURLY MEAN CONCENTRATIONS OF NO_2 AT SENSITIVE RECEPTORS - EXISTING PERMITTED SOURCES

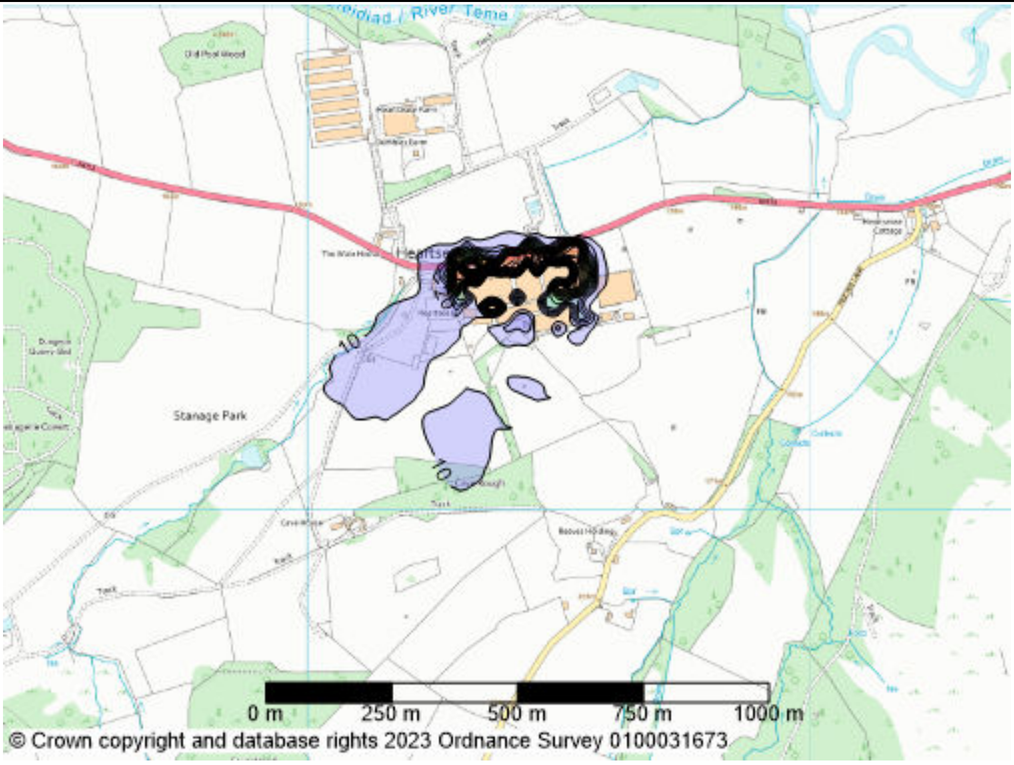
Ref	Receptor	Hourly PC (µg m-3) (a)	Hourly PC as %age of AQS	PEC as %age of AQS (b)	Impact Descriptor
Max	Maximum predicted	181.5	90.8%	94.3%	AQO doesn't apply
R1	Heartsease	53.9	26.9%	30.4%	Potentially significant
R2	Bungalow	7.2	3.6%	7.1%	Not significant
R3	The Wain House	6.0	3.0%	6.5%	Not significant
R4	The Dumbles	71.3	35.6%	39.1%	Potentially significant
R5	Heartsease Cott	3.3	1.6%	5.1%	Not significant
R6	Reeves Lane	6.4	3.2%	6.7%	Not significant
R7	Reeves Holding	5.3	2.6%	6.1%	Not significant
R8	Cave House	5.4	2.7%	6.2%	Not significant
R9	Dumbles Farm	3.4	1.7%	5.2%	Not significant
(a)	As a worst-case, assumes 35% conversion of NO to NO_2				

FIGURE 4.1 PREDICTED ANNUAL MEAN NO_2 CONCENTRATIONS (µg m-3) – EXISTING PERMITTED SOURCES



For both averaging periods, maximum predicted concentrations occur on the site and decrease with distance from the site.

FIGURE 4.2 PREDICTED 99.8TH PERCENTILE OF HOURLY NO_2 CONCENTRATIONS (µg m^{-3}) - EXISTING PERMITTED SOURCES



Sulphur Dioxide

Predicted short-term ground level concentrations of SO_2 arising as a result of emissions from the existing permitted boilers (A1 to A5) are presented in *Table 4.3*.

TABLE 4.3 MAXIMUM PREDICTED SO_2 CONCENTRATIONS – EXISTING PERMITTED SOURCES

Ref	Receptor	99.2nd Percentile of 24-hour Means		99.7th Percentile of 1-hour means		99.9th Percentile of 15-minute Means	
		PC (µg m^{-3})	%age AQAL	PC (µg m^{-3})	%age AQAL	PC (µg m^{-3})	%age AQAL
Max	Maximum	44.4	35.5%	69.5	19.9%	71.6	26.9%
R1	Heartsease	10.4	8.3%	17.0	4.9%	30.9	11.6%
R2	Bungalow	1.7	1.4%	3.0	0.8%	4.1	1.5%
R3	The Wain House	1.0	0.8%	2.4	0.7%	3.4	1.3%
R4	The Dumbles	5.3	4.2%	26.8	7.6%	29.1	10.9%
R5	Heartsease Cott	0.3	0.2%	1.3	0.4%	2.0	0.7%
R6	Reeves Lane	0.4	0.3%	2.7	0.8%	4.4	1.7%
R7	Reeves Holding	0.3	0.2%	2.1	0.6%	3.1	1.2%
R8	Cave House	0.3	0.2%	2.3	0.7%	3.3	1.3%
R9	Dumbles Farm	0.4	0.3%	1.3	0.4%	2.2	0.8%

Except for the 15-minute mean, predicted concentrations at all sensitive receptor locations are less than 10% of respective AQO for SO_2 and would be assessed as not significant. For the 15-minute mean, the PC exceeds 10% of the 15-minute AQO at R1 (11.9%) and R4 (10.9%). However, the predicted concentration at both of these receptors is less than 20% of the difference between the AQO and twice the annual mean background concentration (20% of 266 – 2.8 = 52.6 µg m^{-3}). Therefore, it is concluded that it is unlikely that the AQO would be exceeded at these receptors.

4.2.2 New Emission Source

Nitrogen Dioxide

Predicted annual and hourly mean ground level concentrations of NO_2 arising as a result of emissions from the new boiler (A6) are presented in *Table 4.4* and *Table 4.5*, respectively.

TABLE 4.4 PREDICTED ANNUAL MEAN GROUND LEVEL CONCENTRATIONS OF NO_2 AT SENSITIVE RECEPTORS – NEW BOILER

Ref	Receptor	Annual Mean PC (µg m^{-3}) (a)	Annual Mean PC as %age of AQS	Annual Mean PEC as %age of AQS (b)	Impact Descriptor
Max	Maximum predicted	15.0	37.5%	46.2%	AQO doesn't apply
R1	Heartsease	2.0	5.0%	13.7%	AQO met
R2	Bungalow	0.89	2.2%	11.0%	AQO met
R3	The Wain House	0.52	1.3%	10.0%	AQO met
R4	The Dumbles	2.4	6.1%	14.8%	AQO met
R5	Heartsease Cott	0.33	0.8%	9.6%	Not significant
R6	Reeves Lane	0.26	0.6%	9.4%	Not significant
R7	Reeves Holding	0.30	0.8%	9.5%	Not significant
R8	Cave House	0.27	0.7%	9.4%	Not significant
R9	Dumbles Farm	0.21	0.5%	9.3%	Not significant

(a) As a worst-case, assumes 70% conversion of NO to NO_2

As a maximum at any location, the contribution of the facility to annual mean concentrations is 15.0 µg m^{-3} and is 37.5% of the air quality objective (AQO) of 40 µg m^{-3}. The location of the maximum predicted concentration occurs within the installation site (refer *Figure 4.3*) where the AQO would not apply. The highest predicted concentration at sensitive receptors is 2.4 µg m^{-3} and is 6.1% of the AQO. However, combined with the background concentration of 3.5 µg m^{-3} the PEC would be well below 70% of the AQO. Therefore, it is unlikely that the AQO would be exceeded.

For the short-term objective (99.8th percentile of hourly means), the maximum predicted impact of the facility is 22.9% of the AQO but as the maximum occurs within the site (refer *Figure 4.4*) the AQO would not apply. For all of the sensitive receptors, the predicted impact is less than 10% of the AQO and would be assessed as not significant.

Predicted annual mean and predicted hourly mean (as the 99.8th percentile) ground level concentrations are also presented as contour plots in *Figure 4.3* and *Figure 4.4*, respectively. These are presented for the 2020 meteorological data which gives rise to the highest predicted concentrations.

TABLE 4.5 PREDICTED 99.8TH PERCENTILE OF HOURLY MEAN CONCENTRATIONS OF NO_2 AT SENSITIVE RECEPTORS – NEW BOILER

Ref	Receptor	Hourly PC (µg m^{-3}) (a)	Hourly PC as %age of AQS	PEC as %age of AQS (b)	Impact Descriptor
Max	Maximum predicted	45.8	22.9%	26.4%	AQO doesn't apply
R1	Heartsease	15.8	7.9%	11.4%	Not significant
R2	Bungalow	5.7	2.9%	6.4%	Not significant
R3	The Wain House	4.1	2.0%	5.5%	Not significant
R4	The Dumbles	11.0	5.5%	9.0%	Not significant
R5	Heartsease Cott	2.9	1.4%	4.9%	Not significant
R6	Reeves Lane	9.4	4.7%	8.2%	Not significant
R7	Reeves Holding	15.8	7.9%	11.4%	Not significant
R8	Cave House	14.9	7.5%	11.0%	Not significant
R9	Dumbles Farm	3.5	1.7%	5.2%	Not significant
(a)	As a worst-case, assumes 35% conversion of NO to NO_2				

FIGURE 4.3 PREDICTED ANNUAL MEAN NO_2 CONCENTRATIONS (µg m^{-3}) – NEW BOILER

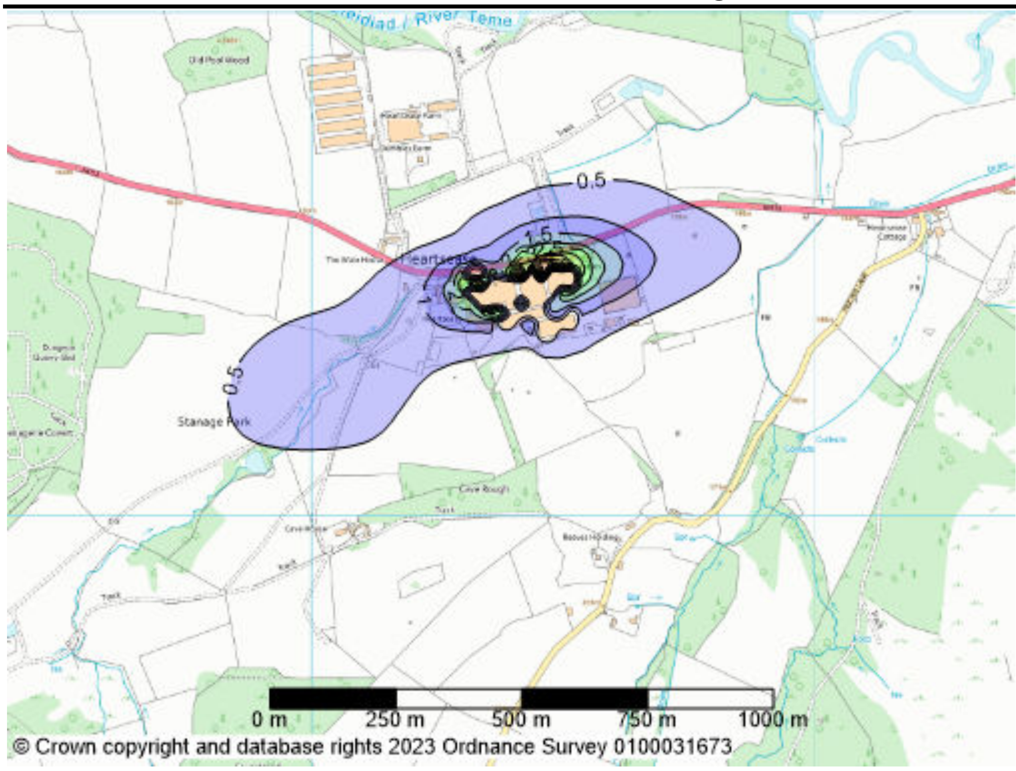
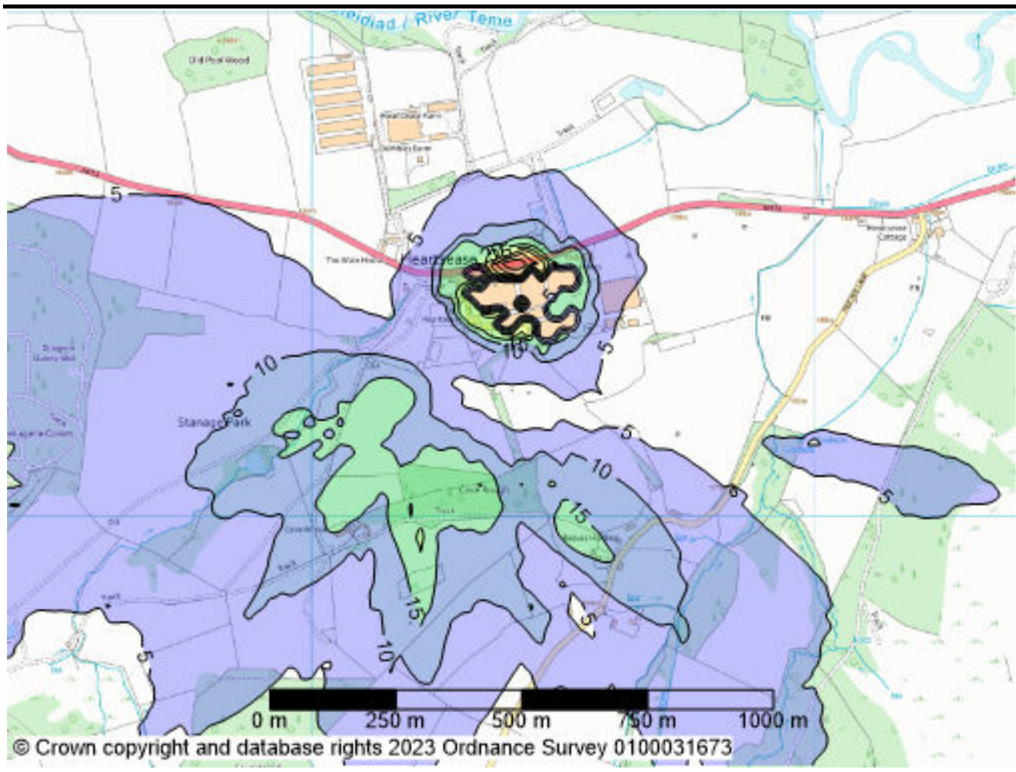


FIGURE 4.4 PREDICTED 99.8TH PERCENTILE OF HOURLY NO_2 CONCENTRATIONS ($\mu g\ m^{-3}$) – NEW BOILER



Sulphur Dioxide

Predicted short-term ground level concentrations of SO_2 arising as a result of emissions from the new boiler (A6) are presented in *Table 4.6*.

TABLE 4.6 MAXIMUM PREDICTED SO_2 CONCENTRATIONS – NEW BOILER

Ref	Receptor	99.2nd Percentile of 24-hour Means		99.7th Percentile of 1-hour means		99.9th Percentile of 15-minute Means	
		PC ($\mu g\ m^{-3}$)	%age AQAL	PC ($\mu g\ m^{-3}$)	%age AQAL	PC ($\mu g\ m^{-3}$)	%age AQAL
Max	Maximum	12.8	10.2%	22.6	6.5%	25.3	9.5%
R1	Heartsease	4.3	3.5%	7.8	2.2%	8.5	3.2%
R2	Bungalow	1.6	1.3%	2.8	0.8%	3.4	1.3%
R3	The Wain House	1.1	0.9%	2.0	0.6%	2.4	0.9%
R4	The Dumbles	2.7	2.2%	5.4	1.5%	6.1	2.3%
R5	Heartsease Cott	0.30	0.2%	1.4	0.4%	2.0	0.8%
R6	Reeves Lane	0.52	0.4%	4.5	1.3%	7.4	2.8%
R7	Reeves Holding	0.79	0.6%	7.1	2.0%	13.5	5.1%
R8	Cave House	0.58	0.5%	6.0	1.7%	12.3	4.6%
R9	Dumbles Farm	0.54	0.4%	1.7	0.5%	2.3	0.9%

Predicted concentrations at all sensitive receptor locations are less than 10% of respective AQO for SO_2 and would be assessed as not significant.

4.2.3 Future Normal Operation

Nitrogen Dioxide

Predicted annual and hourly mean ground level concentrations of NO_2 arising as a result of emissions from the normal future operation of boilers at the installation (A1, A5 and A6) are presented in *Table 4.7* and *Table 4.8*, respectively.

TABLE 4.7 PREDICTED ANNUAL MEAN GROUND LEVEL CONCENTRATIONS OF NO_2 AT SENSITIVE RECEPTORS – FUTURE NORMAL OPERATION

Ref	Receptor	Annual Mean PC ($\mu g\ m^{-3}$) (a)	Annual Mean PC as %age of AQS	Annual Mean PEC as %age of AQS (b)	Impact Descriptor
Max	Maximum predicted	16.4	41.1%	49.9%	AQO doesn't apply
R1	Heartsease	3.0	7.4%	16.1%	AQO met
R2	Bungalow	1.3	3.3%	12.0%	AQO met
R3	The Wain House	0.70	1.8%	10.5%	AQO met
R4	The Dumbles	2.7	6.8%	15.6%	AQO met
R5	Heartsease Cott	0.42	1.1%	9.8%	AQO met
R6	Reeves Lane	0.36	0.9%	9.6%	Not significant
R7	Reeves Holding	0.37	0.9%	9.7%	Not significant
R8	Cave House	0.34	0.8%	9.6%	Not significant
R9	Dumbles Farm	0.27	0.7%	9.4%	Not significant
(b) As a worst-case, assumes 70% conversion of NO to NO_2					

As a maximum at any location, the contribution of the facility to annual mean concentrations is 16.4 $\mu g\ m^{-3}$ and is 41.1% of the air quality objective (AQO) of 40 $\mu g\ m^{-3}$. The location of the maximum predicted concentration occurs within the installation site (refer *Figure 4.5*) where the AQO would not apply.

The highest predicted concentration at sensitive receptors is 2.7 $\mu g\ m^{-3}$ and is 6.8% of the AQO. However, combined with the background concentration of 3.5 $\mu g\ m^{-3}$ the PEC would be well below 70% of the AQO. Therefore, it is unlikely that the AQO would be exceeded.

For the short-term objective (99.8th percentile of hourly means), the maximum predicted impact of the facility is 23.8% of the AQO but as the maximum occurs within the site (refer *Figure 4.6*) the AQO would not apply. For all of the sensitive receptors, the predicted impact is less than 10% of the AQO and would be assessed as not significant.

Predicted annual mean and predicted hourly mean (as the 99.8th percentile) ground level concentrations are also presented as contour plots in *Figure 4.5* and

Figure 4.6, respectively. These are presented for the 2020 meteorological data which gives rise to the highest predicted concentrations.

TABLE 4.8 PREDICTED 99.8TH PERCENTILE OF HOURLY MEAN CONCENTRATIONS OF NO_2 AT SENSITIVE RECEPTORS – FUTURE NORMAL OPERATION

Ref	Receptor	Hourly PC ($\mu g\ m^{-3}$) (a)	Hourly PC as %age of AQS	PEC as %age of AQS (b)	Impact Descriptor
Max	Maximum predicted	47.5	23.8%	27.3%	AQO doesn't apply
R1	Heartsease	16.0	8.0%	11.5%	Not significant
R2	Bungalow	7.3	3.6%	7.1%	Not significant
R3	The Wain House	5.4	2.7%	6.2%	Not significant
R4	The Dumbles	11.5	5.7%	9.2%	Not significant
R5	Heartsease Cott	3.7	1.8%	5.3%	Not significant
R6	Reeves Lane	11.2	5.6%	9.1%	Not significant
R7	Reeves Holding	17.0	8.5%	12.0%	Not significant
R8	Cave House	16.6	8.3%	11.8%	Not significant
R9	Dumbles Farm	3.9	2.0%	5.5%	Not significant
(b)	As a worst-case, assumes 35% conversion of NO to NO_2				

FIGURE 4.5 PREDICTED ANNUAL MEAN NO_2 CONCENTRATIONS ($\mu g\ m^{-3}$) – FUTURE NORMAL OPERATION

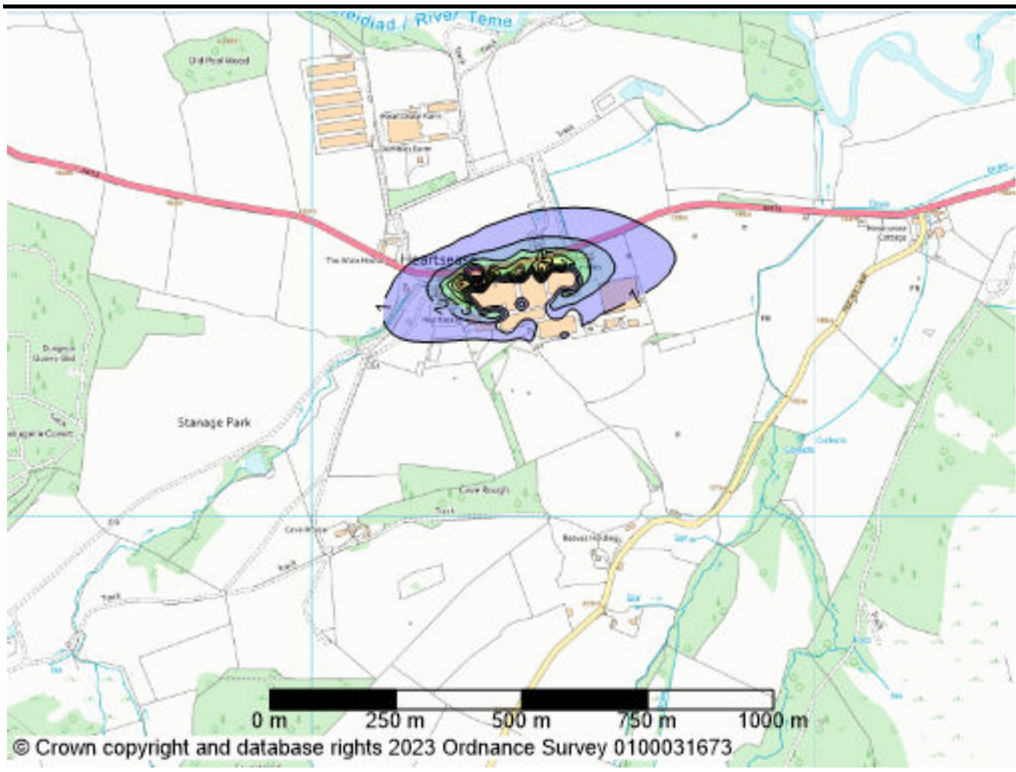
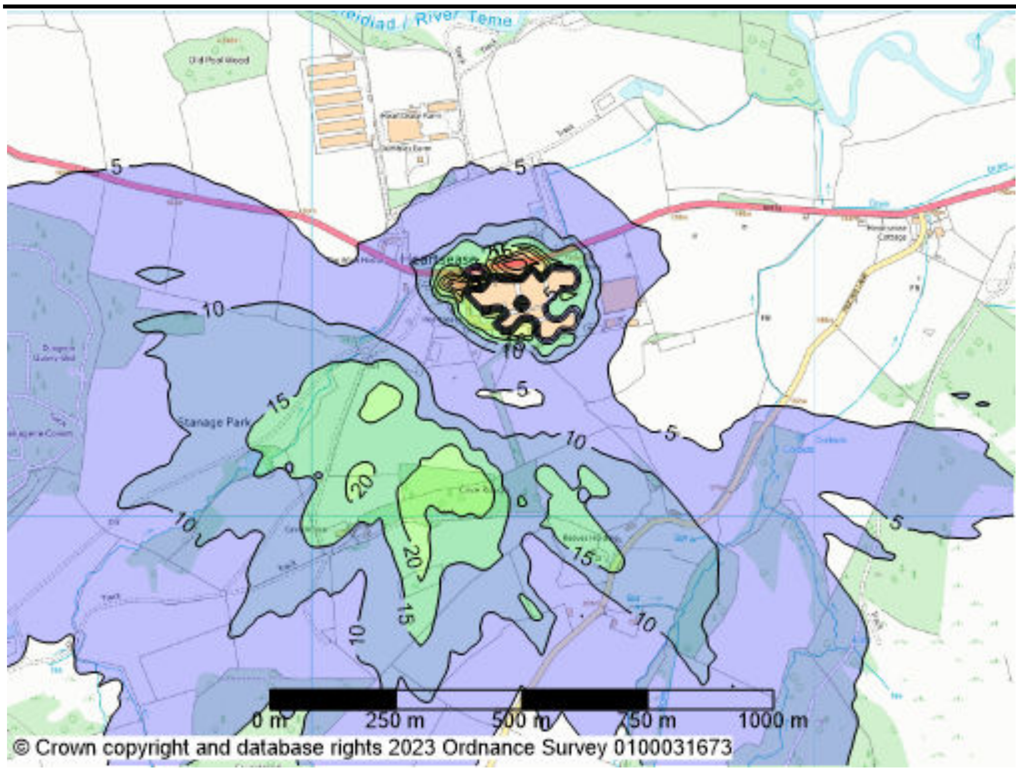


FIGURE 4.6 PREDICTED 99.8TH PERCENTILE OF HOURLY NO_2 CONCENTRATIONS ($\mu g\ m^{-3}$) – FUTURE NORMAL OPERATION



Sulphur Dioxide

Predicted short-term ground level concentrations of SO_2 arising as a result of emissions from the future emissions (A1, A5 and A6) are presented in *Table 4.9*.

TABLE 4.9 MAXIMUM PREDICTED SO_2 CONCENTRATIONS – FUTURE NORMAL OPERATION

Ref	Receptor	99.2nd Percentile of 24-hour Means		99.7th Percentile of 1-hour means		99.9th Percentile of 15-minute Means	
		PC ($\mu g\ m^{-3}$)	%age AQAL	PC ($\mu g\ m^{-3}$)	%age AQAL	PC ($\mu g\ m^{-3}$)	%age AQAL
Max	Maximum	13.1	10.5%	23.3	6.7%	25.6	9.6%
R1	Heartsease	4.6	3.7%	7.8	2.2%	8.6	3.2%
R2	Bungalow	2.2	1.8%	3.5	1.0%	4.3	1.6%
R3	The Wain House	1.4	1.1%	2.6	0.7%	3.1	1.2%
R4	The Dumbles	2.9	2.3%	5.6	1.6%	6.3	2.4%
R5	Heartsease Cott	0.4	0.3%	1.7	0.5%	2.4	0.9%
R6	Reeves Lane	0.6	0.5%	5.4	1.5%	8.7	3.3%
R7	Reeves Holding	0.9	0.7%	7.7	2.2%	14.1	5.3%
R8	Cave House	0.7	0.5%	6.7	1.9%	13.2	5.0%
R9	Dumbles Farm	0.7	0.5%	1.8	0.5%	2.7	1.0%

Predicted concentrations at all sensitive receptor locations are less than 10% of respective AQO for SO_2 and would be assessed as not significant.

4.2.4 Change in Predicted Concentrations

The operation of the new boiler along with A2, A3 and A4 being moved to standby operation, will generally benefit air quality compared to the existing operation of the boilers. For annual mean NO_2 concentrations, the predicted difference between the existing and future operation is summarised in *Table 4.10*.

TABLE 4.10 PREDICTED ANNUAL MEAN GROUND LEVEL CONCENTRATIONS OF NO_2 AT SENSITIVE RECEPTORS – CHANGE IN PREDICTED CONCENTRATIONS

Ref	Receptor	Annual Mean Change ($\mu g\ m^{-3}$) (a)	Annual Mean Change as %age of AQO
Max	Maximum predicted	-43.2	-108%
R1	Heartsease	-0.81	-2.0%
R2	Bungalow	-0.04	-0.1%
R3	The Wain House	0.00	0.0%
R4	The Dumbles	-1.3	-3.2%
R5	Heartsease Cott	0.06	0.1%
R6	Reeves Lane	0.06	0.1%
R7	Reeves Holding	0.18	0.5%
R8	Cave House	0.16	0.4%
R9	Dumbles Farm	0.08	0.2%
(a) As a worst-case, assumes 70% conversion of NO to NO_2			

There is a significant reduction in the maximum predicted annual mean concentration of NO_2 as a result of the additional boiler. For the majority of the discrete receptors there is a very small increase in predicted concentrations. However, the biggest change is for receptor R4 where predicted concentrations decrease by 1.3 $\mu g\ m^{-3}$ (3.2% of the AQO).

5 PREDICTED OPERATIONAL IMPACT ON HABITAT SITES

5.1 CRITICAL LEVELS AND CRITICAL LOADS

5.1.1 Introduction

There are many impacts on ecosystems associated with elevated levels of atmospheric nitrogen and its deposition to sensitive habitats. The most important of these are [5]:

- short-term direct effects of nitrogen gases and aerosols on individual species;
- soil mediated effects;
- increased susceptibility to secondary stress factors, such as drought or frost; and
- changes in (competitive) relationships between species, resulting in loss of biodiversity.

In order to provide benchmark levels, below which significant harmful effects to the environment do not occur, critical levels and critical loads have been developed referring to gaseous airborne concentrations of pollutants and deposition of pollution to land and water, respectively.

5.1.2 Critical Levels

Critical levels are thresholds of airborne pollutant concentrations above which damage may be sustained to sensitive plants and animals. High concentrations of pollutants in ambient air directly cause harm to leaves and needles of forests and other plant communities. Critical levels for NO_x and SO_2 are provided in *Section 2.2.3*.

5.1.3 Critical Loads

Introduction

Critical loads refer to the threshold beyond which deposition of pollutants to water or land results in measurable damage to vegetation and habitats. This takes the form of either gravitational settling of particulate matter (dry deposition) or wet deposition, where atmospheric pollutants dissolve in water vapour and then precipitate to the ground (e.g. as rain, snow, fog etc.).

5 Air Quality Guidelines for Europe, Second Edition, WHO Regional publications European Series No. 91, Chapter 11: Effects of nitrogen-containing air pollutants: critical levels, Chapter 14 : Effects of airborne nitrogen pollutants on vegetation: critical loads (2000)

The issue for ecosystems is the risk that the deposition rate of acid (acidification) or nutrient nitrogen (eutrophication) may be in excess of the amount that the ecosystem can tolerate. The point at which this occurs is the 'critical load'.

Eutrophication

Critical loads for nutrient nitrogen are determined largely on the basis of the species or habitat type affected. Critical loads have been determined for a number of habitat types at the European level and reflect the way different plants have adapted to differing availabilities of nutrient. Those in nutrient deficient environments, e.g. coastal sand dunes, will be less tolerant of excess nitrogen from aerial deposition.

Critical loads for eutrophication at the identified sensitive habitat receptors, obtained from the Air Pollution Information System (APIS) [6] are summarised in *Table 5.1.* For the River Teme SSSI, a critical load is not provided. Therefore, predicted impacts are compared to background deposition rates.

TABLE 5.1 CRITICAL LOADS FOR EUTROPHICATION

Habitat Site	Most Sensitive Habitat Type	Critical Load (kg N $ha^{-1}a^{-1}$)
River Teme SSSI	Lutra lutra (otter)	Not provided
Brampton Bryan Park SSSI	Dry heaths	5 - 15

Acidification

For acidification, the critical load of a habitat site is determined mostly by the underlying geology and soils. Alkaline soils have an innate capacity for neutralising acidic deposition, whereas acidic soils do not. The level of acidification depends on the donation of hydrogen ions to the soil arising primarily from deposition of:

- sulphur dioxide, which reacts with water to produce sulphuric acid;
- nitrogen oxides, which react with water to produce nitric acid; and
- acid gases such as hydrogen chloride.

The critical load of acidification is defined by a critical load function which describes the relationship between the relative contributions of sulphur (S) and nitrogen (N) to the total acidification. The critical load function is defined by the following parameters:

- CLmaxS, the maximum critical load of acidity for S, assuming there is no N deposition;

6 www.apis.co.uk

- ClminN, is the critical load of acidity due to nitrogen removal processes in the soil only (i.e. independent of deposition); and
- ClmaxN, is the maximum critical load of acidity for N, assuming there is no S deposition.

The values of these parameters (as provided by APIS) for the selected habitat receptors are presented in *Table 5.2*. As for nutrient nitrogen deposition, a critical load is not provided for the River Teme SSSI. Therefore, predicted impacts are compared to background deposition rates.

TABLE 5.2 CRITICAL LOADS FOR ACIDIFICATION (keq $ha^{-1}a^{-1}$)

Habitat Site	Most Sensitive Habitat Type	CLminN	CLmaxN	CLmaxS
River Teme SSSI	Lutra lutra (otter)	Not provided		
Brampton Bryan Park SSSI	Dwarf shrub heath	0.499	1.369	0.86

5.2 BACKGROUND CONCENTRATIONS AND DEPOSITION FLUXES

5.2.1 Introduction

Information on background nutrient nitrogen deposition, acidification and airborne concentrations of NO_x and SO_2 have been obtained from information provided by the Centre for Ecology and Hydrology (CEH) and available from the Air Pollution Information System (APIS) website.

5.2.2 Airborne Concentrations

Background NO_x and SO_2 concentrations for the area surrounding the habitat sites have been obtained from the APIS and are summarised in *Table 5.3.*

TABLE 5.3 AIRBORNE CONCENTRATIONS OF NO_X AT SENSITIVE HABITAT SITES

Habitat Site	Annual Mean NO_x ($\mu g\ m^{-3}$)	24-hour Mean NO_x ($\mu g\ m^{-3}$) (a)	Annual Mean SO_2 ($\mu g\ m^{-3}$)
River Teme SSSI	4.1	4.8	0.7
Brampton Bryan Park SSSI	4.1	4.8	0.7
(a) Derived from the annual by multiplying by 2 to generate an hourly mean and 0.59 to convert to a 24-hour mean			

Background concentrations of NO_x at the habitat site are below the annual mean and 24-hour mean critical levels of 30 $\mu g\ m^{-3}$ and 75 $\mu g\ m^{-3}$, respectively. Background concentrations of SO_2 are well below the most stringent critical level of 10 $\mu g\ m^{-3}$.

5.2.3 Nutrient Nitrogen Deposition (Eutrophication) and Acidification

APIS is able to provide an indication of background nutrient nitrogen deposition and acidification by geographical location and habitat type. The estimates are made from 1 km resolution mapped data, which are derived from a combination of modelling studies and measured deposition and acidification rates [7]. There is an inherent level of uncertainty resulting from this process, particularly in areas with significant emissions sources. However, in the absence of local measurements, the APIS data provides a useful benchmark for comparison with deposition and acidification rates predicted by the dispersion model. A summary of the background fluxes provided by APIS for habitat sites selected for the assessment is presented in *Table 5.4*.

TABLE 5.4 BACKGROUND NITROGEN DEPOSITION AND ACIDIFICATION FLUXES

Habitat Site	Background Nutrient Nitrogen Flux (kg N $ha^{-1}a^{-1}$)	Background Acidification Flux (keq $ha^{-1}a^{-1}$)
River Teme SSSI	20.66	1.53
Brampton Bryan Park SSSI	20.66	1.53

For the Brampton Bryan Park SSSI, the background deposition rate for nutrient nitrogen exceeds the lower critical load for the habitat by a factor of four. The background acidification rate for this habitat also exceeds the respective critical load.

5.2.4 Calculation of Acid and Nutrient Nitrogen Deposition

The deposition of acid and nutrient nitrogen is not directly modelled but is derived from the concentration predicted at each sensitive ecological receptor for each pollutant of interest. The derivation is based upon Environment Agency guidance [8] and uses the conversion factors set out in *Table 5.5*. The factors take into account the difference in deposition velocity and mechanisms experienced in woodlands, and moorlands and other non-arboreal areas.

7 Transboundary Air Pollution: Acidification, Eutrophication, and Griund Level Ozone in the UK, NEGTAP, EPG 1/3/153, 2001

8 AQTAG06 – Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air, Environment Agency, produced (March 2014)

TABLE 5.5 FACTORS FOR CONVERSION OF ANNUAL MEAN CONCENTRATIONS TO NUTRIENT NITROGEN AND ACID DEPOSITION

Pollutant	Deposition Velocity ($m\ s^{-1}$)	Conversion Factor ($\mu g\ m^{-2}\ s^{-1}$ to kgN $ha^{-1}\ year^{-1}$)	Conversion Factor ($\mu g\ m^{-2}\ s^{-1}$ to keq $ha^{-1}\ year^{-1}$)
NO_x as NO_2	0.0015 (grassland) 0.003 (woodland)	96	6.84
SO_2	0.012 (grassland) 0.024 (woodland)	-	9.84

5.3 PREDICTED IMPACT OF EMISSIONS ON HABITAT SITES

5.3.1 Airborne Concentrations of NO_x

Predicted concentrations of NO_x at the habitat sites are presented in *Table 5.6* and compared to the relevant critical levels. Results are presented for the existing operational boilers, the new boiler alone and the future normal operation of the boilers. For the annual mean concentrations, the change between existing and future operational scenarios is also provided.

TABLE 5.6 PREDICTED AIRBORNE NO_X CONCENTRATIONS AT HABITAT SITES

Habitat	Annual Mean PC NO_x ($\mu g\ m^{-3}$)	Annual Mean PC as %age of Critical Level	24 Hour Mean PC NO_x ($\mu g\ m^{-3}$)	24 Hour Mean PC as %age of Critical Level
River Teme SSSI				
Existing	0.20	0.7%	2.2	2.9%
New boiler alone	0.24	0.8%	2.0	2.7%
Future	0.29	1.0%	2.6	3.4%
Predicted change	0.09	0.3%	-	-
Brampton Bryan Park SSSI				
Existing	0.47	1.6%	2.6	3.5%
New boiler alone	0.42	1.4%	3.0	3.9%
Future	0.54	1.8%	3.4	4.5%
Predicted change	0.079	0.3%	-	-

For the River Teme SSSI, predicted concentrations for all scenarios are 1% or less of the critical level for NO_x of 30 $\mu g\ m^{-3}$ and the impact would be assessed as not significant. For both habitats, predicted 24-hour mean concentrations are less than 10% of the critical level of 75 $\mu g\ m^{-3}$ and would also be assessed as not significant.

For the Brampton Bryan Park SSSI, predicted concentrations are in excess of 1% of the annual mean critical level for the existing and future operation and are potentially significant. However, the change in concentrations at 0.3% is less than 1% of the critical level and would be assessed as not significant. Furthermore, the PEC for the future scenario (4.6 µg m^{-3}) is well below 70% of the critical level.

5.3.2 Airborne Concentrations of SO_2

Predicted concentrations of SO_2 at the habitat sites are presented in *Table 5.7* and compared to the relevant critical level. Information provided by APIS indicates that the less stringent critical level of 10 µg m^{-3} should be applied to the River Teme SSSI but the more stringent level of 20 µg m^{-3} should be applied to the Brampton Bryan Park SSSI.

TABLE 5.7 PREDICTED AIRBORNE SO_2 CONCENTRATIONS AT HABITAT SITES

Habitat	Annual Mean PC SO_2 (µg m^{-3})	Annual Mean PC as %age of Critical Level
River Teme SSSI		
Existing	0.030	0.2%
New boiler alone	0.043	0.2%
Future	0.051	0.3%
Predicted change	0.21	0.1%
Brampton Bryan Park SSSI		
Existing	0.068	0.7%
New boiler alone	0.074	0.7%
Future	0.092	0.9%
Predicted change	0.024	0.2%

For both habitat sites, predicted concentrations for all scenarios are 1% or less of the adopted critical level for SO_2 and the impact would be assessed as not significant.

5.3.3 Nutrient Nitrogen Deposition

Deposition of nitrogen compounds causes eutrophication and has been taken into account in assessing the impact of the emissions of NOx from the installation. A summary of the predicted PC and PEC is provided in *Table 5.8* along with the predicted exceedance and deposition as a proportion of the critical load.

TABLE 5.8 MAXIMUM PREDICTED PCS AND PECS FOR NUTRIENT NITROGEN DEPOSITION

Habitat	PC N (kgN $ha^{-1}a^{-1}$)	PC %age of Critical Load	PEC N (kgN $ha^{-1}a^{-1}$)	PEC %age of Critical Load
River Teme SSSI				
Existing	0.029	0.1%	20.69	100.1%
New boiler alone	0.034	0.2%	20.69	100.2%
Future	0.042	0.2%	20.70	100.2%
Predicted change	0.013	0.1%	-	-
Brampton Bryan Park SSSI				
Existing	0.067	1.3%	20.73	414.5%
New boiler alone	0.061	1.2%	20.72	414.4%
Future	0.078	1.6%	20.74	414.8%
Predicted change	0.011	0.2%	-	-

For the River Teme SSSI, predicted nutrient nitrogen deposition rates are less than 1% of the background deposition rate in the absence of site-specific critical loads. Furthermore, even with the application of a stringent critical load of 5 kg N ha^{-1} a^{-1}, predicted deposition rates would still be assessed as not significant for this habitat site.

For the Brampton Bryan Park SSSI, predicted deposition rates are in excess of 1% of the critical load of 5 kg N ha^{-1} a^{-1} for the existing and future operation and impacts are potentially significant. However, the change in deposition rate at 0.2% is less than 1% of the critical load and would be assessed as not significant.

5.3.4 Acidification

Deposition of NO_x and SO_2 causes acidification and has been taken into account in assessing the acidification impacts of the installation on the habitat sites. The predicted acidification rate for the habitat sites is presented in *Table 5.9*.

TABLE 5.9 MAXIMUM PREDICTED ACIDIFICATION DEPOSITION AT HABITAT SITES

Habitat	PC (keq $ha^{-1}a^{-1}$)	PC %age of Critical Load	PEC (keq $ha^{-1}a^{-1}$)	PEC %age of Critical Load
River Teme SSSI				
Existing	0.0057	0.4%	1.54	100.4%
New boiler alone	0.0075	0.5%	1.54	100.5%
Future	0.0090	0.6%	1.54	100.6%
Predicted change	0.0034	0.2%	-	-
Brampton Bryan Park SSSI				
Existing	0.013	0.9%	1.54	112.7%
New boiler alone	0.013	0.9%	1.54	112.7%
Future	0.016	1.2%	1.55	113.0%
Predicted change	0.003	0.2%	-	-

For the River Teme SSSI, the predicted PC is less than 1% of the critical load (background deposition rate for the River Teme SSSI) for all scenarios and would be assessed as not significant. For the River Teme SSSI, even with the application of a more stringent critical load of 0.5 keq $ha^{-1}a^{-1}$ (CLmaxN), the change in predicted deposition rates would still be less than 1% of the critical load.

For the Brampton Bryan Park SSSI, the future scenario slightly exceeds 1% of the critical load (1.2%). However, the change in impacts compared to the existing emissions is well below 1% at 0.2%.

6 SUMMARY AND CONCLUSIONS

6.1 SUMMARY

An air quality assessment for the proposed operation of a new boiler at the Radnor Hills facility has been carried out to support an application to vary the permit for the proposed site activities.

The new boiler has a significantly larger capacity (4.11 MW_{th}) than the currently permitted boilers. Therefore, some of the existing boilers will become standby boilers and will only operate when the new boiler or other duty boilers are under maintenance or repair. The assessment has considered the impact of the existing boilers, the new boiler alone and the proposed future operation of boilers at the installation.

The assessment of operational impacts has focussed on emissions of NO_x and SO_2. The impact of emissions on human health and habitats has been assessed. The air quality assessment has been carried out in accordance with guidance produced by the Environment Agency in their risk assessment guidance, as adopted by Natural Resources Wales.

Where there is relevant long-term public exposure (e.g. residential properties), the predicted long-term impact of nitrogen dioxide (NO_2) emissions on sensitive receptors would be described as 'not significant' or the 'air quality objective likely to be met' for all operational scenarios.

Except for the existing scenario, short-term concentrations of NO_2 were less than 10% of the AQO at sensitive receptors and it is concluded that the impact of short-term concentrations would be 'not significant'. However, existing emissions are potentially significant at two sensitive receptors for short-term concentrations of NO_2. Therefore, the future scenario represents an improvement with respect to short-term concentrations.

The assessment has also considered the impact of the facility on sensitive habitat sites and, in particular, the River Teme SSSI and the Brampton Bryan Park SSSI. The assessment has considered airborne concentrations of NO_x and SO_2, acidification and nutrient nitrogen deposition.

Taking into consideration the change in NO_x and SO_2 concentrations and deposition rates for nutrient nitrogen and acidification, the impact of these changes would be assessed as 'not significant'.

6.2 CONCLUSIONS

Therefore, based on the quantitative assessment carried out, it is concluded that the impact of the new boiler emissions on human health and sensitive habitat sites would be 'not significant'.

Gair Consulting Limited
Osterley
White Lackington
Piddletrenthide
Dorchester
DT2 7QU

Tel: 01869 278889

Appendix B – EMS-007 Monitoring Emissions Procedure

RADNOR HILLS MINERAL WATER COMPANY
ENVIRONMENTAL MANAGEMENT SYSTEMS
EMS 007 - MONITORING EMISSIONS PROCEDURE

PURPOSE

The procedure for monitoring Radnor Hills' emissions to air and water as required by the permits:

- NRW EPRAB3697CN Permit - Emissions to Air and Water
- NRW EPRBB3298CT Permit - Wetland Treatment System

Ensuring we are compliant in our day-to-day activities. When a breach to our permit occurs, this will be reported to NRW by the quality and technical department in accordance with document "EMS 013 – NRW Permit Breaches and Reporting Procedure".

BUNDING AND CONTAINMENT

A requirement of NRW to prevent pollution of raw materials and chemicals into the environment in-line are stored within a containment that meets the requirements of CIRIA 736 regulations. To ensure we comply the following is conducted:

- Monthly checks are conducted by the QA controllers using document "EMF 009 - Bund Data Review, Inspection and Integrity Testing Assessment". If during assessment a bund / containment has not complied with a parameter a non-conformity form will be used to document the problem. Following the procedure of the non-conformity report immediate corrective action will be taken and recorded. Action such as decommissioning the bund / containment until fully compliant will be applied.

- Hydrostatic testing is conducted when a bund / containment has been completed to ensure the requirements have been met and has successfully contained the contents. Once a test has been completed this will recorded on "EMF – Bund Data Sheet Form" and given a reassessment due in three years' time.

EMISSIONS TO AIR

The maintenance department conduct daily checks on all LPG Boilers and record this information on "FRM 068 – Boiler Blowdown". Safety checks of the Boilers are conducted daily and weekly to ensure they are working to the manufacturers' specification.

We have external contract companies CFB, Cochran and Lindon Heating to conduct the servicing and emissions testing for our boilers conducted on a 6 monthly and annual basis. All documents are maintained by the Engineering and Quality and Technical Department.

EMISSIONS TO WATER

MBR treatment plant is monitored everyday by the quality and technical department, ensuring that operation of the plant is working at its best.

All testing of the effluent treatment process is divided into four process stages:

- **STAGE 1** – EFFLUENT
  These results allow us to steer operational performance and treatment of the MBR.
- **STAGE 2** – BIOMASS
  These results determine the sludge waste amount of the MBR to regenerate the biology.
- **STAGE 3** – UF PERMEATE
  These results will determine nutrient dosing rate of the MBR.
- **STAGE 4** – UF + RO PERMEATE
  Final point of the treated effluent before discharging to the swale and are reflected against the permit discharge requirements.

The discharge from the MBR plant enters a swale system for attenuation with the natural stream before entering the River Teme. There are three additional samples points at this location which are taken weekly or in situation to demonstrate compliance with the permit.

- Swale Inflow – Sample of the stream entering the swale prior to attenuation with discharge.
- Swale Permeate Outfall – Sample taken from pipe outfall discharged direct from treatment plant.
- Swale outfall – Discharge to the river, treatment plant and stream mixed.

To record the analysis of the MBR "Effluent Weekly Testing Master" is the day-to-day spreadsheet that is used by the Quality and Technical Department. Stating what needs to be tested when and its frequency as a daily on-going operation. All the parameters have been given conditional formatting which will turn figures red if they have exceeded their operating and reporting emission limits.

Results are emailed every day as a notification to William Watkins, Dave Pope, Rob Isaac, Ben Price and the Quality and Technical Department. These members will review the results and adjust operations of the MBR plant accordingly to ensure positive treatment of the effluent. Breaches to the permit will be identified and notified to NRW and Aquabio by the Quality and Technical Department. Actions and preventive measures taken will be reported to NRW using document "EMF 005".

SIC meetings are conducted three times a day throughout the week to discuss the daily operations of all departments at Radnor Hills. Discussing current and future production of the factory enables us to determine how to best manage and control the operations of the MBR plant. The results of the day are also discussed as a notification of the day-to-day operations.

External sampling of the treated effluent from the MBR and treated sewage from the Klargester is sent every Tuesday to ALS Environmental for a BOD analysis.

All analysis and operational log data associated with the Wetland Treatment System is transferred to "Surface and Groundwater Sample Data" spreadsheet, recorded, and maintained by the Quality and Technical Department.

All analysis and operational log data of the MBR is transferred from the daily testing document to "Plant Data Spreadsheet Radnor" recorded and maintained by the Quality and Technical Department.

Waste syrup IBCs are held in stock for use of satisfying the chemical concentration levels for the biological process. This is prominently conducted during seasonal and production changes for example when there are fewer products containing juice being manufacturing. This can result the MBR system being deficient for its chemical oxygen demand therefore waste syrups are used to satisfy / sustain demand. This is further detailed in document "EMS 020 – Product Disposal Authorisation Procedure".

Nutrient dosing of nitrogen and phosphate is fed direct to the bioreactor and conducted as a feed-back system to satisfy the biological treatment process. With the purpose of supplementing effluent with essential nutrients for a healthy biomass and positive reaction. Dosing concentration is adjusted based on analysis results of effluent and permeate samples of COD, phosphate, ammonia, MLSS, TSS and nitrate. Additional factors can include dissolved oxygen, pH, and temperature levels of the biomass, effluent and ambient.

SURFACE AND GROUNDWATER ANALYSIS

Conducted on a 4 – 6 weekly bases are the sampling and environmental analysis of piezometers and spot sample sections of the River Teme, Stream 1, 2, 3, 4, 4L, 5, and Spring 1. Including monitoring borehole at drainage mound found after the wetland treatment system, 3 monthly. Studying the water quality principles of groundwater flow and impacts of effluents on groundwater quality.

Comparing the water levels against the piezometer levels and overall trying to show how groundwater levels have risen and then fallen significantly also considering the seasonal effects such as dilution by background groundwater flow. Along with improvements, stabilising and / or decreasing environmental concentrations within the surrounding sample area. Parameters such as Manganese, BOD, COD, sulphate are analysed.

The methodology for sampling the Piezometers can be found in document "EMS 012 – Piezo Sampling Procedure" all analysis results can be accessed through "myALS".

PLANNED MAINTEANCE OF THE MBR

QA controllers will conduct the day-to-day monitoring of the MBR routinely documenting information regarding operation performance of the system. Any irregularities will be investigated and if needed inform to the maintenance team to resolve.

The maintenance team will also be informed when an item needs to be completed on the maintenance schedule ensuring that we are complying to the manufacturers specification on items and equipment at the MBR system.