Britannia Refined Metals Ltd

BRM, Northfleet - E-Scrap Project

Air Quality Assessment

WSP Environment & Infrastructure Solutions UK Limited - April 2023

Report for

Diego Garcia-Arenal
Britannia Refined Metals Ltd
Manor Way
Northfleet
Gravesend
DA11 9BG

Main contributors

Liam Shelmerdine

Issued by

....
Liam Shelmerdine

Approved by

ioanna.gegisian Digitally signed by ioanna.gegisian Date: 2023.04.06 14:52:21 +01'00'
....
Ioanna Gegisian

WSP Environment & Infrastructure Solutions UK Limited

3rd Floor
11 Westferry Circus
Canary Wharf
London E14 4HD
United Kingdom
Tel +44 (0)20 3215 1610

Doc Ref. 808678-WSPE-ZZ-XX-RP-OA-00002

r:\projects\808678 brm e-scrap\deliver stage\d design_technical\01 planning and permitting\01-applications\air quality\report\phase 1 - dust only\808678-wspe-zz-xx-rp-oa-00002.docx

Document revisions

No.	Details	Date
P01	Draft	Mar 2023
P02	Issued Report	Apr 2023

Executive summary

Purpose of this report

Britannia Refined Metals (BRM), plans to redevelop a plot of land next to the site it currently occupies on Botany Road, in Northfleet Gravesend. The redeveloped site will accommodate a facility that will accept specific types of waste, some of which will be shredded at the installation.

These wastes are referred to as E-Scrap throughout this report. More detailed information relating to the nature and characteristics of the wastes that comprise E-Scrap are outlined in the Environmental Permit application. Emissions associated with the activities will be subject to abatement using a bag filter.

The report presents predicted concentrations at sensitive receptors to assess their impact. The predicted concentrations resulting from the facility have been assessed against legal limits and guideline values.

Impacts of the following pollutants have been assessed at appropriate receptor locations against appropriate assessment levels:

- Particulate matter with an aerodynamic diameter of 10µm or less (PM_{10});
- Particulate matter with an aerodynamic diameter of 2.5µm or less ($PM_{2.5}$) and;
- Mercury (Hg).

A stack height assessment was also required to determine the stack height required in order to cause no impacts at any local receptors.

Emission Limit Values (ELVs) from the ‘Waste electrical and electronic equipment (WEEE): appropriate measures for permitted facilities’ guidance. The ELV of 5mg/m^3 for Dust and 7µg/m^3 for Mercury (Hg) as stated in the guidance has been used for this assessment.

Conclusions

The assessment concludes:

- All process contributions are below the legal limits and guidelines at all sensitive receptors; and,
- Based on information provided by the contractor designing the dust abatement system, emissions will comply with the WEEE ELV of 5mg/m^3 and therefore impacts can be screened out as insignificant.

Contents

1. Introduction

1.1 Background, aims and objectives

Britannia Refined Metals (BRM), plans to redevelop a plot of land next to the site it currently occupies on Botany Road, in Northfleet Gravesend. The redeveloped site will accommodate a facility that will accept specific types of waste, some of which will be shredded at the installation.

These wastes are referred to as E-Scrap throughout this report. More detailed information relating to the nature and characteristics of the wastes that comprise E-Scrap are outlined in the Environmental Permit application. Emissions associated with the activities will be subject to abatement using a bag filter.

Emissions associated with the proposed facility will be discharged via a stack to the rear of the building in which waste treatment will be undertaken, as identified at Figure 1.2. The specialist contractor appointed to specify the abatement plant has confirmed the technologies to be installed will achieve compliance Dust Emission Limit Value (ELVs) from the 'Waste electrical and electronic equipment (WEEE): appropriate measures for permitted facilities' guidance[1]. The compliance criteria specified references 5mg/m^3 of dust channelled emissions to air from all mechanical treatment of WEEE.

The ELV is stated as total PM. As such, for the purposes of the dispersion modelling it was considered that 100% of the emission consisted of either PM_{10} or $PM_{2.5}$ in order to provide a worse case assessment. Concentrations of Hg were also modelled at sensitive receptor locations.

An assessment of the impact of emissions to air associated with the facility is required to determine the potential air quality impacts at local receptors released from the stack.

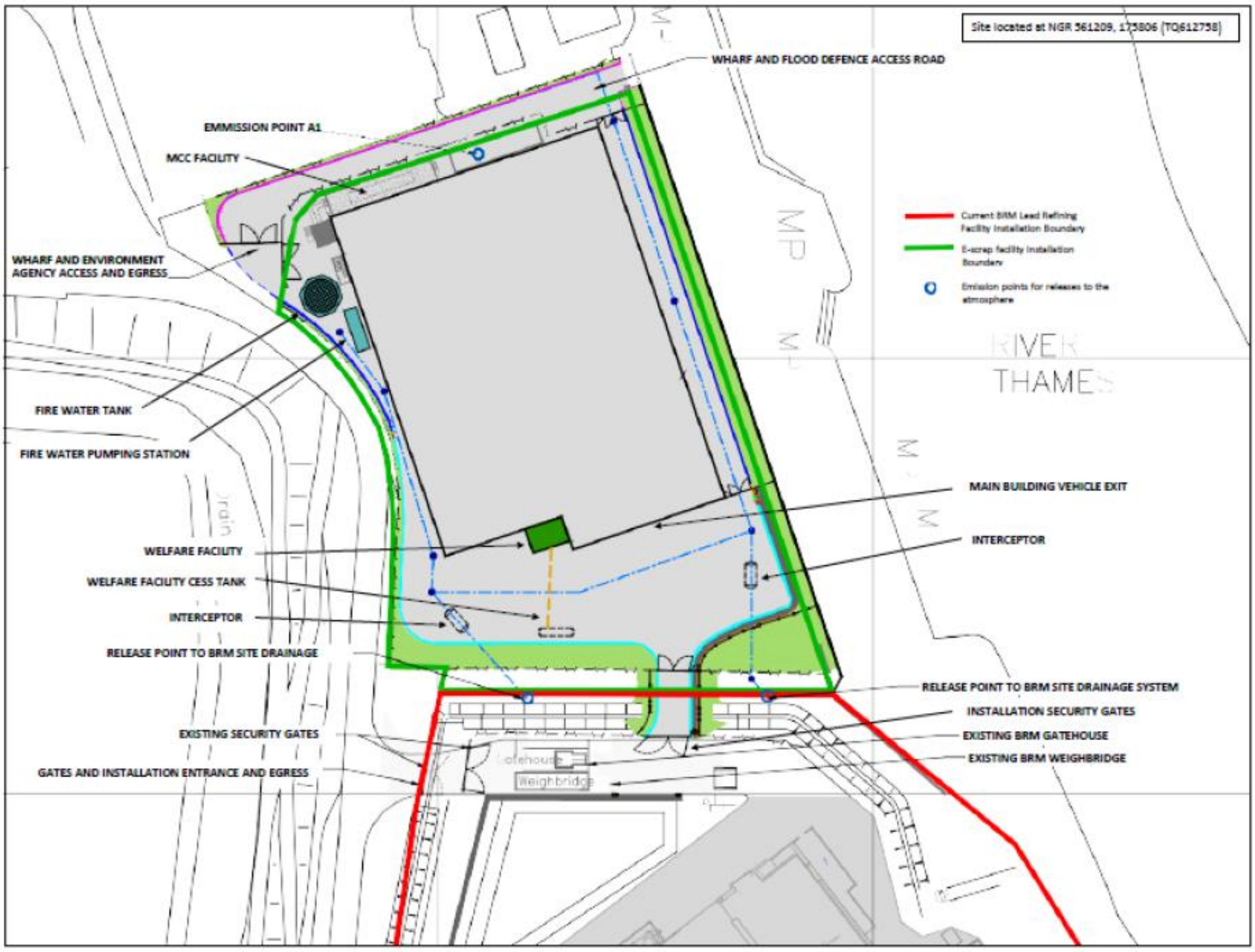
1.2 Site description

The Installation will be located on Botany Road approximately 2km north-west of Northfleet at grid reference TQ 61180 75850. Botany Road and Manor Way bound the site to the west and the Thames Estuary is to the east. To the south is a container port and to the north are open fields (Broadfield Salt Marsh). The Site location is shown in Figure 1.1. The site layout is presented in Figure 1.2.

1 https://www.gov.uk/guidance/waste-electrical-and-electronic-equipment-weee-appropriate-measures-for-permitted-facilities, Environment Agency, July 2022.

Figure 1.1 Site location

Figure 1.2 Site layout



1.3 Sources of information

The information used in this report is shown in Table 1.1.

Table 1.1 Sources of information

Item	Source
Process and Emissions Data	Waste electrical and electronic equipment (WEEE): appropriate measures for permitted facilities – Emission Limit Values
Site Layout	WSP Drawings
Baseline Air Quality	Government bodies; Local Authorities and third parties
Ordnance Survey Maps	Open Street Maps
Meteorological Data	Atmospheric Dispersion Modelling Limited

1.4 Report structure

The structure of this report is set out in Table 1.2.

Table 1.2 Report structure

Section	Aims and Objectives
Section 2	Details the assessment criteria
Section 3	Describes the dispersion model, assessment methodology, model inputs and assumptions used in the assessment
Section 4	Details the ambient air quality in the area
Section 5	Presents an assessment of the potential air quality impacts arising from the site emissions
Section 6	Contains a summary and conclusions of the assessment

2. Assessment criteria

2.1 Relevant Legislation and Guidance

EU Legislation

Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe

Directive 2008/50/EC (the 'Directive'), which came into force in June 2008, consolidates existing EU-wide air quality legislation (with the exception of Directive 2004/107/EC) and provides a new regulatory framework for $PM_{2.5}$.

The Directive sets limits, or target levels, for selected pollutants that are to be achieved by specific dates and details procedures EU Member States should take in assessing ambient air quality. The limit and target levels relate to concentrations in ambient air. At Article 2(1), the Directive defines ambient air as:

> *"…outdoor air in the troposphere, excluding workplaces as defined by Directive 89/654/EEC where provisions concerning health and safety at work apply and to which members of the public do not have regular access."*

In accordance with Article 2(1), Annex III, Part A, paragraph 2 details locations where compliance with the limit values does not need to be assessed:

> *"Compliance with the limit values directed at the protection of human health shall not be assessed at the following locations:*
>
> *a) any locations situated within areas where members of the public do not have access and there is no fixed habitation;*
>
> *b) in accordance with Article 2(1), on factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply; and*
>
> *c) on the carriageway of roads; and on the central reservation of roads except where there is normally pedestrian access to the central reservation."*

UK legislation

The Air Quality Standards Regulations 2010

The Air Quality Standards Regulations 2010 (the 'Regulations') came into force on 11 June 2010 and transpose EU Directive 2008/50/EC into UK legislation. The Directive's limit values are transposed into the Regulations as 'Air Quality Standards' (AQS) with attainment dates in line with the Directive.

These standards are legally binding concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health including the effects of sensitive groups or on ecosystems.

Similar to Directive 2008/50/EC, the Regulations define ambient air as:

> *"…outdoor air in the troposphere, excluding workplaces where members of the public do not have regular access."*

with direction provided in Schedule 1, Part 1, Paragraph 2 as to where compliance with the AQS' does not need to be assessed:

> *"Compliance with the limit values directed at the protection of human health does not need to be assessed at the following locations:*
>
> *a) any location situated within areas where members of the public do not have access and there is no fixed habitation;*
>
> *b) on factory premises or at industrial locations to which all relevant provisions concerning health and safety at work apply; and*
>
> *c) on the carriageway of roads and on the central reservation of roads except where there is normally pedestrian access to the central reservation."*

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

The 2007 Air Quality Strategy for England, Scotland Wales and Northern Ireland provides a framework for improving air quality at a national and local level and supersedes the previous strategy published in 2000.

Central to the Air Quality Strategy are health-based criteria for certain air pollutants; these criteria are based on medical and scientific reports on how and at what concentration each pollutant affects human health. The objectives derived from these criteria are policy targets often expressed as a maximum ambient concentration not to be exceeded, without exception or with a permitted number of exceedances, within a specified timescale. At paragraph 22 of the 2007 Air Quality Strategy, the point is made that the objectives are:

> *"…a statement of policy intentions or policy targets. As such, there is no legal requirement to meet these objectives except where they mirror any equivalent legally binding limit values…"*

The air quality objectives (AQOs), based on a selection of the objectives in the Air Quality Strategy, were incorporated into UK legislation through the Air Quality Regulations 2000, as amended.

Paragraph 4(2) of The Air Quality (England) Regulations 2000 states:

> *"The achievement or likely achievement of an air quality objective prescribed by paragraph (1) shall be determined by reference to the quality of air at locations –*
>
> *a) which are situated outside of buildings or other natural or man-made structures above or below ground; and*
>
> *b) where members of the public are regularly present."*

Consequently, compliance with the AQOs should focus on areas where members of the general public are present over the entire duration of the concentration averaging period specific to the relevant objective.

The Environment Act 1995 (Revised by The Environment Act 2021)

Part IV of the Environment Act 1995 requires that Local Authorities periodically review air quality within their individual areas. This process of Local Air Quality Management (LAQM) is an integral part of delivering the Government's AQOs.

To carry out an air quality Review and Assessment under the LAQM process, the Government recommends a three-stage approach. This phased review process uses initial simple screening methods and progresses through to more detailed assessment methods of modelling and monitoring in areas identified to be at potential risk of exceeding the objectives in the Regulations.

Review and assessments of local air quality aim to identify areas where national policies to reduce vehicle and industrial emissions are unlikely to result in air quality meeting the Government's air quality objectives by the required dates.

For the purposes of determining the focus of Review and Assessment, Local Authorities should have regard to those locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective.

Where the assessment indicates that some or all of the objectives may be potentially exceeded, the Local Authority has a duty to declare an AQMA. The declaration of an AQMA requires the Local Authority to implement an Air Quality Action Plan (AQAP), to reduce air pollution concentrations so that the required AQOs are met.

The Environment Act 2021 presents the new environmental programme. It aims to improve air and water quality, tackle waste, increase recycling, halt the decline of species and improve the natural environment. The Act establishes legally binding duty to the government to bring two new targets in Secondary legislation in October 2022. These include reducing the annual mean levels of fine particles ($PM_{2.5}$) and reducing public exposure to $PM_{2.5}$.

Other guideline values

In the absence of statutory standards for the other prescribed substances that may be found in the emissions, there are several sources of applicable air quality guidelines.

Air Quality Guidelines for Europe, the World Health Organization (WHO)

The aim of the WHO Air Quality Guidelines for Europe (WHO, 2021) provide a basis for protecting public health from adverse effects of air pollutants and to eliminate or reduce exposure to those pollutants that are known or likely to be hazardous to human health or well-being. These guidelines are intended to provide guidance and information to international, national and local authorities making risk management decisions, particularly in setting air quality standards.

Environmental Assessment Levels (EALs)

The Environment Agency's Air emissions risk assessment for your environmental permit guidance provides methods for quantifying the environmental impacts of emissions to all media. It contains long and short-term Environmental Assessment Levels (EALs) and Environmental Quality Standards (EQS) for releases to air derived from a number of published UK and international sources. For the pollutants considered in this study, these EALs and EQS are equivalent to the AQS and AQOs set in force by the Air Quality Strategy for England, Scotland, Wales and Northern Ireland.

2.2 Criteria appropriate to the assessment

Air Quality Standards, Objectives and Guidelines

Table 2.1 sets out those AQS, AQOs and EALs that are relevant to this assessment.

Table 2.1 Air Quality Standards and Objectives

Pollutant	Receptors Affected	AQS /AQO/EAL	Averaging Period	Value (μgm^{-3})
PM_{10}	Human	AQS	Annual mean	40
	Human	AQS	24-hour mean, no more than 35 exceedances per year (90.4th percentile)	50
$PM_{2.5}$	Human	AQO	Annual mean	20
Hg	Human	EAL	Annual mean	0.25
	Human	EAL	1-hour mean (100th percentile)	7.5

Public exposure

Guidance from the UK Government and Devolved Administrations makes clear that exceedances of the health-based objectives should be assessed at outdoor locations where members of the general public are regularly present over the averaging time of the objective. This excludes workplaces. Table 2.2 provides an indication of those locations that may or may not be relevant for each averaging period.

Table 2.2 Examples of where the Air Quality Objectives should apply for human receptors

Averaging Period	Objectives Should Apply At:	Objectives Should Generally Not Apply At:
Annual mean	All locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
24-hour and 8-hour mean	All locations where the annual mean objectives would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
1-hour mean	All locations where the annual mean and 24- and 8-hour mean objectives would apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where the public might reasonably be expected to spend one hour or more.	1-hour mean

Averaging Period	Objectives Should Apply At:	Objectives Should Generally Not Apply At:
	Any outdoor locations at which the public may be expected to spend one hour or longer.	
15-minute mean	All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

For gardens, such locations should represent parts of the garden where relevant public exposure is likely, for example where there is a seating or play areas. It is unlikely that relevant public exposure would occur at the extremities of the garden boundary, or in front gardens, although local judgement should always be applied.

Significance Criteria

EA online guidance *'Air Emissions Risk Assessment'* provides the criteria for screening out-source contributions in the context of environmental permit applications. This guidance suggests applicants first perform a screening assessment and, if the results of that do not meet the screening-out criteria, then perform a detailed modelling assessment.

This guidance introduces the terms 'process contribution' (PC), meaning the concentration or deposition rate resulting from the activities only, excluding other sources, and 'predicted environmental concentration' (PEC), meaning the total modelled concentration, equal to the PC plus the background contribution from all other sources. These terms are commonly used in air quality assessments, even where the term 'process' is not strictly accurate, and so are used in this assessment with 'process' referring to the proposed development. The term PEC is also used to describe total deposition rates.

For human receptors the guidance states there is no need for further assessment if the screening calculation finds that:

- Both the following are met:
  - the short-term PC is less than 10% of the short-term AQO/S; and
  - the long-term PC is less than 1% of the long-term AQO/S;
- Or:
  - the short term PC is less than 20% of the short term environmental standards minus twice the long term background concentration; and,
  - the long-term PEC is less than 70% of the long-term AQO/S.

3. Assessment Methodology

3.1 Dispersion Model

The model used in this assessment is the latest version of the ADMS 5.2 atmospheric dispersion model developed and validated by Cambridge Environmental Research Consultants (CERC). The model was used to predict the ground level concentration of compounds emitted to atmosphere from the installation. The model has been used extensively throughout the UK for regulatory compliance purposes and is accepted as an appropriate air quality modelling tool by the Environment Agency and local authorities.

ADMS 5.2 parameterises stability and turbulence in the atmospheric boundary layer by the Monin-Obukhov length and the boundary layer depth. This approach allows the vertical structure of the boundary layer to be more accurately defined than by the stability classification methods of earlier dispersion models. In ADMS, the concentration distribution follows a symmetrical Gaussian profile in the vertical and crosswind directions in neutral and stable conditions. However, the vertical profile in convective conditions follows a skewed Gaussian distribution to take account of the inhomogeneous nature of the vertical velocity distribution in the Convective Boundary Layer.

A number of complex modules, including the effects of plume rise, complex terrain, coastlines, concentration fluctuations, radioactive decay and buildings effects, are also included in the model, as well as the facility to calculate long-term averages of hourly mean concentration, dry and wet deposition fluxes, and percentile concentrations, from either statistical meteorological data or hourly average data.

A range of input parameters is required including, among others, data describing the local area, meteorological measurements and emissions data. The data used in modelling the emissions are given in the following sections of this chapter.

3.2 Process Emissions

The principal inputs to the model with respect to the emissions to air has been derived from the site drawings, process description and relevant ELVs.

The following pollutants are specified within the WEE guidance and have therefore been assessed within the report:

- PM_{10};
- $PM_{2.5}$; and,
- Hg.

It is assumed that all particles are emitted in the PM_{10} and $PM_{2.5}$ fractions for comparison against the PM_{10} and $PM_{2.5}$ AQO/S.

Model input parameters are given in Table 3.1.

Table 3.1 Model input parameters

Parameter	Stack Characteristics	Units
Stack location (x, y)	561211, 175947	m

Parameter	Stack Characteristics	Units
Stack Height	3.0	m
Stack Diameter	1.0	m
Temperature	Ambient	°C
Velocity	12.5	m/s
Volume Flow Rate	9.8	Am^3/s
	Emission concentration (273K, dry)	
PM (PM_{10} and $PM_{2.5}$)	5	mg/Nm^3
Hg	7	$\mu g/Nm^3$
	Emission rates	
PM_{10}	0.0492	g/s
$PM_{2.5}$	0.0492	g/s
Hg	$6.9x10^{-5}$	g/s

Emissions from the facility have modelled as if the site is in operation continuously for 8,760 hours per year. This is a worst case assessment as it doesn't not take into account times when the plant is not operation.

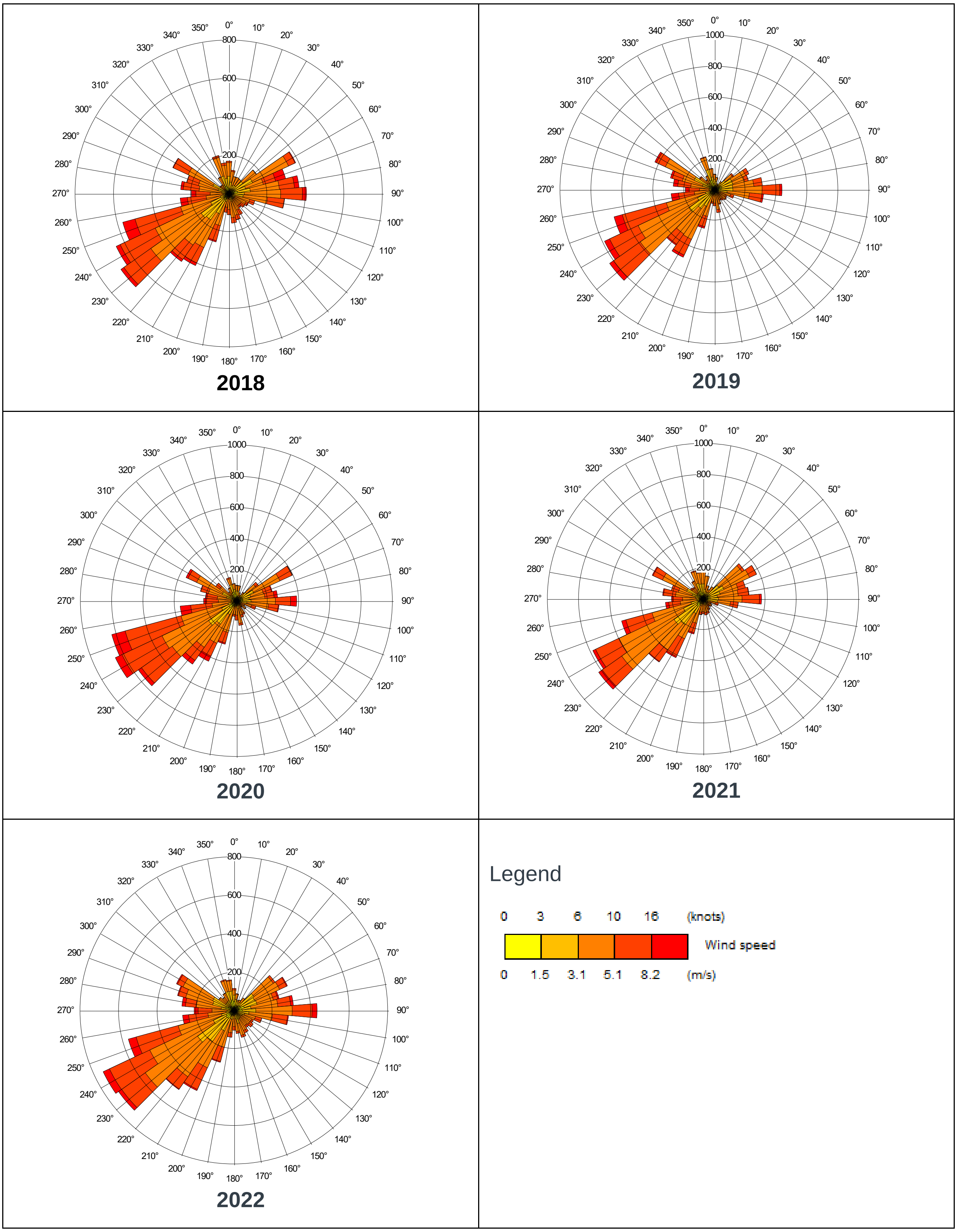
3.3 Meteorology

For meteorological data to be suitable for dispersion modelling purposes, a number of meteorological parameters are 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. The year of meteorological data that is used for a modelling assessment can also have a significant effect on ground level concentrations.

This assessment has used meteorological data recorded at the London City meteorological station from 2018 to 2022. The meteorological station is located approximately 18.3 km northwest, offering data in a suitable format for the model and representative of local meteorological conditions.

Figure 3.1 shows the wind roses for each year modelled, illustrating the frequency of monitored wind direction and wind speed.

Figure 3.1 Wind Rose: London City meteorological station 2018 – 2022



Monin-Obukhov length

The minimum Monin-Obukhov length can be selected in ADMS for both the dispersion site and the meteorological site. This is a measure of the minimum stability of the atmosphere and can be adjusted to account for urban heat island effects which prevent the atmosphere in urban areas from ever becoming completely stable. The minimum Monin-Obukhov length has been set to 30 m for the dispersion site and 30 m for the meteorological site. The surroundings of the dispersion site are mainly industrial. A value of 30 m is recommended by CERC for mixed urban/industrial areas and is considered appropriate for the surroundings of the dispersion site.

3.4 Surface characteristics

The predominant surface characteristics and land use in a model domain have an important influence in determining turbulent fluxes and, hence, the stability of the boundary layer and atmospheric dispersion. Factors pertinent to this determination are detailed below.

Surface roughness

Roughness length, z_0, represents the aerodynamic effects of surface friction and is defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing.

The surface roughness length is related to the height of surface elements; typically, the surface roughness length is approximately 10% of the height of the main surface features. Thus, it follows that surface roughness is higher in urban and congested areas than in rural and open areas. Oke (1987) and CERC (2003) suggest typical roughness lengths for various land use categories (Table 3.2).

Table 3.2 Typical surface roughness lengths for various land use categories

Type of Surface	z_0 (m)
Ice	0.00001
Smooth snow	0.00005
Smooth sea	0.0002
Lawn grass	0.01
Pasture	0.2
Isolated settlement (farms, trees, hedges)	0.4
Parkland, woodlands, villages, open suburbia	0.5-1.0
Forests/cities/industrialised areas	1.0-1.5
Heavily industrialised areas	1.5-2.0

Increasing surface roughness increases turbulent mixing in the lower boundary layer. With respect to elevated sources under neutral and stable conditions, increasing the roughness length can have complex and conflicting effects on ground level concentrations:

- The increased mixing can bring portions of an elevated plume down towards ground level, resulting in increased ground level concentrations close to the emission source; and
- The increased mixing increases entrainment of ambient air into the plume and dilutes plume concentrations, resulting in reduced ground level concentrations further downwind from an emission source.

The overall impact on ground level concentration is, therefore, strongly correlated with the distance of a receptor from the emission source.

Surface Energy Budget

One of the key factors governing the generation of convective turbulence is the magnitude of the surface sensible heat flux. This, in turn, is a factor of the incoming solar radiation. However, not all solar radiation arriving at the Earth's surface is available to be emitted back to atmosphere in the form of sensible heat. By adopting a surface energy budget approach, it can be identified that, for fixed values of incoming short and long wave solar radiation, the surface sensible heat flux is inversely proportional to the surface albedo and latent heat flux.

The surface albedo is a measure of the fraction of incoming short-wave solar radiation reflected by the Earth's surface. This parameter is dependent upon surface characteristics and varies throughout the year. Oke (1987) recommends average surface albedo values of 0.6 for snow covered ground and 0.23 for snow-free ground, respectively.

The latent heat flux is dependent upon the amount of moisture present at the surface. Areas where moisture availability is greater will experience a greater proportion of incoming solar radiation released back to atmosphere in the form of latent heat, leaving less available in the form of sensible heat and, thus, decreasing convective turbulence. The modified Priestly-Taylor parameter (α) can be used to represent the amount of moisture available for evaporation. Holstag and van Ulden (1983) suggest values of 0.45 and 1.0 for dry grassland and moist grassland respectively.

Selection of appropriate surface characteristic parameters for the site

A detailed analysis of the effects of surface characteristics on ground level concentrations by Auld et al. (2002) led them to conclude that, with respect to uncertainty in model predictions:

"…the energy budget calculations had relatively little impact on the overall uncertainty".

In this regard, it is not considered necessary to vary the surface energy budget parameters spatially or temporally, and annual averaged values have been adopted throughout the model domain for this assessment.

As snow covered ground is only likely to be present for a very small fraction of the year, the surface albedo of 0.23m for snow-free ground advocated by Oke (1987) has been used whilst the model default α value of 1.0m has also been retained.

The area around the site is a mix of cities and woodlands. In view of this, a roughness length of 1 m was used. A sensitivity test on this parameter was undertaken, shown in Appendix C.

Buildings

Any large object has an impact on atmospheric flow and air turbulence within the locality of the object. This can result in maximum ground level concentrations that are significantly different (generally higher) from those encountered in the absence of buildings. The building 'zone of influence' is generally regarded as extending a distance of 5 L (where L is the lesser of the building height or width) from the foot of the building in the horizontal plane and three times the height of the building in the vertical plane. Table 3.3 details the building as they are included in the model. A sensitivity test on this parameter was undertaken, shown in Appendix C.

Table 3.3 Modelled Buildings

ID		X (m)	Y (m)	Z (m)	Length (m)	Width (m)	Angle (°)
1	Main Building	561219	175801	18.6	87.8	66.4	161.5

Terrain

The concentrations of an emitted pollutant found in elevated, complex terrain differ from those found in simple level terrain. There have been numerous studies on the effects of topography on atmospheric flows. The UK ADMLC provides a summary of the main effects of terrain on atmospheric flow and dispersion of pollutants (Hill et al., 2005):

- *"Plume interactions with windward facing terrain features:*
  - *Plume interactions with terrain features whereby receptors on hills at a similar elevation to the plume experience elevated concentrations;*
  - *Direct impaction of the plume on hill slopes in stable conditions;*
  - *Flow over hills in neutral conditions can experience deceleration forces on the upwind slope, reducing the rate of dispersion and increasing concentrations; and*
  - *Recirculation regions on the upwind side of a hill can cause partial or complete entrainment of the plume, resulting in elevated ground level concentrations.*
- *Plume interactions with lee sides of terrain features:*
  - *Regions of recirculation behind steep terrain features can rapidly affect pollutants towards the ground culminating in elevated concentrations; and*
  - *As per the upwind case, releases into the lee of a hill in stable conditions can also be recirculated, resulting in increased ground level concentrations.*
- *Plume interactions within valleys:*
  - *Releases within steep valleys experience restricted lateral dispersion due to the valley sidewalls. During stable overnight conditions, inversion layers develop within the valley essentially trapping all emitted pollutants. Following sunrise and the erosion of the inversion, elevated ground level concentrations can result during fumigation events; and*
  - *Convective circulations in complex terrain due to differential heating of the valley side walls can lead to the impingement of plumes due to crossflow onto the valley sidewalls and the subsidence of plume centrelines, both having the impact of increasing ground level concentrations."*

These effects are most pronounced when the terrain gradients exceed 1 in 10, i.e. a 100m change in elevation per 1km step in the horizontal plane. As the area surrounding the site is not flat, terrain was applied. A sensitivity test on this parameter was undertaken, shown in Appendix C.

3.5 Modelled domain and receptors

Modelled domain

An 1.8 km × 1.8 km Cartesian grid centred on the site was modelled, with a receptor resolution of 4.5 m, to assess the impact of atmospheric emissions from the site on local air quality. This resolution is considered suitable for capturing the maximum process contribution from site emissions.

Human receptors

Discrete receptors considered were chosen based on locations where people may be located and judged in terms of the likely duration of their exposure to pollutants and proximity to the site, following the guidance given in Section 3 of this report. Details of the locations of human receptors are given in Table 3.4 and Figure 3.2.

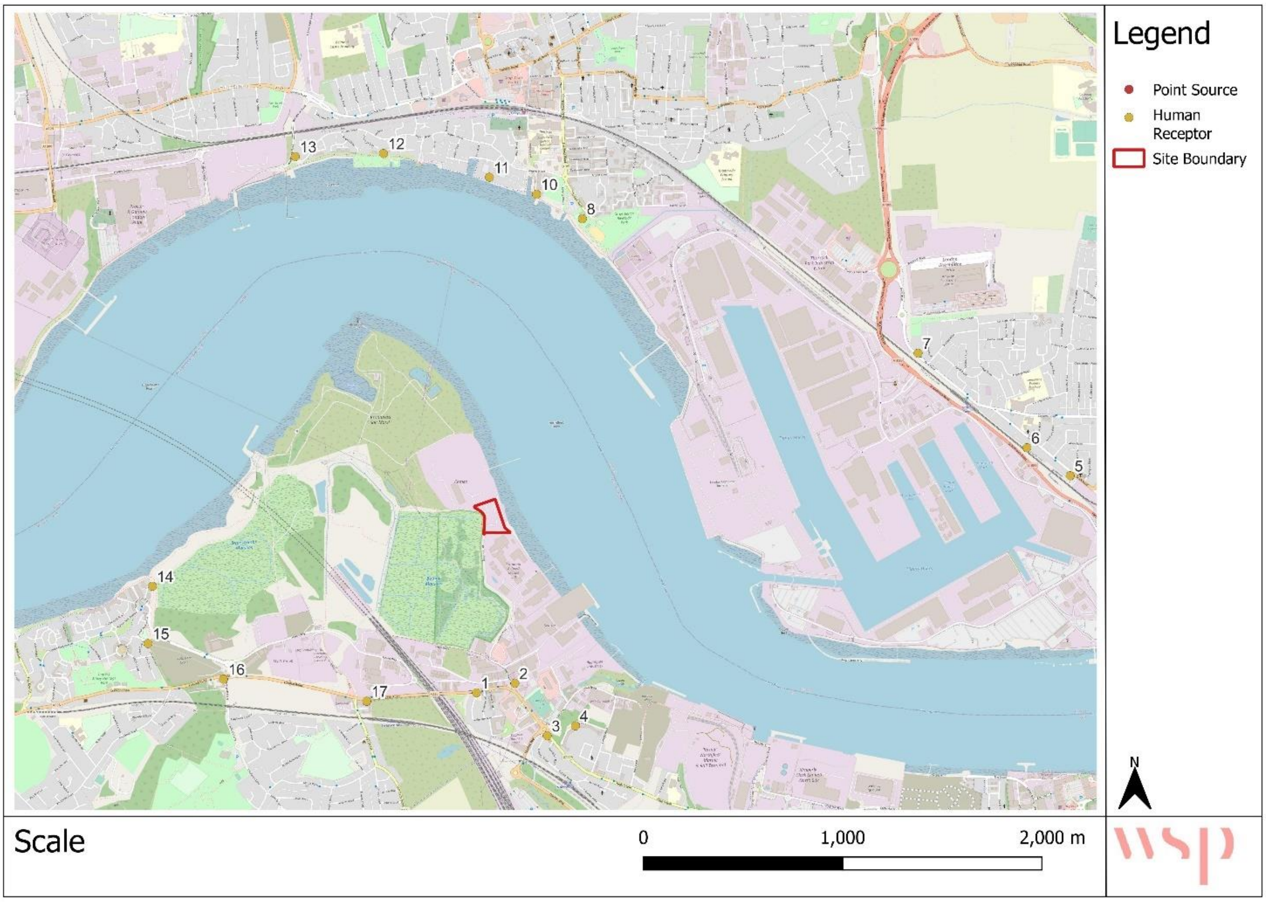
For the purposes of assessing air quality impacts, workplace locations have been excluded from the assessment in accordance with Schedule 1, Part 1, Paragraph 2 of the Air Quality Standards Regulations 2010. These Regulations are detailed in Section 3 of this report and do not differentiate between whether this is a workplace location under the control of the operator, or an off-site workplace location.

Table 3.4 Details of modelled human receptors

ID	Type	X (m)	Y (m)	Z (m)	Distance from Site (m)
R1	School	561147	174897	1.5	950
R2	Residential	561340	174945	1.5	910
R3	Residential	561502	174682	1.5	1,200
R4	Residential	561644	174732	1.5	1,200
R5	Residential	564126	175985	1.5	2,930
R6	Residential	563910	176126	1.5	2,720
R7	Residential	563363	176599	1.5	2,290
R8	Residential	561679	177273	1.5	1,510
R9	Residential	561448	177396	1.5	1,570
R10	Residential	561212	177481	1.5	1,330
R11	Residential	560680	177600	1.5	1,630
R12	Residential	560238	177585	1.5	1,830
R13	Residential	559521	175432	1.5	1,990
R14	Residential	559499	175144	1.5	1,730
R15	Residential	559878	174965	1.5	1,840

ID	Type	X (m)	Y (m)	Z (m)	Distance from Site (m)
R16	Residential	560596	174855	1.5	1,590

Figure 3.2 Location of Modelled Human Receptors



Other treatments

Specialised model treatments, for short-term (puff) releases, coastal models, fluctuations or photochemistry were not used in this assessment.

3.6 Sensitivity analysis and uncertainty

Sensitivity analysis

Wherever possible, this assessment has used worst-case scenarios, which will exaggerate the impact of the emissions on the surrounding area, including emissions, operational profile, ambient concentrations, meteorology and surface roughness. This assessment has considered five years of meteorological data, with data reported from the year(s) predicting the highest ground-level concentrations at the nearest sensitive receptor for comparison with the AQS/AQO/EAL.

Model uncertainty

Process emissions have been modelled under expected operation using the standard steady-state algorithms in ADMS to determine the impact on local human receptors. In order to model atmospheric dispersion using standard Gaussian methods, the following assumptions have to be made and limitations accepted:

- Conservation of mass - the entire mass of emitted pollutant remains in the atmosphere and no allowance is made for loss due to chemical reactions or deposition processes (although the standard Gaussian model can be modified to include such processes, as is the case with ADMS). Portions of the plume reaching the ground are assumed to be dispersed back away from the ground by turbulent eddies (eddy reflection);
- Steady-state emissions - emission rates are assumed to be constant and continuous over the time averaging period of interest; and
- Steady-state meteorology - no variations in wind speed, direction or turbulent profiles occur during transport from the source to the receptor. This assumption is reasonable within a few kilometres of a source but may not be valid for receptor distances in the order of tens of kilometres. For example, for a receptor 50 km from a source and with a wind speed of 5 m s^{-1} it will take nearly three hours for the plume to travel this distance during which time many different processes may change (e.g., the sun may rise or set and clouds may form or dissipate affecting the turbulent profiles). For this reason, Gaussian models are practically limited to predicting concentrations within ~20 km of a source.

As a result of the above, and in combination with other factors, not least attempting to replicate stochastic processes (e.g. turbulence) by deterministic methods, dispersion modelling is inherently uncertain, but is nonetheless a useful tool in plume footprint visualisation and prediction of ground-level concentrations. The use of dispersion models has been widely used in the UK for regulatory and compliance purposes for a number of years and is an accepted approach for this type of assessment.

This assessment has incorporated a number of worst-case assumptions, as described above, which will result in an overestimation of the predicted ground-level concentrations from the process. As a result of these worst-case assumptions, the predicted results should be considered the upper limit of model uncertainty for a scenario where the actual Installation impact is determined. Therefore, the actual predicted ground level concentrations would be expected to be lower than those reported in this assessment and, in some cases, significantly lower.

4. Ambient air quality

4.1 Existing baseline conditions

Mapped background concentrations

Defra maintains a nationwide model (the Pollution Climate Mapping (PCM) model) of existing and future background air quality concentrations at a 1 km grid square resolution. The PCM model is semi-empirical in nature: it uses data from the national atmospheric emissions inventory (NAEI) to model the concentrations of pollutants at the centroid of each 1 km grid square but then calibrates these concentrations in relation to actual monitoring data.

Annual mean background data for PM_{10} and $PM_{2.5}$ for 2022 was obtained from the PCM model. A summary is presented in Table 4.1 showing the mapped annual mean background concentration expected at the site.

Table 4.1 Mapped annual mean background concentration (μgm^{-3})

Pollutant ID	Concentration (μgm^{-3})	Dataset
PM_{10}	14.85	Defra 2022 Dataset
$PM_{2.5}$	10.00	Defra 2022 Dataset

Note: Backgrounds presented were doubled for the assessment of short term impacts.

National monitoring data

Mercury

Mercury is monitored as part of the Heavy Metals Network. London Westminster is the closest monitoring site to the Site. A summary of data used is presented in Table 4.2.

Table 4.2 Metals national monitoring data obtained from London Westminster

Substance	Max Concentration (ng/m^3)	Year
Mercury (Hg)	2.7	2018

Local monitoring data

Continuous monitoring data

Gravesham Borough Council operates two continuous PM monitors within its jurisdiction. The nearest of these is ZG3 which is located 1.7 km away. Table 4.3 shows the location of the automatic monitoring sites, the classification type and the distance from the Site. (see Figure 4.1)

Table 4.3 Automatic monitoring sites operated by Gravesham Borough Council

Site ID	Site Name	Classification	X (m)	Y (m)	Inlet Height (Z) (m)	Distance to Road (m)	Distance to Site (m)
ZG2	Gravesham A2 Roadside	Roadside	562589	172076	3	72	1.7
ZG3	Gravesham Industrial Background	Industrial	562155	174360	3	24	4.0

Figure 4.1 Location of continuous monitors in the vicinity of the Site

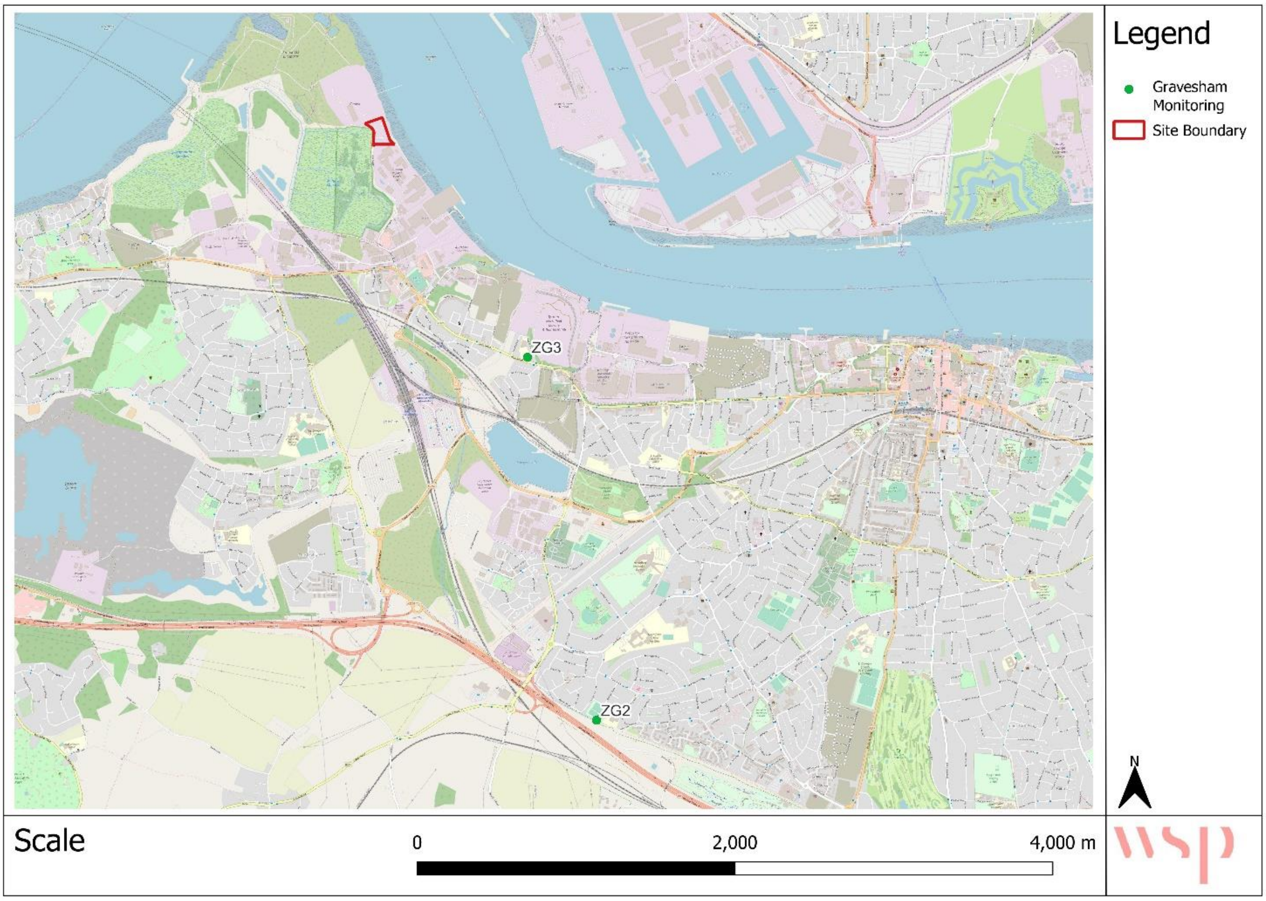


Table 4.4 shows the monitored concentrations of PM_{10} from automatic monitoring sites. The data was obtained from the most recently available Annual Status Report, published by Gravesham Borough Council.

Table 4.4 Summary of automatic PM_{10} monitoring data: Annual Mean (μgm^{-3})

Site ID	2017	2018	2019	2020	2021
ZG2	16.7	15.4	15.3	16.3	16.0
ZG3	19.4	21.9	22.3	21.3	20.6

The data in Table 4.4 shows that annual mean PM_{10} concentrations are below the 40 µgm^{-3} AQO between 2017 and 2021.

Gravesham Borough Council does not undertake monitoring of $PM_{2.5}$ within its jurisdiction.

The annual mean background concentrations for the receptors considered in this assessment have used the maximum value presented in Table 4.1. The annual average process contribution is added to the annual average background concentration to give a total concentration at each receptor location. This total concentration can then be compared against the relevant AQS/AQO and the likelihood of an exceedance determined.

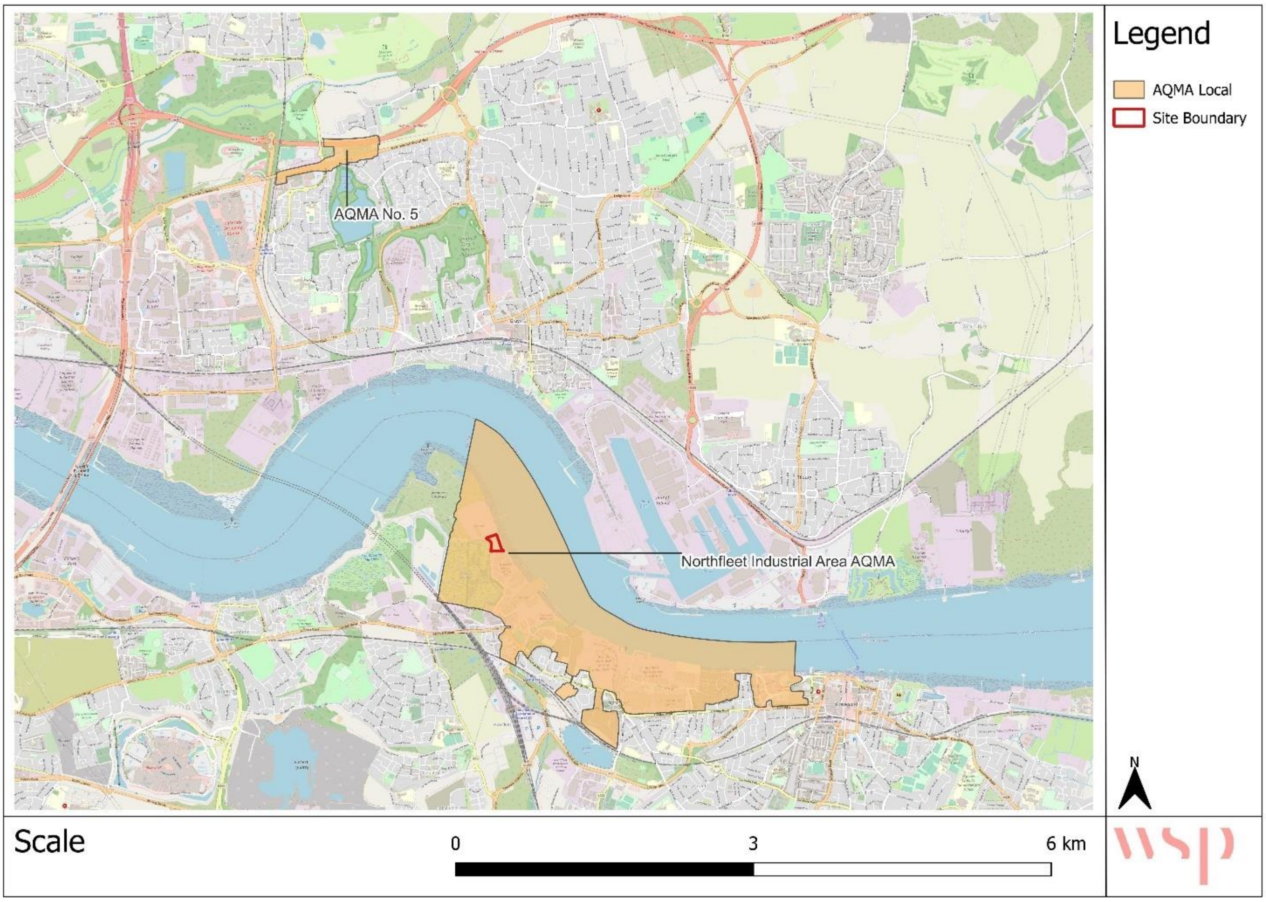
It is not technically rigorous to add predicted short-term or percentile concentrations to ambient background concentrations, since peak contributions from different sources would not necessarily coincide at the same time or at the same location. Without hourly ambient background monitoring data available, it is difficult to make an assessment against the achievement or short-term assessment criteria. For the current assessment, conservative short term ambient levels have been derived by applying a factor of two to the annual mean background data as per the recommendation in the Environmental Agency guidance[2].

Air Quality Management Areas

The Installation lies within the administrative area Gravesham Borough Council. There are currently four Air Quality Management Areas (AQMAs) declared by Gravesham Borough Council. The site is situated within the 'Northfleet Industrial Area AQMA' which has been declared due to exceedances of Annual Mean PM_{10} concentrations. The site is also situated approximately 3.2 km north of 'Gravesham A2 AQMA' which has been declared due to exceedances of 24-hour PM_{10} concentrations. Figure 4.2 shows the AQMAs located within the vicinity of the Site.

[2] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

Figure 4.2 Location of Air Quality Management Areas



5. Assessment of impact

This section sets out the results of the dispersion modelling and compares predicted ground level concentrations against the assessment criteria detailed in Section 3. The predicted concentrations resulting from the process (i.e. the process contribution (PC)) are presented along with background concentrations and the percentage contribution that the predicted environmental concentrations (PEC), would make towards the relevant standard, objective or guideline value.

5.1 Meteorological data sensitivity analysis

As described in Section 0, results were calculated separately for five different years of meteorological data (‘met year’). For each of the specific receptors and for each pollutant measure, the met year giving the highest concentration was determined, and the corresponding concentration is the one presented here. In other words, each of the individual results are the worst case for that measure. For plotting the concentration isopleths, a single met year was chosen, namely the year producing the highest mean concentration at any point in the model domain. This means that some results in the tables of specific receptors will not accord exactly with the contour bandings on the figure (they will be higher in the tables).

5.2 Human Receptors

Table 5.1 presents a summary of the maximum predicted PC at any human receptor for all pollutants modelled.

For all pollutants, the maximum PC is predicted to be less than 1% for long-term averages and less than 10% for short-term averages (Where the PEC is less than 70% of the AQAL), therefore the change in concentration as a result of the modifications proposed is considered to be negligible.

Table 5.1 Impact to air quality at human receptors (Maximum PC)

Pollutant	Averaging Period	AQAL (μgm^{-3})	Receptor at which max PC change occurs	Max PC (μgm^{-3})	Max PEC (μgm^{-3})	Max PC as a % of AQAL	Max PEC as a % of AQAL
PM_{10}	Annual	40	R2	0.02	16.29	0.07	54.31
	24-hour mean, no more than 35 exceedances per year (90.4 percentile)	50	R2	0.08	32.60	0.16	65.21
$PM_{2.5}$	Annual	20	R2	0.02	11.14	0.10	55.70
Hg	Annual	0.25	R2	2.8×10^{-5}	2.7×10^{-3}	0.01	1.08
	1-hour	7.5	R2	1.2×10^{-3}	6.6×10^{-3}	0.02	0.09

6. Conclusion

Emissions associated with the proposed facility will be discharged via a stack to the rear of the process building. An assessment of the impact of emissions to air associated with the facility was undertaken to determine the potential air quality impacts at local receptors.

The impact assessment demonstrated that exceedances of any AQS/AQO/EAL are unlikely at the local receptors identified to protect human health. Therefore, the impact of emissions on human is insignificant.

Appendix A Model Checklist

Item	✓/✗	Reason for Omission
Location map	✓	
Site plan	✓	
List of pollutants modelled and relevant air quality guidelines	✓	
Details of modelled scenarios	✓	
Details of relevant ambient concentrations used	✓	
Model description and justification	✓	
Special model treatments used	✓	
Table of emission parameters used	✓	
Details of modelled domain and receptors	✓	
Details of meteorological data used, including origin, and justification	✓	
Details of terrain treatment	✓	
Details of buildings treatment	✓	
Details of modelling wet/dry deposition	✓	
Sensitivity analysis	✓	
Assessment of impacts	✓	
Model input files	✓	

Appendix B Full Results

Particulate matter (PM_{10})

Predicted concentrations of annual mean PM_{10} are given in Table 6.1. The contour plot of the annual mean PM_{10} PC is given in Figure 6.1. The below table assumes that the facility is operating continuously.

Table 6.1 Annual mean PM_{10} impacts

Receptor	AQS (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	PC (% of AQS)	PEC (% of AQS)
R1	40	0.02	15.50	0.05	51.67
R2	40	0.02	15.50	0.07	51.68
R3	40	0.01	15.50	0.04	51.66
R4	40	0.01	15.50	0.04	51.66
R5	40	<0.01	14.81	0.01	49.37
R6	40	<0.01	16.06	0.01	53.54
R7	40	0.01	16.07	0.04	53.57
R8	40	0.01	15.39	0.03	51.31
R9	40	0.01	15.39	0.02	51.30
R10	40	0.01	15.39	0.02	51.30
R11	40	0.01	15.40	0.02	51.32
R12	40	<0.01	15.39	0.01	51.32
R13	40	0.01	15.34	0.05	51.14
R14	40	0.01	15.34	0.04	51.13
R15	40	0.01	15.84	0.04	52.79
R16	40	0.01	16.29	0.02	54.31

The long-term human receptor experiencing the highest PC is R2 at 0.02% of the AQS. Concentrations at all receptors are within the AQS. PCs at all receptors are below 1% and therefore according to the EA significance criteria impacts are not significant.

Figure 6.1 Annual mean PM_{10} PC contour plot

Predicted concentrations of 90.4th percentile 24-hour mean PM_{10} are given in are given in Table 6.2. The contour plot of the 24-hour mean PM_{10} PC is given in Figure 6.2.

Predicted concentrations at all receptors are within the AQS. The short-term human receptor experiencing the highest PEC is R16, with the PC reported to be 0.06% of the short-term AQS. PCs at all receptors are below 1% and therefore according to the EA significance criteria impacts are not significant.

Table 6.2 90.4th percentile 24-hour mean PM_{10} impacts

Receptor	AQS ($\mu g\ m^{-3}$)	PC ($\mu g\ m^{-3}$)	PEC ($\mu g\ m^{-3}$)	PC (% of AQS)	PEC (% of AQS)
R1	50	0.06	31.03	0.11	62.05
R2	50	0.08	31.05	0.16	62.10
R3	50	0.05	31.02	0.10	62.04
R4	50	0.05	31.02	0.10	62.03
R5	50	0.01	29.63	0.02	59.25
R6	50	0.01	32.13	0.02	64.26
R7	50	0.03	32.15	0.06	64.30

Receptor	AQS (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	PC (% of AQS)	PEC (% of AQS)
R8	50	0.03	30.80	0.06	61.60
R9	50	0.02	30.79	0.04	61.58
R10	50	0.02	30.79	0.04	61.58
R11	50	0.02	30.80	0.04	61.61
R12	50	0.02	30.80	0.03	61.60
R13	50	0.06	30.71	0.12	61.43
R14	50	0.05	30.70	0.10	61.41
R15	50	0.04	31.69	0.08	63.39
R16	50	0.03	32.60	0.06	65.21

Figure 6.2 24-hour mean PM_{10} PC contour plot

Particulate Matter ($PM_{2.5}$)

Predicted concentrations of annual mean $PM_{2.5}$ are given in Table 6.3. The below table assumes that the facility is operating continuously.

Table 6.3 Annual mean $PM_{2.5}$ impacts

Receptor	AQO (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	PC (% of AQO)	PEC (% of AQO)
R1	20	0.02	10.46	0.08	52.32
R2	20	0.02	10.47	0.10	52.34
R3	20	0.01	10.46	0.06	52.30
R4	20	0.01	10.46	0.06	52.30
R5	20	<0.01	10.11	0.02	50.54
R6	20	<0.01	10.65	0.02	53.27
R7	20	0.01	10.66	0.05	53.31
R8	20	0.01	10.40	0.04	52.01
R9	20	0.01	10.40	0.03	51.99
R10	20	0.01	10.40	0.03	51.99
R11	20	0.01	10.50	0.03	52.50
R12	20	<0.01	10.50	0.02	52.50
R13	20	0.01	10.33	0.07	51.67
R14	20	0.01	10.33	0.06	51.67
R15	20	0.01	10.73	0.06	53.63
R16	20	0.01	11.14	0.03	55.70

The long-term human receptor experiencing the highest PC is R2 at 0.1% of the AQO. Concentrations at all receptors are within the AQO. PCs at all receptors are below 1% and therefore according to the EA significance criteria impacts are not significant.

Mercury (Hg)

Table 6.4 Annual mean Hg impacts

Receptor	AQS (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	PC (% of AQS)	PEC (% of AQS)
R1	0.25	2.2×10^{-5}	2.7×10^{-3}	0.01%	1.08%
R2	0.25	2.8×10^{-5}	2.7×10^{-3}	0.01%	1.08%
R3	0.25	1.8×10^{-5}	2.7×10^{-3}	0.01%	1.08%

Receptor	AQS (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	PC (% of AQS)	PEC (% of AQS)
R4	0.25	1.7×10^{-5}	2.7×10^{-3}	0.01%	1.08%
R5	0.25	4.5×10^{-6}	2.7×10^{-3}	<0.01%	1.08%
R6	0.25	5.8×10^{-6}	2.7×10^{-3}	<0.01%	1.08%
R7	0.25	1.5×10^{-5}	2.7×10^{-3}	0.01%	1.08%
R8	0.25	1.2×10^{-5}	2.7×10^{-3}	<0.01%	1.08%
R9	0.25	8.0×10^{-6}	2.7×10^{-3}	<0.01%	1.08%
R10	0.25	7.1×10^{-6}	2.7×10^{-3}	<0.01%	1.08%
R11	0.25	7.2×10^{-6}	2.7×10^{-3}	<0.01%	1.08%
R12	0.25	6.0×10^{-6}	2.7×10^{-3}	<0.01%	1.08%
R13	0.25	2.1×10^{-5}	2.7×10^{-3}	0.01%	1.08%
R14	0.25	1.8×10^{-5}	2.7×10^{-3}	0.01%	1.08%
R15	0.25	1.6×10^{-5}	2.7×10^{-3}	0.01%	1.08%
R16	0.25	1.0×10^{-5}	2.7×10^{-3}	0.00%	1.08%

Table 6.5 1-hour mean Hg impacts

Receptor	AQS (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	PC (% of AQS)	PEC (% of AQS)
R1	7.5	0.001	0.006	0.01%	0.08%
R2	7.5	<0.001	0.007	<0.01%	0.08%
R3	7.5	<0.001	0.006	<0.01%	0.08%
R4	7.5	0.001	0.006	0.01%	0.08%
R5	7.5	0.001	0.006	0.01%	0.08%
R6	7.5	0.001	0.006	0.01%	0.08%
R7	7.5	0.001	0.006	0.01%	0.08%
R8	7.5	<0.001	0.006	0.01%	0.08%
R9	7.5	<0.001	0.006	0.01%	0.08%
R10	7.5	0.001	0.006	0.01%	0.08%

Receptor	AQS (µg m^{-3})	PC (µg m^{-3})	PEC (µg m^{-3})	PC (% of AQS)	PEC (% of AQS)
R11	7.5	0.001	0.006	0.01%	0.08%
R12	7.5	0.001	0.006	0.01%	0.08%
R13	7.5	0.001	0.006	0.01%	0.09%
R14	7.5	0.001	0.006	0.01%	0.08%
R15	7.5	<0.001	0.006	<0.01%	0.08%
R16	7.5	<0.001	0.006	<0.01%	0.08%

Appendix C Stack Height Assessment

Stack heights of 3, 4.5 and 6 m were assessed. For each stack height assessed, predicted concentrations of pollutants at all human receptors assessed were found to be below the relevant standards and objectives for each respective pollutant and averaging periods. Table B.1 presents the results of the stack height assessment, using annual average PM_{10} averaging period as an example.

The modelling was undertaken based on an outline design and predicted air quality impacts at offsite locations, concluding that air quality effects are not a constrain to the stack height assessment.

Table B.1 Annual Mean PM_{10} – Maximum annual average PM_{10} concentrations at any human receptor

Stack Height (m)	PC (mg m^{-3})	% PC of AQS	PEC (mg m^{-3})	% PEC of AQS
3	0.01	0.04	15.50	38.75
4.5	0.01	0.04	15.50	38.75
6	0.01	0.04	15.50	38.75

Appendix D Sensitivity testing

The model sensitivity testing for this scheme includes the models for 2019, the year with the highest grid concentration.

Surface Roughness

Table C.2 presents a comparison of the main assessment results (with a surface roughness at 1 m) for the annual mean PM_{10} against model runs with the surface roughness set at 1.5 m. The results indicate that there are no significant changes in predicted concentrations with varying the surface roughness.

Table C.2 Annual Mean PM_{10} – Surface Roughness

Receptor	Surface Roughness at 1 m		Surface Roughness at 1.5	
	PC (μgm^{-3})	% PC of AQS	PC (μgm^{-3})	% PC of AQS
R1	0.01	0.03	0.01	0.02
R2	0.02	0.05	0.01	0.03
R3	0.01	0.03	0.01	0.02
R4	0.01	0.03	0.01	0.02
R5	<0.01	0.01	<0.01	0.01
R6	<0.01	0.01	<0.01	0.01
R7	0.01	0.02	0.01	0.02
R8	0.01	0.02	0.01	0.02
R9	0.01	0.01	0.01	0.01
R10	<0.01	0.01	<0.01	0.01
R11	<0.01	0.01	<0.01	0.01
R12	<0.01	0.01	<0.01	0.01
R13	0.01	0.03	0.01	0.03
R14	0.01	0.03	0.01	0.03
R15	0.01	0.03	0.01	0.02
R16	0.01	0.02	<0.01	0.01

Buildings

Table C.3 presents a comparison of the main assessment results (with buildings included) for the annual mean PM_{10} against model runs with no buildings. The results indicate that there are no significant changes in predicted concentrations with varying absence of buildings in the model.

Table C.3 Annual Mean PM_{10} – Buildings

Receptor	With Buildings		Without Buildings	
	PC (μgm^{-3})	% PC of AQS	PC (μgm^{-3})	% PC of AQS
R1	0.01	0.03	0.01	0.03
R2	0.02	0.05	0.02	0.05
R3	0.01	0.03	0.01	0.03
R4	0.01	0.03	0.01	0.04
R5	<0.01	0.01	<0.01	0.01
R6	<0.01	0.01	<0.01	0.01
R7	0.01	0.02	0.01	0.03
R8	0.01	0.02	0.01	0.03
R9	0.01	0.01	0.01	0.02
R10	<0.01	0.01	0.01	0.01
R11	<0.01	0.01	<0.01	0.01
R12	<0.01	0.01	<0.01	0.01
R13	0.01	0.03	0.01	0.03
R14	0.01	0.03	0.01	0.03
R15	0.01	0.03	0.01	0.03
R16	0.01	0.02	0.01	0.02

Terrain

Table C.3 presents a comparison of the main assessment results (with terrain included) for the annual mean PM_{10} against model runs with no terrain. The results indicate that there are no significant changes in predicted concentrations with the absence of terrain data in the model.

Table C.4 Annual Mean PM_{10} – Terrain

Receptor	With Buildings		Without Buildings	
	PC (μgm^{-3})	% PC of AQS	PC (μgm^{-3})	% PC of AQS
R1	0.01	0.03	0.01	0.03
R2	0.02	0.05	0.02	0.04
R3	0.01	0.03	0.01	0.03
R4	0.01	0.03	0.01	0.03
R5	<0.01	0.01	<0.01	0.01
R6	<0.01	0.01	<0.01	0.01
R7	0.01	0.02	0.01	0.02
R8	0.01	0.02	0.01	0.03
R9	0.01	0.01	0.01	0.01
R10	<0.01	0.01	<0.01	0.01
R11	<0.01	0.01	<0.01	0.01
R12	<0.01	0.01	<0.01	0.01
R13	0.01	0.03	0.01	0.02
R14	0.01	0.03	0.01	0.02
R15	0.01	0.03	0.01	0.03
R16	0.01	0.02	0.01	0.02

wsp.com