FICHTNER

Consulting Engineers Limited

Medway Energy Recovery Limited

Dispersion Modelling Assessment

ENGINEERING CONSULTING

Document approval

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Management Summary

Fichtner Consulting Engineers Ltd (Fichtner) has been engaged by Medway Energy Recovery Limited to undertake a Dispersion Modelling Assessment to support the application for an Environmental Permit (EP) for the MedwayOne Energy Hub (the Facility). Full details of the Facility can be found in the Supporting Information document submitted with this application.

1) Dispersion Modelling of Emissions

The ADMS dispersion model is routinely used for air quality assessments to the satisfaction of the Environment Agency (EA). The model uses weather data from the local area to predict the spread and movement of the exhaust gases from the stack for each hour over a five-year period. The model takes account of wind speed, wind direction, temperature, humidity and the amount of cloud cover, as all of these factors influence the dispersion of emissions. The model also takes account of the effects of buildings and terrain on the movement of air.

To set up the model, it has been assumed that the Facility operates for the whole year and releases emissions at the emission limits compliant with the BAT-AELs set out in the Waste Incineration BREF for new plants. The model has been used to predict the ground level concentration of pollutants on a long-term and short-term basis across a grid of points. In addition, concentrations have been predicted at the identified sensitive receptors.

2) Approach and Assessment of Impact on Air Quality – Protection of Human Health

The air quality impact of the Facility on human health has been assessed using a standard approach based on guidance provided by the EA. Using this approach, in relation to the Air Quality Assessment Levels (AQALs) set for the protection of human health the following can be concluded from the assessment.

1. Emissions from the operation of the Facility will not cause a breach of any AQAL.
2. The overall impact of long-term and short-term process emissions associated with the operation of the Facility can be screened out as ‘insignificant’ or ‘not significant’ in accordance with the EA’s screening criteria at the point of maximum impact and at all identified human sensitive receptors.
3. When considered cumulatively with potential emissions from the permitted but not yet constructed Damhead Creek II power station, there is no risk of exceedance of any AQAL and no significant in-combination impacts are predicted.

3) Approach and Assessment of Impact on Air Quality – Protection of Ecosystems

The impact of air quality on ecology has been assessed using a standard approach based on guidance provided by the EA. Using this approach, in relation to the Critical Level and Critical Loads set for the protection of ecology it can be concluded that all of the impacts at ecological features can be screened out as ‘insignificant’ or ‘not significant’ except for airborne ammonia and nitrogen deposition impacts at the Medway Estuary SPA/Ramsar site/SSSI, and nitrogen deposition impacts on saltmarsh habitats at the Medway Estuary SPA/Ramsar site/SSSI and the Thames Estuary SPA/Ramsar site/SSSI. Further analysis undertaken by the project ecologist has concluded no significant effects are likely, either alone or cumulatively with emissions from the Damhead Creek II power station.

4) Summary and Conclusions

The assessment has shown that emissions from the Facility would not result in a breach of any AQAL and would not have a significant impact on local air quality, the general population or the local community, either alone or in-combination with other plans and projects. As such, there should be no air quality constraint in granting an EP to operate.

Contents

1 Introduction

1.1 Background

Fichtner Consulting Engineers Ltd (Fichtner) has been engaged by Medway Energy Recovery Limited to undertake a Dispersion Modelling Assessment to support the application for an Environmental Permit (EP) for the MedwayOne Energy Hub (the Facility). The Facility will comprise a twin line waste incineration plant and associated infrastructure, processing mainly refuse derived fuel (RDF) and solid recovered fuel (SRF). The design thermal capacity of the Facility is 83 MWth per line (166 MWth aggregated). The location of the Facility is shown on Figure 1.

When considering the impact on human health, the predicted atmospheric concentrations have been compared to the Air Quality Assessment Levels (AQALs) for the protection of human health. It is noted that for some pollutants such as metals and dioxins they have the potential to accumulate within the environment. A separate Dioxin Pathway Intake Assessment has been undertaken to assess the pathway intake of these pollutants and impacts compared to the Tolerable Daily Intakes (TDIs).

When considering the impact on ecosystems the predicted atmospheric concentrations have been compared to the Critical Levels for the protection of ecosystems. It is noted that deposition of emissions over a prolonged period can have nutrification and acidification impacts. An assessment of the long-term deposition of pollutants has been undertaken and the results compared to the habitat specific Critical Loads.

One cumulative development, the Damhead Creek II power station, has been identified which could give rise to a cumulative environmental effects when considering process emissions from the Facility. Consideration has been given to the cumulative impact.

1.2 Structure of the report

This report has the following structure.

- Air quality legislation and guidance are considered in section 2.
- The assessment criteria used are described in section 3.
- The baseline levels of ambient air quality are described in section 4.
- The residential properties and ecological receptors which are sensitive to changes in air quality associated with the operation of the Facility and identified in section 5.
- The inputs used for the dispersion model are contained in section 6
- Details of the sensitivity analysis carried out is presented in section 7.
- The assessment methodology and results of the assessment of the impact of emissions on human health is presented in section 8.
- The assessment methodology and results of the assessment of the impact of emissions at ecological sites is presented in section 9.
- The assessment of cumulative schemes is presented in section 10.
- The conclusions of the assessment are set out in section 11.
- The Appendices include illustrative figures and detailed results tables.

2 Legislation Framework and Policy

2.1 Air quality assessment levels

In the UK, Ambient Air Directive (AAD) Limit Values, Targets, and air quality standards and objectives for major pollutants are described in The Air Quality Strategy (AQS). In addition, the Environment Agency include Environmental Assessment Levels (EALs) for other pollutants in the environmental management guidance 'Air Emissions Risk Assessment for your Environmental Permit'[1] ("Air Emissions Guidance"), which are also considered. The long-term and short-term EALs from these documents have been used when the AQS does not contain relevant objectives. Standards and objectives for the protection of sensitive ecosystems and habitats are also contained within the Air Emissions Guidance and the Air Pollution Information System (APIS).

AAD Target and Limit Values, AQS Objectives, and EALs are set at levels well below those at which significant adverse health effects have been observed in the general population and in particularly sensitive groups. For the remainder of this report these are collectively referred to as AQALs.

Table 1 to Table 3 summarise the AQALs used in this assessment.

Table 1: Air Quality Assessment Levels (AQALs)

Pollutant	AQAL (µg/m³)	Averaging Period	Frequency of Exceedances	Source
Nitrogen dioxide	200	1 hour	18 times per year (99.79th percentile)	AAD Limit Value
	40	Annual	-	AAD Limit Value
Sulphur dioxide	266	15 minutes	35 times per year (99.9th percentile)	AQS Objective
	350	1 hour	24 times per year (99.73rd percentile)	AAD Limit Value
	125	24 hours	3 times per year (99.18th percentile)	AAD Limit Value
Particulate matter (PM_{10})	50	24 hours	35 times per year (90.41st percentile)	AQS Objective
	40	Annual	-	AQS Objective
Particulate matter ($PM_{2.5}$)	20	Annual	-	AQS Target
	10	Annual		Environmental Targets (fine particulate matter) (England) regulations 2023

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

Pollutant	AQAL (µg/m³)	Averaging Period	Frequency of Exceedances	Source
Carbon monoxide	10,000	8 hours, running	-	AAD Limit Value
	30,000	1 hour	-	Air Emissions Guidance
Hydrogen chloride	750	1 hour		Air Emissions Guidance
Hydrogen fluoride	160	1 hour	-	Air Emissions Guidance
	16	Annual	-	Air Emissions Guidance
Ammonia	2,500	1 hour	-	Air Emissions Guidance
	180	Annual	-	Air Emissions Guidance
Benzene	5	Annual	-	Air Emissions Guidance
	30	24 hours	-	Air Emissions Guidance
PCBs	6	1-hour	-	Air Emissions Guidance
	0.2	Annual	-	Air Emissions Guidance
PAHs	0.00025	Annual	-	AQS Objective

Table 2: Air Quality Assessment Levels for Metals

Pollutant	AQAL (ng/m³)	Averaging Period	Source
Cadmium	30	24 hour	Air Emissions Guidance
	5	Annual	AAD Target Value
Mercury	600	1 hour	Air Emissions Guidance
	60	24 hour	Air Emissions Guidance
	-	Annual	-
Antimony	150,000	1 hour	Air Emissions Guidance
	5,000	Annual	Air Emissions Guidance
Arsenic	-	1 hour	-
	6	Annual	Air Emissions Guidance
Chromium (III)	2,000	24 hour	Air Emissions Guidance
	-	Annual	-
Chromium (VI)	-	1 hour	-
	0.25	Annual	Air Emissions Guidance
Copper	50	24 hour	Air Emissions Guidance
	-	Annual	-
Lead	-	1 hour	-
	250	Annual	AQS Target
Manganese	1,500,000	1 hour	Air Emissions Guidance
	150	Annual	Air Emissions Guidance
Nickel	700	1 hour	Air Emissions Guidance

Pollutant	AQAL (ng/m^3)	Averaging Period	Source
	20	Annual	AAD Limit
Vanadium	1,000	24 hours	Air Emissions Guidance
	-	Annual	-

Table 3: Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	Concentration (µg/m^3)	Measured as	Source
Nitrogen oxides (as nitrogen dioxide)	75/200*	Daily mean	APIS
	30	Annual mean	AAD Critical Level
Sulphur dioxide	10	Annual mean where lichens and bryophytes are an important part of the ecosystem's integrity	Air Emissions Guidance / APIS
	20	Annual mean for all higher plants	AAD Critical Level
Hydrogen fluoride	5	Daily mean	Air Emissions Guidance / APIS
	0.5	Weekly mean	Air Emissions Guidance / APIS
Ammonia	1	where lichens and bryophytes are an important part of the ecosystem's integrity	APIS
	3	Annual mean for all higher plants	APIS

Note:
**only for detailed assessments where the ozone is below the AOT40 Critical Level and sulphur dioxide is below the lower Critical Level of 10 µg/m^3.*
The *AOT40 for ozone is 3,000 ppb.h (6,000 µg/m^3.h) calculated from accumulated hourly ozone concentrations – AOT40 means the sum of the difference between each hourly daytime (08:00 to 20:00 Central European Time, CET) ozone concentration greater than 80 µg/m^3 (40 ppb) and 80 µg/m^3, for the period between 01 May and 31 July.*

In the first instance the lower Critical Level for oxides of nitrogen of 75 µg/m^3 will be applied as a conservative measure, and consideration will be given to the applicability of the higher Critical Level if it is considered that there is a risk of exceedance of the Lower Critical Level.

In addition to the Critical Levels set out in the table above, APIS provides habitat specific Critical Loads for nitrogen and acid deposition. Full details of the habitat specific Critical Loads can be found in Appendix B.

2.2 Areas of relevant exposure

The AQALs apply only at areas of exposure relevant to the assessment level. The following table extracted from Local Authority Air Quality Technical Guidance (2022) (LAQM.TG(22))[2] explains where the AQALs apply.

Table 4: Guidance on Where AQALs Apply

Averaging period	AQALs should apply at:	AQALs should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades 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 mean and 8-hour mean	All locations where the annual mean AQAL 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 AQALs apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc., which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

Source: Box 1-1, Local Air Quality Management Technical Guidance (TG22), Defra, August 2022

2 Department for Environment, Food and Rural Affairs, Local Air Quality Management Technical Guidance (TG22), August 2022, available at: https://laqm.defra.gov.uk/wp-content/uploads/2022/08/LAQM-TG22-August-22-v1.0.pdf

2.3 Industrial pollution regulation

The Industrial Emissions Directive (IED) (Directive 2010/75/EU), adopted on 7th January 2013, is the key European Directive which covers almost all regulation of industrial processes in the EU. Within the IED, the requirements of the relevant sector Best Available Techniques Reference Document (BREF) become binding as BAT guidance, as follows.

- Article 15, paragraph 2, of the IED requires that Emission Limit Values (ELVs) are based on best available techniques, referred to as BAT.
- Article 13 of the IED, requires that 'the Commission' develops BAT guidance documents (referred to as BREFs).
- Article 21, paragraph 3, of the IED, requires that when updated BAT conclusions are published, the Competent Authority (in England this is the EA) has up to four years to revise permits for facilities covered by that activity to comply with the requirements of the sector specific BREF.

The Waste incineration (WI) BREF was adopted by the European IPPC Bureau in December 2019, and implemented by the EA in December 2023. The WI BREF introduces BAT-Associated Emission Limits (BAT-AELs) which are more stringent than the ELVs currently set out in the IED. It has been assumed that emissions from the Facility will comply with the upper end of the BAT-AEL range for each pollutant, except where otherwise stated.

2.4 Local air quality management

In accordance with Section 82 of the Environment Act (1995) (Part IV), local authorities are required to periodically review and assess air quality within their area of jurisdiction, under the system of Local Air Quality Management (LAQM). This review and assessment of air quality involves assessing present and likely future ambient pollutant concentrations against AQALs. If it is predicted that levels at the façade of buildings where members of the public are regularly present (normally residential properties) are likely to be exceeded, then the local authority is required to declare an AQMA. For each AQMA, the local authority is required to produce an AQAP, the objective of which is to reduce pollutant levels in pursuit of the relevant AQALs.

3 Assessment Criteria

3.1 Human health

The Air Emissions Guidance states that to screen out 'insignificant' PCs:

- *the long-term PC must be less than 1% of the long-term environmental standard; and*
- *the short-term PC must be less than 10% of the short-term environmental standard.*

As part of this assessment, predicted PCs have been compared to the AQALs detailed in section 2.1.

If the above criteria are achieved, it can be concluded that it is not likely that emissions would lead to significant environmental impacts and the PCs can be screened out.

The long-term 1% PC threshold is based on the judgement that:

- it is unlikely that an emission at this level will make a significant contribution to air quality; and
- the threshold provides a substantial safety margin to protect health and the environment.

The short-term 10% PC threshold is based on the judgement that:

- spatial and temporal conditions mean that short-term PCs are transient and limited in comparison with long-term PCs; and
- the threshold provides a substantial safety margin to protect health and the environment.

For the purpose of this assessment, if the impact can be screened out as 'insignificant' at the point of maximum impact, further assessment is not required. If PCs cannot be screened out, assessment will be undertaken for the following:

- the Predicted Environmental Concentration (PEC, defined as the PC plus the background concentration) at the point of maximum impact; and
- the PC and PEC at areas of public exposure.

If the long-term PEC is below 70% of the AQAL, or the short-term PC is less than 20% of the headroom[3], it can be concluded that "there is little risk of the PEC exceeding the AQAL", and the impact can be considered 'not significant'.

For the assessment of group 3 metals, guidance taken from the EA document 'Guidance on assessing group 3 metals stack emissions from incinerators – V.4 June 2016' ('EA metals guidance') has been used. The EA metals guidance states that where the process contribution for any metal exceeds 1% of the long term or 10% of the short term environmental standard (in this case the AQAL), this is considered to have potential for significant pollution. Where the process contribution exceeds these criteria, the PEC should be compared to the AQAL. The PEC can be screened out if is less than the AQAL. Where the impact is within these parameters it can be concluded that there is no significant risk of exceeding the AQAL.

3.2 Ecology

The Air Emissions Guidance states that to screen out impacts as 'insignificant' at European and UK statutory designated sites:

- the long-term PC must be less than 1% of the long-term environmental standard (i.e., the Critical Level or Load); and

[3] Calculated as the AQAL minus twice the long-term background concentration.

- the short-term PC must be less than 10% of the short-term environmental standard.

If the above criteria are met, no further assessment is required. If the long-term PC exceeds 1% of the long-term environmental standard, the PEC must be calculated and compared to the standard. If the resulting PEC is less than 70% of the long-term environmental standard, the Air Emissions Guidance states that the emissions are 'insignificant' and further assessment is not required. In accordance with the guidance, calculation of the PEC for short-term standards is not required.

The Air Emissions Guidance states further that to screen out impacts as 'insignificant' at local nature sites[4]:

- the long-term PC must be less than 100% of the long-term environmental standard; and
- the short-term PC must be less than 100% of the short-term environmental standard.

In accordance with the guidance, calculation of the PEC for local nature sites is not required.

[4] Ancient woodlands, local wildlife sites and national and local nature reserves.

4 Baseline Air Quality

This section presents a review of the baseline air quality and defines appropriate baseline concentrations to be used within this assessment.

The Facility is located on the site of the former Kingsnorth Power Station, near Hoo St Werburgh, Kent within the administrative area of Medway Council (MC).

The Damhead Creek Power Station, a natural gas-fired combined cycle gas turbine power station, is located close to the north of the Facility. This power station has been operational since 2001 and its contribution to local air pollution is included in modelled and monitored baseline concentrations. As such, it is not considered necessary to explicitly model emissions from this source.

4.1 Air quality review and assessment

There are two AQMAs within 5 km of the Facility. These are summarised in Table 5.

Table 5: Air Quality Management Areas

AQMA name	Local authority	Reason for declaration	Distance from Facility (km)
Pier Road Gillingham AQMA	Medway Council	Annual mean nitrogen dioxide from road transport emissions	4.2
Four Elms Hill Chattenden AQMA	Medway Council	Annual mean nitrogen dioxide from road transport emissions	4.7

Due to the distance from the Facility it is considered that the impact of process emissions from the Facility within these AQMAs will be negligible. However, the impact in these AQMAs has been quantified as part of this assessment for completeness.

4.2 National modelling – mapped background data

In order to assist local authorities with their responsibilities under Local Air Quality Management, the Department for Environment Food and Rural Affairs (Defra) provides modelled background concentrations of pollutants across the UK on a 1 km by 1 km grid. This model is based on known pollution sources and background measurements and is used by local authorities in lieu of suitable monitoring data. Mapped background concentrations have been downloaded for the grid squares containing the Site and immediate surroundings. In addition, mapped atmospheric concentrations of ammonia are available from Defra via the National Environment Research Council (NERC) Centre for Ecology and Hydrology (CEH) throughout the UK.

The mapped background data is calibrated against monitoring data. For instance, the most recently available data, the 2018 mapped background concentrations, are based on 2018 meteorological data and are calibrated against monitoring undertaken in 2018. As a conservative approach where mapped background data is used the concentration for the year against which the data was validated has been used. This eliminates any potential uncertainties over anticipated trends in future background concentrations.

Concentrations will vary over the modelling domain area. Therefore, the maximum mapped background concentration from within 5 km of the Facility has been calculated, as presented in Table 6, together with the concentration at the Facility.

Table 6: Mapped Background Data

Pollutant	Annual mean concentration (µg/m³)		Dataset
	At site	Max within 5 km of site	
Nitrogen dioxide	12.78	20.76	Defra 2018 Dataset
Sulphur dioxide	11.80	36.20	Defra 2001 Dataset
Particulate matter (as PM_{10})	14.15	19.60	Defra 2018 Dataset
Particulate matter (as $PM_{2.5}$)	9.62	14.29	Defra 2018 Dataset
Carbon monoxide	300	439	Defra 2001 Dataset
Benzene	0.54	1.03	Defra 2001 Dataset
Ammonia	0.55	1.00	Defra (CEH) 2014

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4.3 AURN and LAQM monitoring data

Monitoring locations are broadly classified into 'roadside' and 'background' locations. 'Background' locations are typically sited so that no single pollutant source is dominant and are intended to be representative of background concentrations over several square kilometres. 'Roadside' sites are dominated by road traffic emissions and only representative of concentrations in the immediate vicinity of the analyser. This analysis has considered monitoring sites within 5 km of the Facility.

The UK Automatic Urban and Rural Network (AURN) is a country-wide network of air quality monitoring stations operated on behalf of Defra. This includes automatic monitoring of nitrogen dioxide and particulate matter. In addition, non-automatic (diffusion tube) monitoring of benzene is co-located with a number of AURN sites.

The nearest AURN monitoring station is Rochester Stoke, a rural background site located 4.3 km north-east of the Facility. No other AURN monitoring locations lie within 5 km of the Facility. The Rochester Stoke site measures several pollutants relevant to this assessment. The most recent five years of monitoring data is presented in Table 7, along with the mapped background concentration for the grid square containing the analyser.

Table 7: AURN Monitoring – Rochester Stoke

Pollutant	2018 mapped Bg (µg/m³)	Annual mean concentration (µg/m³)				
		2018	2019	2020	2021	2022
Nitrogen dioxide	12.4	13	13	10	11	11
Sulphur dioxide	9.0(1)	1	1	1	1	1
PM_{10}	15.8	17	15	15	15	16
$PM_{2.5}$	9.9	10	11	10	10	11

Note:
(1) Sulphur dioxide mapped background taken from 2001-based background map.

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As shown, with the exception of sulphur dioxide, the mapped background concentration is very similar to the monitored concentration. The monitored concentrations of sulphur dioxide are much lower than the mapped background concentration. According to the National Atmospheric

Emissions Inventory (NAEI), emissions of sulphur dioxide in the UK have decreased by 96% since 1990. As such, the monitored concentration is much more likely to be representative of the actual baseline concentrations in the vicinity of the Facility.

Aside from AURN sites, MC does not have any continuous monitoring sites within their jurisdiction. However, they do undertake non-automatic (diffusion tube) monitoring for nitrogen dioxide at various sites across the district. Four of these sites are within 5 km of the Facility and a further four are located just over 5 km away, within or very close to the AQMAs detailed in Table 5. These have been included in the review of baseline concentrations for completeness.

A summary of monitoring data from the non-automatic (diffusion tube) sites is provided in Table 8. The latest available data (2017 -2021) has been taken from the 2022 MC Local Air Quality Monitoring (LAQM) Annual Status Report. This is the most recent report available at the time of writing this assessment. Exceedances of the annual mean AQAL of 40 µg/m³ are highlighted.

Table 8: Summary of non-automatic nitrogen dioxide monitoring data within 5 km of the Site

ID	Distance from Site (km)	2018 Mapped Bg (µg/m³)	Annual mean concentration (µg/m³)				
			2017	2018	2019	2020	2021
Background Monitoring							
DT13(1)	4.3	12.4	13.8	13.1	13.1	10.0	12.3
Roadside Monitoring							
DT22	5.6	18.0	31.0	28.0	27.2	23.4	25.9
DT24	5.2	18.0	**50.8**	**47.4**	**53.2**	**44.5**	**45.7**
DT25	4.5	20.8	**42.9**	37.9	35.8	29.1	27.9
DT26	4.5	16.8	28.1	27.9	24.4	19.0	20.5
DT27	4.5	20.8	39.1	35.6	34.1	26.6	31.4
DT32	5.2	18.0	**47.5**	**46.3**	**43.1**	38.9	38.1
DT33	5.1	18.0	**43.5**	**41.6**	**42.0**	36.6	36.9
Note:							
(1) DT13 is co-located with the Rochester Stoke AURN monitoring location.							

Source: Medway Council 2022 LQAM Annual Status Report (June 2022) and © Crown 2023 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

All of the roadside sites are located in or very close to the AQMAs detailed in Table 5. Several of these roadside sites have recorded exceedances of the annual mean AQAL over the last five years of available monitoring data, although there is an overall decreasing trend in concentrations evident.

The concentrations measured at the roadside sites are not representative of baseline concentrations across the modelling domain. The maximum mapped background concentrations of nitrogen dioxide, PM_{10}, and $PM_{2.5}$ from within the modelling domain (presented in Table 6) are higher than the concentrations monitored at the Rochester Stoke AURN site and co-located diffusion tube. As a conservative measure the maximum mapped background concentrations of these pollutants from within the modelling domain have been used as the baseline concentrations in the first instance.

As noted above, the sulphur dioxide concentration monitored at the Rochester Stoke AURN site is much lower than the mapped background concentration, and much more likely to be representative of the actual baseline concentration in the vicinity of the Facility. Therefore, the maximum monitored concentration from the last 5 years of monitoring data has been used as the baseline concentration for this assessment.

The choice of baseline concentrations of each pollutant will be considered further if the impact of the Facility cannot be screened out as 'insignificant'.

4.4 National monitoring data

4.4.1 Hydrogen chloride

Hydrogen chloride was measured until the end of 2015 on behalf of Defra as part of the UK Eutrophying and Acidifying Atmospheric Pollutants (UKEAP) project. This consolidates the previous Acid Deposition Monitoring Network (ADMN), and National Ammonia Monitoring Network (NAMN). Monitoring of hydrogen chloride ceased at the end of 2015 and none of the historic sites were located within 10 km of the Facility. Prior to the cessation of the monitoring concentrations were fairly constant.

The maximum annual average monitored within the UK between 2011 and 2015 was 0.71 µg/m^3. In lieu of any recent representative monitoring this has been used as the baseline concentration for this assessment as a conservative estimate.

4.4.2 Hydrogen fluoride

Baseline concentrations of hydrogen fluoride are not measured locally or nationally, since these are not generally of concern in terms of local air quality. However, the EPAQS report 'Guidelines for halogens and hydrogen halides in ambient air for protecting human health against acute irritancy effects' contains some estimates of baseline levels, reporting that measured concentrations have been in the range of 0.036 µg/m^3 to 2.35 µg/m^3.

In lieu of any local monitoring, the maximum measured baseline hydrogen fluoride concentration has been used for the purpose of this assessment as a conservative estimate.

4.4.3 Ammonia

Ammonia is also measured as part of the UKEAP project at rural background locations. There are no UKEAP monitoring locations within 10 km of the Facility. The nearest monitoring site is at Detling located 13 km to the south. The maximum monitored concentration at Detling over the last 5 years of monitoring data is 1.2 µg/m^3 in 2019 (although data capture was low at 41%), while 1.1 µg/m^3 was recorded in 2020 with a 76% data capture rate. These values are similar to the maximum mapped background concentration from within the modelling domain presented in Table 6. The maximum monitored value with data capture >75% (1.1 µg/m^3) has been used as the baseline concentration for the assessment of human health.

Location-specific baseline data for the assessment of effects on ecological habitats has been obtained from APIS where the impact cannot be screened out as 'insignificant'. This analysis is presented in section 9.2.

4.4.4 Volatile Organic Compounds

As part of the Automatic and Non-Automatic Hydrocarbon Network, benzene concentrations are measured at sites co-located with the AURN across the UK. There are no background benzene monitoring locations within 10 km of the Site. The closest background monitoring site is the London Bloomsbury urban background site in central London approximately 50 km to the west. Concentrations at this site would not be representative of the baseline concentrations in the vicinity of the Facility.

In lieu of any local monitoring of benzene, the maximum mapped background concentration within the modelling domain (1.03 µg/m³, as presented in Table 6) will be used as the baseline concentration.

4.4.5 Metals

Metals are measured as part of the Rural Metals and UK Urban/Industrial Networks (previously the Lead, Multi-Element and Industrial Metals Networks). The nearest monitoring sites are at Detling, a rural background site approximately 13 km to the south, and Chadwell St Mary, an urban background site approximately 17 km to the west. No significant sources of metals have been identified in close proximity to either of these monitoring sites, or the Facility. As the Facility is located in a rural area, the monitoring data from Detling is considered to be most representative of likely baseline concentrations of metals in the vicinity of the Facility.

A summary of the most recent 5 years of monitored data from the Detling monitoring site is presented in the following table.

Table 9: Metals Monitoring – Detling

Substance	Annual mean concentration (ng/m³)						Max (as % of AQAL)
	AQAL	2018	2019	2020	2021	2022	
Cadmium	5	0.19	0.15	0.12	0.13	0.11	3.80%
Arsenic	6	0.93	0.81	0.72	0.74	0.67	15.50%
Chromium	-	1.50	1.30	0.66	0.61	0.75	-
Cobalt	-	0.065	0.057	0.047	0.058	0.052	-
Copper	-	4.50	4.70	3.30	3.40	3.30	-
Lead	250	8.10	5.70	5.00	5.40	4.60	3.24%
Manganese	150	3.60	3.70	3.40	3.50	3.70	2.47%
Nickel	20	0.71	0.74	0.53	0.68	0.64	3.70%
Vanadium	-	0.79	0.74	0.93	1.20	1.10	-

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As shown, the concentrations monitored were significantly lower than the AQALs at all monitoring sites considered.

There are also AQALs for antimony and mercury. However, these metals are not currently monitored at Detling. Monitoring of antimony across the UK ceased at the end of 2013. The monitored concentration at Detling in 2013 was 1.30 ng/m³ which has been used as the baseline concentration for the assessment. This value is only 0.026% of the annual mean AQAL of 5,000 ng/m³.

Mercury was widely monitored across the UK until the end of 2013. The monitored concentration at Detling in 2013 was 0.69 ng/m³ which has been used as the baseline concentration for the assessment.

4.4.6 Dioxins, furans and polychlorinated biphenyl (PCBs)

Dioxins, furans and PBCs are monitored on a quarterly basis at a number of urban and rural stations in the UK as part of the Toxic Organic Micro Pollutants (TOMPs) network. There are no monitoring locations within 10 km of the Facility. The closest site is London Nobel House approximately 50 km to the west.

A summary of dioxin and furan and PCB concentrations from all monitoring sites across the UK is presented in Table 10 and Table 11. Note that monitoring data for dioxins and furans is only available up to the end of 2016 from the UK-Air website. For PCBs data is only available up to the end of 2018 from the UK-Air website.

Table 10:TOMPS – Dioxin and Furans Monitoring

Site	Annual mean concentration (fgTEQ/m³)				
	2012	2013	2014	2015	2016
Auchencorth Moss	0.13	0.86	0.01	0.01	0.13
Hazelrigg	8.75	2.02	2.61	5.27	4.59
High Muffles	4.32	0.60	1.07	0.54	2.73
London Nobel House	15.42	3.47	2.89	4.34	21.27
Manchester Law Courts	32.99	10.19	16.52	5.94	12.23
Weybourne	9.30	2.34	1.61	1.42	16.32

Source: © Crown 2023 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

Table 11:TOMPS – PCB Monitoring

Site	Annual mean concentration (pg/m³)				
	2014	2015	2016	2017	2018
Auchencorth Moss	23.23	24.27	25.32	19.09	12.31
Hazelrigg	25.84	41.68	52.58	33.15	22.22
High Muffles	26.11	33.43	37.76	31.63	8.86
London Nobel House	107.49	121.39	110.46	121.87	46.63
Manchester Law Courts	128.93	97.99	92.60	97.27	40.10
Weybourne	17.00	20.95	38.61	32.26	11.23

Source: © Crown 2023 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

As shown, the concentrations vary significantly between sites and years. As there are no monitoring sites located within close proximity of the Facility or any mapped background datasets, the maximum monitored concentration from the past 5 years has been used as the background concentration within this assessment. These values are 32.99 fg/TEQ/m³ for dioxins and furans and 128.93 pg/m³ for PCBs.

4.4.7 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) are monitored at a number of stations in the UK as part of the PAH network. There are no monitoring locations within 10 km of the Facility. The closest site is London Marylebone Road, located approximately 55 km to the west.

For the purpose of this assessment, benzo(a)pyrene is considered as this is the only PAH which an AQAL has been set. A summary of benzo(a)pyrene concentrations from all rural background monitoring sites within the UK is presented in Table 12.

Table 12: National Monitoring - Benzo(a)pyrene

Site type	Quantity	AQAL (ng/m^3)	Annual mean concentration (ng/m^3)				
			2018	2019	2020	2021	2022
All rural background	Min	0.25	0.02	0.01	0.01	0.02	0.02
	Max		0.31	0.30	0.26	0.39	0.11
	Average		0.09	0.09	0.08	0.11	0.06

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As shown, the maximum monitored concentration has exceed the AQAL in four out of the last five years. However, these exceedances were all recorded at a single site, Ruardean in Gloucestershire, which is not representative of the surroundings of the Facility. The average concentration at rural background sites is more likely to be representative of concentrations in the vicinity of the Facility. Therefore, in lieu of any local monitoring of PAHs or any mapped background datasets, the maximum annual average of all rural background sites (0.11 ng/m^3– 2020) has been used. The choice of background concentration will be considered further if the process contribution cannot be screened out as 'insignificant'.

4.5 Summary

The preceding sections have provided a review of the baseline local and national monitoring data and national modelled background concentrations. Table 13 presents the values for the annual baseline concentrations that will be used to evaluate the impact of the Facility. Further consideration will be given to the baseline concentrations at specific receptor locations if the predicted impact of emissions of a given pollutant from the Facility cannot be screened out as insignificant.

Table 13: Summary of Baseline Concentrations

Pollutant	Concentration	Units	Justification
Nitrogen dioxide	20.76	$\mu g/m^3$	Maximum monitored concentration from suburban or urban background LAQM within 5 km of the Facility.
Sulphur dioxide	1.00	$\mu g/m^3$	Maximum monitored concentration at Rochester Stoke 2018 - 2022.
Particulate matter (as PM_{10})	19.60	$\mu g/m^3$	Maximum mapped background concentration from within 5 km of the Facility - Defra 2018 dataset.
Particulate matter (as $PM_{2.5}$)	14.29	$\mu g/m^3$	Maximum mapped background concentration from within 5 km of the Facility - Defra 2018 dataset.
Carbon monoxide	439	$\mu g/m^3$	Maximum mapped background concentration from within 5 km of the Facility - Defra 2001 dataset.

Pollutant	Concentration	Units	Justification
Benzene	1.03	µg/m³	Maximum mapped background concentration from within 5 km of the Facility - Defra 2001 dataset.
Ammonia	1.10	µg/m³	Maximum monitored concentration at Detling 2018 – 2022.
Hydrogen chloride	0.71	µg/m³	Maximum monitored concentration across the UK 2012 to 2015
Hydrogen fluoride	2.35	µg/m³	Maximum measured concentration from EPAQS report
Cadmium	0.19	ng/m³	Maximum annual concentrations monitored at Detling 2018 – 2022. Antimony and mercury: maximum monitored at Detling in 2013. Chromium VI assumed to be 20% of total Chromium.
Mercury	0.69	ng/m³	
Antimony	1.30	ng/m³	
Arsenic	0.93	ng/m³	
Chromium	1.50	ng/m³	
Chromium VI	0.30	ng/m³	
Cobalt	0.065	ng/m³	
Copper	4.70	ng/m³	
Lead	8.10	ng/m³	
Manganese	3.70	ng/m³	
Nickel	0.74	ng/m³	
Vanadium	1.20	ng/m³	
Dioxins and Furans	32.99	fgTEQ/m³	Maximum monitored concentration across all UK sites 2012 to 2016
PCBs	128.93	pg/m³	Maximum monitored concentration across all UK sites 2014 to 2018
PaHs	0.11	ng/m³	Highest average of annual concentrations across all rural background sites in UK 2018 – 2022.

5 Sensitive Receptors

5.1 Human sensitive receptors

The general approach to the assessment is to evaluate the highest predicted process contribution to concentrations at a height of 1.5m, to represent typical breathing height. In addition, the predicted process contribution at a number of sensitive receptors has been evaluated. These sensitive receptors have been selected to represent the residential dwellings and schools most likely to be impacted by emissions from the Facility. The human sensitive receptors identified for assessment are displayed in Figure 2 and listed in Table 14.

Table 14: Human Sensitive Receptors

ID	Name	Location		Distance from the stack (km)
		x	y	
R1	Burnt House Farm	580288	172393	0.79
R2	Abbots Court Nursing Home	579373	172152	1.73
R3	Property on Jacobs Lane	580024	172707	1.02
R4	8 Sturdee Cottages	579241	172929	1.83
R5	2 Beluncle Farm Cottages	580111	173376	1.20
R6	1 Stoke Cottages, Tunbridge	580514	173955	1.44
R7	White Hall Farm House	580870	173930	1.33
R8	Property on Stoke Road	581224	174207	1.60
R9	Property on Stoke Road near r/way	581579	174000	1.48
R10	The Lodge, Tudor Farm	581638	174563	2.04
R11	Dingley Dell, Dickenson Close	582355	174957	2.68
R12	Yew Tree Lodge Care Home	578961	172732	2.08
R13	1 Primrose Cottages, Ratcliffe Highway	578533	173928	2.83
R14	Neyfyn House	577761	173334	3.36
R15	Four Elms Hill AQMA	576315	172100	4.75
R16	Gillingham AQMA	578340	169223	4.34

5.2 Ecological sensitive receptors

A study was undertaken to identify the following sites of ecological importance in accordance with the following screening distances laid out in the Air Emissions Guidance:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), or Ramsar sites within 10 km of the Site;
- Sites of Special Scientific Interest (SSSIs) within 2 km of the Site; and
- National Nature Reserves (NNR), Local Nature Reserves (LNRs), local wildlife sites and ancient woodlands within 2 km of the Site. There are collectively referred to as local nature sites.

The sensitive ecological receptors identified as a result of the study are displayed in Figure 3 and are listed in Table 15. A review of the citation and APIS website for each site has been undertaken to determine if lichens or bryophytes are an important part of the ecosystem's integrity. If lichens or bryophytes are present, the more stringent Critical Level has been applied as part of the assessment.

Table 15: Ecological Sensitive Receptors

ID	Site	Designation[1]	Closest point to Facility		Distance from stack (km)	Lichens /bryo-phytes present
			X	Y		
European and UK Designated Sites						
E1	Medway Estuary and Marshes SPA/Ramsar/SSSI	SPA/Ramsar/SSSI	581546	172723	0.52	No
E2	Thames Estuary and Marshes SPA/Ramsar	SPA/Ramsar	584380	175590	4.47	No
E3	Queendown Warren SAC	SAC	583207	163355	9.51	Yes
E4	Benfleet and Southend Marshes SPA/Ramsar	SPA/Ramsar	582466	182330	9.82	No

For sites which are close to the Facility or cover a wide area, the maximum process contribution at ground level within each site has been assessed. This has been done for Thames Estuary and Marshes SPA/Ramsar and Medway Estuary and Marshes SPA/Ramsar/SSSI. For Medway Estuary and Marshes SPA/Ramsar/SSSI, the point of maximum impact within the respective Ramsar designated and SSSI designated areas has been determined to ensure the impact against protected species/habitats is assessed.

6 Dispersion Modelling Methodology

6.1 Selection of model

Detailed dispersion modelling was undertaken using the model ADMS 6, developed and supplied by Cambridge Environmental Research Consultants (CERC) This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the atmospheric stability and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

ADMS is routinely used for modelling of emissions for planning and Environmental Permitting purposes to the satisfaction of the Environment Agency and Local Authorities. The maximum predicted concentration for each pollutant and averaging period has been used to determine the significance of any potential impacts.

6.2 Emission limits

The Industrial Emissions Directive (IED) (Directive 2010/75/EU), adopted on 7th January 2013, is the key European Directive which covers almost all regulation of industrial processes in the EU. Within the IED, the requirements of the relevant sector BREF become binding as BAT guidance, as follows.

- Article 15, paragraph 2, of the IED requires that Emission Limit Values (ELVs) are based on best available techniques, referred to as BAT.
- Article 13 of the IED, requires that 'the Commission' develops BAT guidance documents (referred to as BREFs).
- Article 21, paragraph 3, of the IED, requires that when updated BAT conclusions are published, the Competent Authority (in England this is the Environment Agency) has up to four years to revise permits for facilities covered by that activity to comply with the requirements of the sector specific BREF.

The Waste Incineration BREF was published by the European Integrated Pollution Prevention and Control (IPPC) Bureau in December 2019. The Environment Agency is required to implement conditions within all permits requiring operators to comply with the requirements set out in the BREF within four years of the publication date. This will include the Facility. The Waste Incineration BREF has introduced BAT-AELs (BAT Associated Emission Levels) which are more stringent than those currently set out in the IED for some pollutants.

The Facility will be designed to meet the requirements of the Waste Incineration BREF for a new plant. Therefore, this assessment has been undertaken assuming that the emissions from the Facility will comply with the BAT-AELs set out in the Waste Incineration BREF for new plants. For the remainder of this assessment the anticipated emission limits, which are the BAT-AELs or the emission limits from the IED, are referred to as Emission Limit Values (ELVs).

6.3 Source and emissions data

The principal inputs to the model with respect to the emissions to air from the stacks of the Facility are presented in Table 16 and Table 17. The source parameters are based on the design thermal capacity of 83 MWth per line (166 MWth aggregated).

Table 16: Stack Source Data

Item	Unit	Value
Stack Data		
Height	m	85.0
Internal diameter (each stack)	m	2.28
Centred location of stacks(1)	m, m	581041, 172616
Flue Gas Conditions		
Temperature	°C	130
Exit moisture content	% v/v	17.4%
	kg/kg	0.126
Exit oxygen content	% v/v dry	7.40%
Reference oxygen content	% v/v dry	11.0%
Volume at reference conditions (dry, ref O_2) (each line)	Nm^3/h	168,800
	Nm^3/s	46.9
Volume at actual conditions (each line)	Am^3/h	221,400
	Am^3/s	61.5
Flue gas exit velocity	m/s	15.0

Note:
All flue gas data provided by the technology provider.
(1) The stacks are sufficiently close together that the plumes will interact and dispersion will benefit from the combined momentum and buoyancy of both plumes. Therefore, the 'combine multiple flues' option has been used within ADMS.

Table 17: Stack Emissions Data

Pollutant	Daily or periodic	Half-hourly	Daily or periodic	Half-hourly
	Conc. (mg/Nm^3)		Release rate (g/s) – each line	
Oxides of nitrogen (as NO_2)	120	400	5.627	18.756
Sulphur dioxide	30	200	1.407	9.378
Carbon monoxide	50	150(1)	2.344	7.033
Fine particulate matter (PM)(2)	5	30	0.234	1.407
Hydrogen chloride	6	60	0.281	2.813
Volatile organic compounds (as TOC)	10	20	0.469	0.938
Hydrogen fluoride	1	4	0.047	0.188
Ammonia	10	-	0.469	-
Cadmium and thallium	0.02	-	0.938 mg/s	-
Mercury	0.02	-	0.938 mg/s	-
Other metals(3)	0.3	-	14.07 mg/s	-

Pollutant	Daily or periodic	Half-hourly	Daily or periodic	Half-hourly
	Conc. (mg/Nm³)		Release rate (g/s) – each line	
Benzo(a)pyrene (PAHs)[4]	0.2 µg/Nm³	-	9.378 µg/s	-
Dioxins, furans and dioxin-like PCBs	0.06 ng/Nm³	-	2.813 ng/s	-
PCBs[5]	5 µg/Nm³	-	0.234 mg/s	-

Notes:

All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.

(1) Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.

(2) As a worst-case it has been assumed that the entire PM emissions consist of either PM_{10} or $PM_{2.5}$ for comparison with the relevant AQALs.

(3) Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V).

(4) Figure 8.121 of the 2019 Waste Incineration BREF shows that the maximum recorded at a UK plant was 0.2 µg/m³. This is assumed to be the emission concentration for the Facility.

(5) The 2006 Waste Incineration BREF provides a range of values for PCB emissions to air from European municipal waste incineration plants. This states that the annual average total PCBs is less than 0.005 mg/Nm³ (dry, 11% oxygen, 273K). In lieu of other available operational data, this has been assumed to be the emission concentration for the Facility.

The Facility is designed to operate at full capacity and is not anticipated to have significant changes in loading. Therefore, it is appropriate to base the assessment on the design point of the system.

If the Facility continually operated at the half-hourly limits, the daily limits would be exceeded. The Facility is designed to achieve the daily limits and as such will only operate at the shorter term limits for short periods on rare occasions.

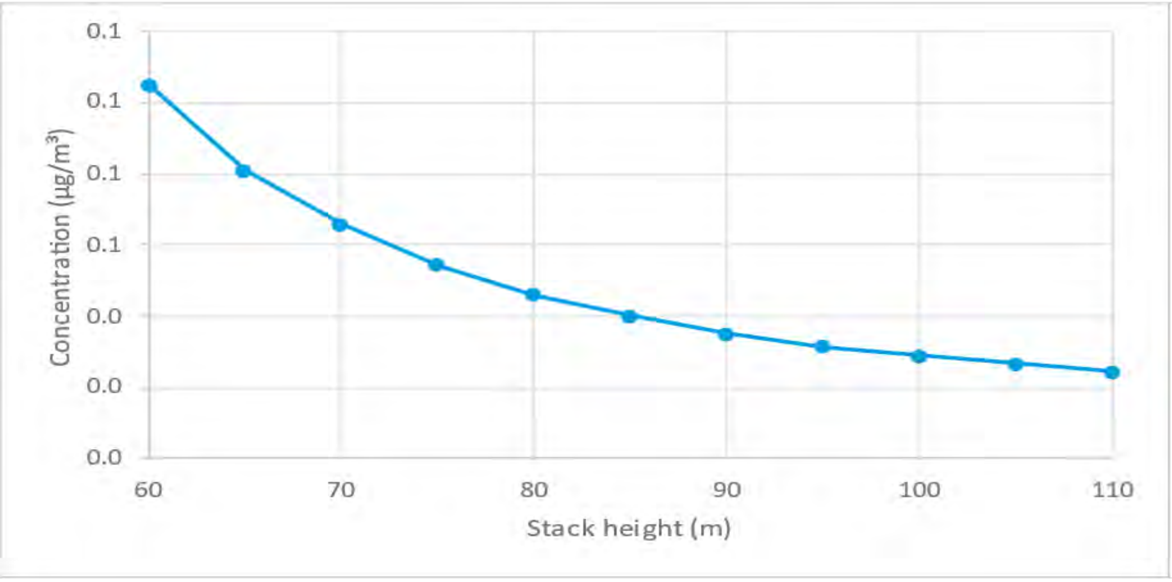
6.4 Stack height justification

When determining a suitable stack height, it is best practice to identify the stack height where the rate of reduction in maximum ground level concentration with increased height slows down. This can be identified on a graph as a step change in the slope. A range of stack heights from 60 m to 110 m has been considered.

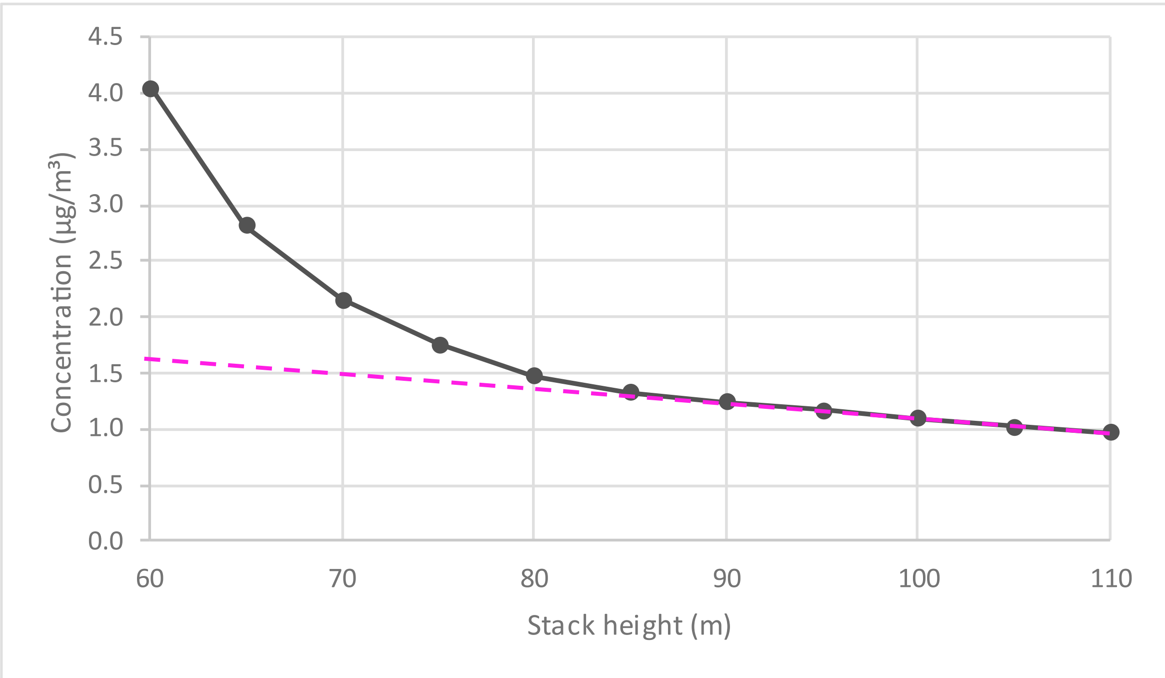
The following parameters were kept constant:

- Buildings – included;
- Dispersion site surface roughness value – varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.02 m;
- Dispersion site Monin-Obukhov length – 1 m;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Gravesend Broadness 2014 to 2018.

The following graphs show the ground level concentration at the point of maximum impact for a range of stack heights for the Facility, for a nominal 1 g/s release rate.



Graph 1 – Annual Mean Stack Height Analysis



Graph 2 – Short-Term Stack Height Analysis

Analysis of the graphs shows that there is a gradual reduction in annual mean concentrations associated with an increased stack height with no significant change in the gradient of the slope between 60 m and 110 m.

For stack heights of 75 – 85 m there is some benefit from increasing the stack height. The point of maximum impact occurs in the Medway Estuary, so the effect of increasing the stack height at areas of human exposure is minimal.

Considering the 99.79th percentile of hourly mean concentrations (which has been selected for its relevance to the short-term AQAL for nitrogen dioxide), for stack heights up to 85 m the angle of the slope becomes shallower with each incremental increase in stack height. For stack heights above 85 m there is no discernible change in the slope, as indicated by the magenta line.

Based on the above, there is a clear benefit to increasing the stack height to 85 m, particularly with regard to short-term concentrations. However, from an air quality perspective, there is limited benefit to increasing it beyond this height.

Overall, it is considered that a stack height of 85 m is appropriate to provides adequate dispersion of pollutants from the Facility, and the remainder of this assessment has been undertaken for a stack height of 85 m.

6.5 Other inputs

6.5.1 Modelling domain

Modelling has been undertaken using a nested grid of points; a 2.5 km x 2.5 km grid with a spatial resolution of 25 m nested within a 10 km x 10 km grid with a spatial resolution of 100 m. The high resolution of the finest grid has been chosen to ensure that the gridded output accurately captures the highest modelled concentrations. Reference to Figure 4 should be made to for a graphical representation of the modelling domain used. The extent of the modelling domain is detailed in Table 18.

Table 18: Modelling Domain

Grid quantity	Fine grid	Wide grid
Grid spacing (m)	25	100
Grid points	101	101
Grid Start X (m)	579850	576200
Grid Finish X (m)	582350	586200
Grid Start Y (m)	171450	167600
Grid Finish Y (m)	173950	177600

6.5.2 Meteorological data and surface characteristics

The dispersion modelling has been undertaken using weather data from the Gravesend Broadness meteorological recording station. Gravesend Broadness is approximately 20 km to the west of the Facility and is the most representative meteorological station available.

The Environment Agency recommends that 5 years of data are used to take into account inter-annual fluctuations in weather conditions. The period 2014 – 2018 has been used as this is the most recent 5 year period available from Gravesend Broadness meteorological station. Wind roses for each year are presented in Figure 5.

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 1 m for the dispersion site, which is model default value recommended by CERC. Based on the mainly rural and open water areas surrounding the Facility, this is deemed an appropriate minimum Monin-Obukhov length.

The minimum Monin-Obukhov length has been set to 10 m for the meteorological site which is recommended by CERC for "small towns <50,000 [population]", and is considered appropriate for the mix of open grassland, water and industrial areas surrounding the meteorological site.

The surface roughness length utilised in ADMS can also be selected for both the dispersion site and meteorological site. There is considerable variation in surface roughness across the 10 x 10 km modelling domain, ranging from open water to built-up urban areas. To account for the varying surface roughness length a spatially-varying surface roughness file has been used as a model input. The land-use class for each point in the file has been extracted from the CORINE Land Cover database[5] and cross-referenced with the most likely surface roughness length value[6].

A surface roughness length of 0.02 m has been selected for Gravesend Broadness. CERC recommends that this value is the maximum value suitable for "open grassland" and is considered representative of the mix of land uses around the meteorological station.

The parameters for the spatially-varying surface roughness file are shown in Table 19 and a visual representation provided in Figure 6.

Table 19: Spatially Varying Surface Roughness File Parameters

Parameter	Value
Grid spacing (m)	100
Grid points	112 x 112
Modelled resolution	64 x 64
Grid Start X (m)	575650
Grid Finish X (m)	586750
Grid Start Y (m)	167050
Grid Finish Y (m)	178150

Table 20: Surface Roughness Lengths Used for Different Land Use Classes

Land use classification	Corine 2018 land use codes	Surface roughness length (m)
Green urban areas	141	0.6
Discontinuous urban fabric, industrial or commercial units, port areas, sport and leisure facilities	112, 121, 123, 142	0.5
Non-irrigated arable land, salt marshes	211, 421	0.05
Pastures	231	0.03
Intertidal flats	423	0.0005

5 https://land.copernicus.eu/pan-european/corine-land-cover

6 Taken from "Roughness length classification of Corine Land Cover classes", Megajoule Consultants, 2007.

Land use classification	Corine 2018 land use codes	Surface roughness length (m)
Water(1)	522, 523	0.0001
Note: *(1) The 'most likely' value for water is given as zero. ADMS cannot model a surface roughness length of zero, so areas of water have been assigned a roughness length of 0.0001 m which is the value recommended by CERC for 'sea'.*		

A summary of the meteorological parameters used in the dispersion modelling is shown in Table 21.

Table 21: Meteorological parameters

Parameter	Dispersion site value (m)	Met site value (m)
Surface roughness length	Spatially varying	0.02
Minimum Monin-Obukhov length	1	10

The sensitivity of the modelling results to the choice of surface roughness has been considered in Section 7.1.

6.5.3 Terrain

It is recommended that, where gradients within 500 m of the modelling domain are greater than 1 in 10, the complex terrain module within ADMS (FLOWSTAR) should be used. A review of the local area has identified areas with gradients greater than 1 in 10 in the modelling domain. A sensitivity analysis has been undertaken to determine the effect of terrain (see section 7.2). A visual representation of the terrain files is shown in Figure 7.

6.5.4 Buildings

The presence of adjacent buildings can significantly affect the dispersion of the atmospheric emissions in various ways:

- Wind blowing around a building distorts the flow and creates zones of turbulence. The increased turbulence can cause greater plume mixing.
- The rise and trajectory of the plume may be depressed slightly by the flow distortion. This downwash leads to higher ground level concentrations closer to the stack than those which would be present without the building.

The Environment Agency recommends that buildings should be included in the modelling if they are both:

- Within 5L of the stack (where L is the smaller of the building height and maximum projected width of the building); and
- Taller than 40% of the stack.

The ADMS 6 user guide also states that buildings less than one third of the stack height will not have any effect on the dispersion calculations in the model.

A review of the site layout has been undertaken and the details of the applicable buildings which may affect dispersion from the Facility are presented in Table 22. The buildings have been modelled at the height of the highest point of the structure. A site plan showing which buildings have been included in the model is presented in Figure 8.

Table 22: Building Details

Buildings	Centre point		Height (m)	Length (m)	Width (m)	Angle (°)
	X (m)	Y (m)				
Boiler Hall(1)	581067	172552	45.0	60.0	67.7	0.0
Bunker	581064	172502	35.0	39.0	75.4	0.0
Tipping Hall	581064	172464	28.0	36.7	75.4	0.0
FGT	581043	172602	35.0	40.0	58.0	0.0
Turbine	581087	172602	20.0	40.0	29.0	0.0
ACCs	581146	172580	24.0	48.3	35.0	0.0

Note:
(1) Selected as the main building for the Facility

6.6 Chemistry

The Facility will release nitric oxide (NO) and nitrogen dioxide (NO_2) which are collectively referred to as NOx. In the atmosphere, nitric oxide will be converted to nitrogen dioxide in a reaction with ozone which is influenced by solar radiation. Since the air quality objectives are expressed in terms of nitrogen dioxide, it is important to be able to assess the conversion rate of nitric oxide to nitrogen dioxide.

Ground level NOx concentrations have been predicted through dispersion modelling. Nitrogen dioxide concentrations reported in the results section assume 70% conversion from NOx to nitrogen dioxide for annual means and a 35% conversion for short term (hourly) concentrations, based upon the worst-case scenario in the Environment Agency methodology. Given the short travel time to the areas of maximum concentrations, this approach is considered conservative.

6.7 Baseline concentrations

Background concentrations for the assessment have been derived from monitoring and national mapping as presented in section 4. For short term averaging periods, the background concentration has been assumed to be twice the long term ambient concentration following the Air Emissions Guidance methodology.

7 Sensitivity Analysis

7.1 Surface roughness

The sensitivity of the results to using spatially varying surface roughness length has been considered by running the model with a variety of surface roughness lengths for the dispersion site. For all sensitivity analyses the impact of changing model parameters on the maximum annual mean and short-term concentrations of oxides of nitrogen have been considered.

The following parameters were kept constant:

- Stack height – 85 m
- Grid – nested;
- Buildings – included;
- Terrain – included;
- Meteorological site surface roughness – 0.02 m;
- Dispersion site Monin-Obukhov length – 1 m;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Gravesend Broadness 2015.

The contribution of the process emissions from the Facility to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 23.

Table 23: Surface Roughness Sensitivity Analysis

Surface roughness (m)	Oxides of nitrogen PC					
	Annual mean		99.79%ile of 1-hour mean		Max 1-hour mean	
	Conc. (µg/m³)	% change from varying	Conc. (µg/m³)	% change from varying	Conc. (µg/m³)	% change from varying
Point of maximum impact						
Varying	**0.45**	-	**14.21**	-	**46.76**	-
0.02	0.37	-17.05%	13.32	-6.26%	24.39	-47.84%
0.1	0.47	3.58%	13.66	-3.84%	25.57	-45.32%
0.3	0.57	26.81%	14.51	2.13%	26.45	-43.44%
0.5	0.64	42.87%	14.75	3.80%	26.94	-42.38%
0.7	0.71	56.51%	15.17	6.79%	28.29	-39.51%
Maximum impacted receptor						
Varying	**0.26**	-	**11.83**	-	**13.50**	-
0.02	0.19	-26.18%	11.37	-3.94%	13.82	2.38%
0.1	0.27	2.46%	12.08	2.06%	14.40	6.68%
0.3	0.35	33.15%	12.41	4.89%	13.72	1.64%

Surface roughness (m)	Oxides of nitrogen PC					
	Annual mean		99.79%ile of 1-hour mean		Max 1-hour mean	
	Conc. (µg/m³)	% change from varying	Conc. (µg/m³)	% change from varying	Conc. (µg/m³)	% change from varying
0.5	0.40	51.58%	12.16	2.73%	13.62	0.91%
0.7	0.44	66.78%	12.24	3.42%	13.35	-1.12%

Increasing the surface roughness value leads to greater annual mean and short-term concentrations at the point of maximum impact. The use of the spatially varying surface roughness file results in annual mean impacts similar to a constant surface roughness length of 0.1 m. The maximum hourly concentrations are much higher for the spatially varying surface roughness file, in comparison to the use of a constant surface roughness length.

At the maximum impacted receptor location the spatially varying surface roughness length results in lower concentrations than the use of a constant surface roughness length, except for at a fixed surface roughness length of 0.02m.

Due to the sensitivity of the results to the choice of surface roughness length it is considered appropriate to use the spatially varying surface roughness file in the main model runs as this most accurately represents the variations in land use and surface roughness across the modelling domain.

7.2 Terrain

The sensitivity of the results to the effect of terrain has been considered by running the model with and without a complex terrain file, which has the same points as the spatially varying surface roughness file shown in Table 19 and was run at 64 x 64 resolution.

The following parameters have been kept constant:

- Stack height – 85 m;
- Grid – nested;
- Buildings – included;
- Dispersion site surface roughness – spatially varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.02 m;
- Dispersion site Monin-Obukhov length – 1 m;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Gravesend Broadness 2015.

The contributions of the process emissions from the Facility to the ground level concentration of oxides of nitrogen at the point of maximum predicted concentration and maximum impacted receptor are presented in Table 24 for each scenario.

Table 24: Effect of Terrain

Scenario used in model	Oxides of nitrogen PC (µg/m³)		
	Annual mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
Including terrain	**0.45**	**14.21**	**46.76**
Excluding terrain	0.44	14.36	45.20
% change	-3.49%	1.12%	-3.35%
Maximum impacted receptor			
Including terrain	**0.26**	**11.83**	**13.50**
Excluding terrain	0.26	11.77	13.40
% change	-2.09%	-0.54%	-0.77%

Modelling the effect of terrain results in slightly higher annual mean concentrations at both the point of maximum impact and maximum impacted receptor. A terrain file has been included in the main model runs as this most accurately represents the variations in topography within the modelling domain.

7.3 Building parameters

The sensitivity of the results to the effect of buildings has been considered by running the model with and without the buildings presented in Table 22.

The following parameters were kept constant:

- Stack height – 85 m;
- Grid – nested;
- Terrain – excluded;
- Dispersion site surface roughness – spatially varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.02 m;
- Dispersion site Monin-Obukhov length – 1 m;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Gravesend Broadness 2015.

The contribution of the process emissions from the Facility to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 25 for each scenario.

Table 25: Effect of Buildings

Scenario used in model	Oxides of nitrogen PC (µg/m³)		
	Annual mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
Including buildings	**0.45**	**14.21**	**46.76**

Scenario used in model	Oxides of nitrogen PC (µg/m³)		
	Annual mean	99.79%ile of 1-hour mean	Max 1-hour mean
Excluding buildings	0.41	14.04	24.08
% change	-9.86%	-1.14%	-48.50%
Maximum impacted receptor			
Including buildings	**0.26**	**11.83**	**13.50**
Excluding buildings	0.24	11.80	13.49
% change	-9.88%	-0.33%	-0.06%

Modelling the presence of buildings results in higher annual mean and maximum hourly mean concentrations at the point of maximum impact, although there is little effect at the 99.79th percentile of hourly means. Buildings have been included in the dispersion model as this is a realistic approach.

7.4 Grid resolution

The sensitivity of the results to the choice of grid resolution has been considered by running the model with the 25 m nested grid resolution detailed in Table 18, and with a finer grid of 10 m resolution.

The following parameters were kept constant:

- Stack height – 85 m;
- Buildings – included;
- Terrain – excluded;
- Dispersion site surface roughness – spatially varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.01 m;
- Dispersion site Monin-Obukhov length – 1 m;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Gravesend Broadness 2015.

The contribution of the process emissions from the Facility to the ground level concentration of oxides of nitrogen at the point of maximum impact is presented in Table 25 for each scenario.

Table 26: Effect of Grid Resolution

Scenario used in model	Oxides of nitrogen PC (µg/m³)		
	Annual mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
25 m grid	**0.45**	**14.21**	**46.76**
15 m grid	0.45	14.32	46.92
% change	0.02%	0.84%	0.33%

Modelling a finer grid of 10 m resolution results in a negligible change in maximum annual mean and short-term concentrations. Therefore, it is considered that no potentially significant effects would be missed by using a grid resolution of 25 m. As such, it is considered fine enough to accurately represent process emissions from the Facility and that the choice of grid resolution does not affect the results of the assessment.

7.5 Sensitivity analysis – operating below the design point

Dispersion modelling has been undertaken using the emission parameters based on the design point for the Facility. The Facility will be operated as a commercial plant, so it is beneficial to operate at full capacity. If loading does fall below the design point the volumetric flow rate and the exit velocity of the exhaust gases would reduce. The effect of this would be to decrease the quantity of pollutants emitted but also to reduce the buoyancy of the plume due to momentum. The reduction in buoyancy, which would lead to reduced dispersion, would be more than offset by the decrease in the amount of pollutants being emitted, so that the impact of the plant when running below the design point would be reduced.

8 Impact on Human Health

8.1 At the point of maximum impact

Table 27 and Table 28 present the results of the dispersion modelling of process emissions from the Facility at the point of maximum impact. This is the maximum predicted concentration based on the following:

- Modelling domain size – a nested grid of points; a 2.5 km x 2.5 km grid with a spatial resolution of 25 m nested within a 10 km x 10 km grid with a spatial resolution of 100 m;
- Buildings – included;
- Stack height – 85 m;
- 5 years of weather data 2014 to 2018 from Gravesend Broadness meteorological recording station;
- Operation at the long term ELVs for 100% of the year;
- Operation at the short term ELVs during the worst-case conditions for dispersion of emissions (Table 28 only);
- Environment Agency's worst case 70% conversion of oxides of nitrogen to nitrogen dioxide;
- The entire VOC emissions are assumed to consist of benzene; and
- Cadmium is released at the combined emission limit for cadmium and thallium.

The baseline concentration is taken from the review of baseline monitoring contained in section 4.

Impacts that cannot be screened out as 'insignificant' are highlighted. Where the impact cannot be screened out as 'insignificant', further analysis has been undertaken.

Table 27: Dispersion Modelling Results – Point of Maximum Impact - Operation at Daily ELVs

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2014	2015	2016	2017	2018	Max			
Nitrogen dioxide	Annual mean	µg/m³	40	20.76	0.28	0.32	0.29	0.31	0.23	0.32	0.79%	21.08	52.69%
	99.79th %ile of hourly means	µg/m³	200	41.52	5.21	4.97	5.10	4.38	4.91	5.21	2.61%	46.73	23.37%
Sulphur dioxide	99.18th %ile of daily means	µg/m³	125	2.00	0.87	0.94	1.14	0.87	1.07	1.14	0.91%	3.14	2.51%
	99.73rd %ile of hourly means	µg/m³	350	2.00	3.59	3.43	3.42	2.98	3.28	3.59	1.03%	5.59	1.60%
	99.9th %ile of 15 min. means	µg/m³	266	2.00	4.49	4.69	4.79	3.87	4.45	4.79	1.80%	6.79	2.55%
PM_{10}	Annual mean	µg/m³	40	19.60	0.02	0.02	0.02	0.02	0.01	0.02	0.05%	19.62	49.05%
	90.41st %ile of daily means	µg/m³	50	39.20	0.07	0.07	0.07	0.07	0.06	0.07	0.15%	39.27	78.55%
$PM_{2.5}$	Annual mean	µg/m³	20	14.29	0.02	0.02	0.02	0.02	0.01	0.02	0.09%	14.31	71.54%
	Annual mean	µg/m³	10	14.29	0.02	0.02	0.02	0.02	0.01	0.02	0.19%	14.31	143.09%
Carbon monoxide	8 hour running mean	µg/m³	10,000	878	5.10	4.45	5.20	4.63	5.69	5.69	0.06%	883.69	8.84%
	Hourly mean	µg/m³	30,000	878	13.82	19.45	16.59	9.98	16.32	19.45	0.06%	897.45	2.99%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	1.66	2.34	1.99	1.20	1.96	2.34	0.31%	3.76	0.50%
Hydrogen fluoride	Annual mean	µg/m³	16	2.35	0.00	0.00	0.00	0.00	0.00	0.00	0.02%	2.35	14.71%
	Hourly mean	µg/m³	160	4.70	0.28	0.39	0.33	0.20	0.33	0.39	0.24%	5.09	3.18%
Ammonia	Annual mean	µg/m³	180	1.10	0.03	0.04	0.04	0.04	0.03	0.04	0.02%	1.14	0.63%
	Hourly mean	µg/m³	2,500	2.20	2.76	3.89	3.32	2.00	3.26	3.89	0.16%	6.09	0.24%

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2014	2015	2016	2017	2018	Max			
VOCs (as benzene)	Annual mean	µg/m³	5	1.03	0.03	0.04	0.04	0.04	0.03	0.04	0.75%	1.07	21.35%
	Daily mean	µg/m³	30	2.06	0.40	0.39	0.51	0.36	0.40	0.51	1.70%	2.57	8.57%
Mercury	Daily mean	ng/m³	60	1.38	0.80	0.78	1.02	0.72	0.81	1.02	1.70%	2.40	4.00%
	Hourly mean	ng/m³	600	1.38	5.53	7.78	6.64	3.99	6.53	7.78	1.30%	9.16	1.53%
Cadmium	Annual mean	ng/m³	5	0.19	0.07	0.08	0.07	0.07	0.05	0.08	**1.50%**	0.27	5.30%
	Daily mean	ng/m³	30	0.38	0.80	0.78	1.02	0.72	0.81	1.02	3.40%	1.40	4.67%
PAHs	Annual mean	pg/m³	250	110	0.65	0.75	0.70	0.74	0.54	0.75	0.30%	110.75	44.30%
Dioxins, furans and dioxin-like PCBs	Annual mean	fg/m³	-	32.99	0.20	0.23	0.21	0.22	0.16	0.23	-	33.22	-
PCBs	Annual mean	ng/m³	200	0.129	0.02	0.02	0.02	0.02	0.01	0.02	0.01%	0.15	0.07%
	Hourly mean	ng/m³	6,000	0.258	1.38	1.94	1.66	1.00	1.63	1.94	0.03%	2.20	0.04%
Other metals	Annual mean	ng/m³	-	-	0.98	1.13	1.05	1.11	0.81	1.13	See metals assessment – Section 8.2.3		
	Daily mean	ng/m³	-	-	11.95	11.70	15.32	10.79	12.08	15.32			
	Hourly mean	ng/m³	-	-	82.94	116.69	99.56	59.87	97.90	116.69			

Note:

All assessment is based on the maximum PC using all 5 years of weather data.

Table 28: Dispersion Modelling Results – Point of Maximum Impact - Short-Term ELVs

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2014	2015	2016	2017	2018	Max			
Nitrogen dioxide	99.79th%ile of hourly means	µg/m³	200	41.52	17.38	16.58	17.00	14.60	16.35	17.38	8.69%	58.90	29.45%
Sulphur dioxide	99.73rd%ile of hourly means	µg/m³	350	2.00	23.94	22.87	22.77	19.85	21.85	23.94	6.84%	25.94	7.41%
	99.9th%ile of 15 min. means	µg/m³	266	2.00	29.93	31.24	31.93	25.79	29.64	31.93	**12.00%**	33.93	12.76%
Carbon monoxide	8 hour running mean	µg/m³	10,000	878	15.31	13.36	15.60	13.88	17.06	17.06	0.17%	895.06	8.95%
	Hourly mean	µg/m³	30,000	878	41.47	58.34	49.78	29.94	48.95	58.34	0.19%	936.34	3.12%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	16.60	23.35	19.93	11.98	19.59	23.35	3.11%	24.77	3.30%
Hydrogen fluoride	Hourly mean	µg/m³	160	4.70	1.11	1.56	1.33	0.80	1.31	1.56	0.97%	6.26	3.91%

Note:
All assessment is based on the maximum PC using all 5 years of weather data and operation of both lines at the short-term ELVs

As shown, at the point of maximum impact the contribution of the process emissions from the Facility is less than 10% of the short-term AQAL and less than 1% of the annual mean AQAL and can be screened out as 'insignificant', with the exception of the following:

- Annual mean cadmium impacts;
- 99.9th percentile of 15-minute mean sulphur dioxide impacts.

Further assessment of these impacts has been undertaken. In addition, although the impact on annual mean concentrations of nitrogen dioxide can be screened out as 'insignificant', an illustrative plot file of the impact is presented as Figure 9.

8.2 Further assessment

8.2.1 Annual mean cadmium

The contribution of the process emissions from the Facility to annual mean cadmium concentrations is predicted to be 1.50% of the AQAL at the point of maximum impact. However, this assumes that the entire cadmium and thallium emissions consist of only cadmium. Data submitted by UK plants to the European Waste Incineration BREF working group in 2017 shows that the average cadmium concentration recorded from UK plants equipped with bag filters was 1.6 µg/Nm³ (or 3.2% of the ELV of 0.02 mg/Nm³), the highest recorded concentration of cadmium and thallium was 14 µg/Nm³ (or 70% of the ELV) and only three lines recorded concentrations higher than 10 µg/Nm³ (or 50% of the ELV of 0.02 mg/Nm³). Therefore, assuming emissions at the ELV is highly conservative.

Table 29 shows the annual mean cadmium PC at the identified sensitive human receptor locations, for cadmium emitted at 100% of the ELV. PCs greater than 1% of the AQAL are highlighted. Figure 10 shows the spatial distribution of emissions assuming cadmium is emitted at 100% of the combined cadmium and thallium emission limit.

Table 29: Annual Mean Cadmium Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL
Point of maximum impact	0.08	**1.50%**	0.27	5.30%
R1	0.04	0.86%	0.23	4.66%
R2	0.04	0.78%	0.23	4.58%
R3	0.02	0.49%	0.21	4.29%
R4	0.02	0.34%	0.21	4.14%
R5	0.01	0.29%	0.20	4.09%
R6	0.02	0.43%	0.21	4.23%
R7	0.03	0.56%	0.22	4.36%
R8	0.04	0.76%	0.23	4.56%
R9	0.04	0.83%	0.23	4.63%
R10	0.04	0.76%	0.23	4.56%
R11	0.04	0.87%	0.23	4.67%

Receptor	PC		PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL
R12	0.02	0.40%	0.21	4.20%
R13	0.01	0.20%	0.20	4.00%
R14	0.01	0.22%	0.20	4.02%
R15	0.02	0.33%	0.21	4.13%
R16	0.01	0.17%	0.20	3.97%

When the baseline concentration of 0.19 ng/m³ is taken into account, the PEC at the point of maximum impact is well below 70% of the AQAL, the overall impact is classed as 'not significant'. Furthermore, the impact at all sensitive receptors is below the 1% screening criteria and therefore is screened out as 'insignificant'.

8.2.2 15-minute mean sulphur dioxide

The impact of the process emissions from the Facility operating at the short-term ELVs exceeds 10% of the AQAL for the 99.9th percentile of 15-minute mean sulphur dioxide. The PC at the point of maximum impact is predicted to be 31.93 µg/m³, which is 12.00% of the AQAL. However, as the short-term baseline concentration is low (2.00 µg/m³), the headroom as defined in section 3.1 is 264 µg/m³. The PC is 12.09% of the headroom; as this is less than 20% of the headroom it is concluded that there is no risk of exceeding the AQAL and the impact is 'not significant'.

Additionally, the impact at all sensitive receptors can also been screened out as 'not significant', as demonstrated in Figure 11 which shows the spatial distribution of the 15-minute mean sulphur dioxide PC from the Facility. Furthermore, these impacts are only predicted to occur in the very unlikely case that both lines are operating at the maximum permitted short-term ELV, during the worst-case weather conditions for dispersion.

8.2.3 Heavy metals – at the point of maximum impact

Table 30 and Table 31 detail the impact of process emissions from the Facility and the PEC assuming that each metal is released at the ELV for group 3 metals. If the PC is greater than 1% of the long-term or 10% of the short-term AQAL and the PEC exceeds the AQAL when it is assumed that each metal is emitted at the ELV, further analysis has been undertaken assuming the release of each metal is no greater than the maximum reported in the Environment Agency metals guidance[7].

[7] Guidance on Assessing group 3 metal stack emissions from incinerators, Environment Agency, 2016

Table 30: Long-Term Metals Results – Point of Maximum Impact

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV [(1)]	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	6	0.93	1.13	**18.76%**	2.06	34.26%	8.3%	0.09	**1.56%**	1.02	17.06%
Antimony	5,000	1.30	1.13	0.02%	2.43	0.05%	3.8%	0.04	<0.01%	1.34	0.03%
Chromium	-	1.50	1.13	-	2.63	-	30.7%	0.35	-	1.85	-
Chromium (VI)	0.25	0.30	1.13	**450.2%**	1.43	**570.2%**	0.043%	<0.01	0.20%	0.30	120.20%
Cobalt	-	0.07	1.13	-	1.19	-	1.9%	0.02	-	0.09	-
Copper	-	4.70	1.13	-	5.83	-	9.7%	0.11	-	4.81	-
Lead	250	8.10	1.13	0.45%	9.23	3.69%	16.8%	0.19	0.08%	8.29	3.32%
Manganese	150	3.70	1.13	0.75%	4.83	3.22%	20.0%	0.23	0.15%	3.93	2.62%
Nickel	20	0.74	1.13	**5.63%**	1.87	9.33%	73.3%	0.83	**4.13%**	1.57	7.83%
Vanadium	-	1.20	1.13	-	2.33	-	2.0%	0.02	-	1.22	-

Notes:

[(1)] Metal as maximum percentage of the group 3 metals ELV, recalculated from the data presented in Environment Agency metals guidance document (V.4) Table A1.

Table 31: Short-Term Metals Results – Point of Maximum Impact

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV [(1)]	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	-	1.86	116.69	-	118.55	-	8.3%	9.72	-	11.58	-
Antimony	150,000	2.60	116.69	0.08%	119.29	0.08%	3.8%	4.47	0.003%	7.07	<0.01%
Chromium[(2)]	2,000	3.00	15.32	0.77%	18.32	0.92%	30.7%	4.70	0.23%	7.70	0.38%
Chromium (VI)	-	0.60	116.69	-	117.29	-	0.043%	0.05	-	0.65	-
Cobalt	-	0.13	116.69	-	116.82	-	1.9%	2.18	-	2.31	-
Copper[(2)]	50	9.40	15.32	**30.63%**	24.72	49.43%	9.7%	1.48	2.96%	10.88	21.76%
Lead	-	16.20	116.69	-	132.89	-	16.8%	19.56	-	35.76	-
Manganese	1,500,000	7.40	116.69	0.01%	124.09	0.01%	20.0%	23.34	0.002%	30.74	0.002%
Nickel	700	1.48	116.69	**16.67%**	118.17	16.88%	73.3%	85.57	**12.22%**	87.05	12.44%
Vanadium[(2)]	1,000	2.40	15.32	1.53%	17.72	1.77%	2.0%	0.31	0.031%	2.71	0.27%

Notes:

[(1)] *Metal as maximum percentage of the group 3 metals ELV, recalculated from the data presented in Environment Agency metals guidance document (V.4) Table A1.*

[(2)] *All impacts maximum 1-hour PC with the exception of chromium, copper, and vanadium, which are the maximum 24-hour PC.*

As shown in Table 30 and Table 31, if it is assumed that the entire emissions of metals consist of only one metal, the impact of process emissions from the Facility is less than 1% of the long-term and less than 10% of the short-term AQAL, with the exception of annual mean impacts of arsenic, chromium (VI), and nickel, and short-term impact of copper and nickel. The PC is only predicted to exceed the long-term AQAL for chromium (VI) using this worst-case screening assumption. If it is assumed that process emissions from the Facility are the maximum values reported in the Environment Agency's metals guidance, the PC is below 1% of the long term and 10% of the short term AQAL for all pollutants except for annual mean arsenic and nickel, and short-term nickel. However, for all of these pollutants the PEC is well below the AQALs. Therefore, the impact of emissions of metals can be screened out and is considered to be 'insignificant'.

9. Impact at Ecological Receptors

This section provides an assessment of the impact of emissions at the ecological receptors identified in Section 5.2.

9.1 Methodology

9.1.1 Atmospheric emissions – Critical Levels

The impact of process emissions from the Facility has been compared to the Critical Levels listed in Table 3 and the results are presented in Section 9.2.

For the purpose of the ecological assessment, the mapped background dataset from APIS has been used. If the PC is than 1% of the long-term or 10% of the short-term Critical Level further consideration will be made to the baseline concentrations.

9.1.2 Deposition of emissions - Critical Loads

In addition to the Critical Levels for the protection of ecosystems, habitat specific Critical Loads for nature conservation sites at risk from acidification and nitrogen deposition (eutrophication) are outlined in APIS. The nitrogen and acid deposition Critical Loads and background levels of deposition appropriate to each habitat are presented in Appendix B.

APIS includes Critical Loads for sand dune habitats for the Medway and Thames Estuary and Marshes designated sites. The ecologist for the project, Fayrewood Ecology, has advised that no sand dune priority habitat has been identified in the study area and all coastal priority habitat for both the Thames and Medway Estuary designations appear to be saltmarsh and mudflats. Therefore, the impact on sand dune habitats has not been considered in this assessment.

If the impact of process emissions from the Facility upon nitrogen or acid deposition is greater than 1% of the Critical Load, further assessment has been undertaken.

9.1.3 Nitrogen deposition – eutrophication

Appendix B summarises the Critical Loads for nitrogen deposition and background deposition rates as detailed in APIS for each identified receptor. The impact has been assessed against these Critical Loads for nitrogen deposition.

9.1.4 Acidification

The APIS Database contains a maximum critical load for sulphur (CLmaxS), a minimum Critical Load for nitrogen (CLminN) and a maximum Critical Load for nitrogen (CLmaxN). These components define the Critical Load function. Where the acid deposition flux falls within the area under the Critical Load function, no exceedances are predicted.

Appendix B summaries the Critical Loads for acidification and background deposition rates as detailed in APIS for each identified habitat. The impact has been assessed against these Critical Load functions. Where a Critical Load function for acid deposition is not available but the habitat is listed as sensitive to acid deposition, the total nitrogen and sulphur deposition has been presented and compared with the background concentration.

9.1.5 Calculation methodology

9.1.5.1 Nitrogen deposition

The impact of deposition has been assessed using the methodology detailed within the Habitats Directive AQTAG06[8] (March 2014). The steps to this method are as follows.

1. Determine the annual mean ground level concentrations of nitrogen dioxide and ammonia at each site.
2. Calculate the dry deposition flux (µg/m^2/s) at each site by multiplying the annual mean ground level concentration by the relevant deposition velocity presented in Table 32.
3. Convert the dry deposition flux into units of kgN/ha/yr using the conversion factors presented in Table 32.
4. Compare this result to the nitrogen deposition Critical Load.

Table 32: Deposition Factors

Pollutant	Deposition Velocity (m/s)		Conversion Factor (µg/m^2/s to kg/ha/year)
	Grassland	Woodland	
Nitrogen dioxide	0.0015	0.003	96.0
Sulphur dioxide	0.0120	0.024	157.7
Ammonia	0.0200	0.030	259.7
Hydrogen chloride	0.0250	0.060	306.7

9.1.5.2 Acidification

Deposition of nitrogen, sulphur, hydrogen chloride and ammonia can cause acidification and should be taken into consideration when assessing the impact of process emissions from the Facility.

The steps to determine the acid deposition flux are as follows.

1. Determine the dry deposition rate in kg/ha/yr of nitrogen, sulphur, hydrogen chloride and ammonia using the methodology outlined in Section 9.1.5.
2. Apply the conversion factor for N outlined in Table 32 to the nitrogen and ammonia deposition rate in kg/ha/year to determine the total keq N/ha/year.
3. Apply the conversion factor for S to the sulphur deposition rate in kg/ha/year to determine the total keq S/ha/year.
4. Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the dry keq Cl/ha/year.
5. Add the contribution from S to HCl and treat this sum as the total contribution from S.
6. Plot the results against the Critical Load functions.

Table 33: Conversion Factors

Pollutant	Conversion Factor (kg/ha/year to keq/ha/year)
Nitrogen	Divide by 14
Sulphur	Divide by 16

[8] Air Quality Advisory Group, AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air, March 2014

Pollutant	Conversion Factor (kg/ha/year to keq/ha/year)
Hydrogen chloride	Divide by 35.5

The March 2014 version of the AQTAG06 document states that, for installations with an HCl emission, the PC of HCl, in addition to S and N, should be considered in the acidity Critical Load assessment. The H+ from HCl should be added to the S contribution (and treated as S in APIS tool). This should include the contribution of HCl from wet deposition.

Consultation with AQMAU confirmed that the maximum of the wet or dry deposition rate for HCl should be included in the calculation. For the purpose of this analysis it has been assumed that wet deposition of HCl is double dry deposition.

The contribution from process emissions from the Facility has been calculated using APIS formula:

Where PEC N Deposition < CLminN:

PC as % of CL function = PC S deposition / CLmaxS

Where PEC N Deposition > CLminN:

PC as % of CL function = (PC S + N deposition) / CLmaxN

9.2 Results – atmospheric emissions - Critical Levels

The impact of process emissions from the Facility has been compared to the Critical Levels and the results are presented in Table 34 and Table 35. If the PC of a particular pollutant is greater than 1% of the long-term or 10% of the short-term Critical Level at a European or UK designated site, or 100% of the long- or short-term Critical Level at a local nature site, further assessment would be undertaken. The PC has been calculated based on the maximum predicted in each designated site using all five years of weather data. This assumes operation at the daily ELVs as set out in Table 17.

Table 34: Process Contribution at Designated Ecological Sites – μg/m³

Site	NOx		SO_2	HF		NH_3
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
European designated sites (within 10 km) and UK designated sites (within 2 km)						
Medway Estuary and Marshes SPA/Ramsar/SSSI	0.45	6.10	0.11	0.025	0.051	0.037
Thames Estuary and Marshes SPA/Ramsar	0.23	2.02	0.06	0.008	0.017	0.019
Queendown Warren SAC	0.03	0.70	0.01	0.001	0.006	0.002
Benfleet and Southend Marshes SPA/Ramsar	0.05	0.59	0.01	0.002	0.005	0.004

Table 35: Process Contribution at Designated Ecological Sites – as % of Critical Level

Site	NOx		SO_2	HF		NH_3
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
European designated sites (within 10 km) and UK designated sites (within 2 km)						
Medway Estuary and Marshes SPA/Ramsar/SSSI	**1.50%**	8.13%	0.56%	4.98%	1.01%	**1.25%**
Thames Estuary and Marshes SPA/Ramsar	0.77%	2.69%	0.29%	1.52%	0.34%	0.64%
Queendown Warren SAC	0.10%	0.93%	0.07%	0.29%	0.12%	0.25%
Benfleet and Southend Marshes SPA/Ramsar	0.16%	0.78%	0.06%	0.38%	0.10%	0.14%

Notes:

As shown in Table 15 the higher Critical Levels of 20 µg/m³ for sulphur dioxide and 3 µg/m³ for ammonia have been applied at all sites, with the exception of Queensdown Warren SAC where the lower Critical Levels of 10 µg/m³ for sulphur dioxide and 1 µg/m³ for ammonia apply.

As shown in Table 35, at all designated sites the PC from the Facility is less than the screening and can be screened out as ‘insignificant’ for all pollutants considered, with the exception of annual mean NOx and annual mean ammonia at the Medway Estuary and Marshes SPA/Ramsar/SSSI.

The following Illustrative plot files of impacts that cannot be screened out as ‘insignificant’ have been produced:

- Figure 12 [Annual Mean Oxides of Nitrogen]; and
- Figure 13 [Annual Mean Ammonia].

Exceedances of the screening criteria do not automatically result in a significant effect but do require further analysis to determine the significance of effect. For annual mean impacts, the PEC has been calculated for each site, taking the background concentrations for the grid square where the maximum PC occurs in each site, to determine the potential for a significant effect.

Table 36: Impact at Designated Ecological Sites – Further Analysis of Annual Mean Impacts

Site	Facility (µg/m³)	Background (µg/m³	PEC	
			(µg/m³)	% of CL
Annual Mean Oxides of Nitrogen				
Medway Estuary and Marshes SPA/Ramsar/SSSI	0.45	15.70	16.15	53.83%
Annual Mean Ammonia				
Medway Estuary and Marshes SPA/Ramsar/SSSI	0.037	1.100	1.137	37.90%

As shown, at the Medway Estuary and Marshes SPA/Ramsar/SSSI the PEC is below 70% of the Critical Level for annual mean oxides of nitrogen and ammonia, so the impact can be screened out as 'not significant' and the impact is 'not significant'.

9.3 Results - deposition of emissions - Critical Loads

Appendix C presents the results at each of the identified statutory designated ecological receptors. As shown, at all designated sites the contribution from process emissions from the Facility is less than the screening criteria and can be screened out as 'insignificant' at all designated sites considered, with the exception of nitrogen deposition impacts on saltmarsh habitats at the Medway Estuary and Marshes SPA/Ramsar/SSSI and at the Thames Estuary and Marshes SPA/Ramsar/SSSI. Figure 14 shows the extent of impacts that cannot be screened out as 'insignificant'.

Baseline nitrogen deposition already exceeds the Critical Load, so the nitrogen deposition impacts cannot be screened out based on PEC.

Further assessment of the impact of nitrogen deposition has been undertaken by Fayrewood Ecology and is presented in Appendix J of the Application Pack. This has concluded that nitrogen deposition due to emissions from the Facility will result in "no likely significant effects" on the identified habitats within the designated sites.

10 Cumulative Assessment

10.1 Identification of cumulative point source emissions

In addition to the Facility, point sources of emissions to air have been identified within the local area, consisting of the following:

1. Damhead Creek I (an operational 805 MWe natural gas fired CCGT power station); and
2. Damhead Creek II power station (a proposed 1,800 MWe natural gas fired CCGT power station).

As the Damhead Creek I power station has been operational for many years, the contribution made to the baseline pollutant concentrations is already included for as detailed in Section 4.

The proposed additional Damhead Creek II power station, which has not yet been constructed, is described in a permit variation issued by the EA on 30 June 2017 (Ref: EPR/DP3933DN/V002) as the following:

"an additional 1,800 megawatt electrical (MWe) combined cycle gas turbine (CCGT) power plant fired on natural gas…to be located adjacent to the existing Damhead Creek Power Station at Kingsnorth, Hoo St Werburgh, Rochester. The additional CCGT power plant will comprise of three generating units each consisting of a gas turbine, heat recovery steam generator (HRSG) and a steam turbine in a single shaft configuration. Each CCGT has an electricity capacity of 600 MWe (thermal input of 1,093 MWth each)".

The detailed atmospheric dispersion modelling conducted to support the Environmental Permit Variation application represented a worst case scenario for impacts of nitrogen dioxide and carbon monoxide from both the existing installation and proposed additional installation. These maximum impacts were described in the Decision Document that accompanied the grant of the EP variation. However, it has not been possible to obtain the Air Quality Assessment submitted with the EP application, so the model inputs required to include the Damhead Creek II power station as a source in the dispersion modelling are not available. Therefore, a worst-case cumulative impact assessment has been undertaken whereby the maximum impact of the Damhead Creek II power station has been added to the maximum impact of the Facility. This is conservative as the maximum impacts are not likely to occur at the same location, or at the same time (for short-term impacts). The cumulative assessment results are detailed in Section 10.2 for human health and Section 10.3 for ecology.

10.2 Results – Human health

As detailed in Section 8, the impact of the Facility screens out as insignificant for nitrogen dioxide and carbon monoxide (the only two pollutants regulated within the varied EP for Damhead Creek II). However, for completeness, both the long term and short term impacts from the cumulative development on the overall PEC has been considered and are outlined in Table 37and Table 38.

Table 37: Cumulative Analysis - Human Health - Annual Mean Nitrogen Dioxide

Source	At point of maximum impact (µg/m³)	as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
AQAL (µg/m³)				**40**
Baseline(1)	20.76	51.90%	-	-
Facility	0.32	0.79%	21.08	52.69%
Damhead Creek II Power Station(2)	2.01	5.03%	22.77	56.93%

Source	At point of maximum impact (µg/m³)	as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
Total cumulative impact	2.33	5.81%	23.09	57.71%

(1) *Maximum monitored concentration from suburban or urban background LAQM within 5 km of Site.*

(2) *PC obtained from Table 1 of EP variation decision notice (Ref: EPR/DP3933DN/V002)*

As shown in Table 37, the inclusion of the Damhead Creek II cumulative development would not change the conclusion that all other long term impacts would screen out as 'insignificant' as the overall PEC is well below 70% of the AQAL at the point of maximum impact.

Table 38: Cumulative Analysis - Human Health - Short Term Impacts

Source	At point of maximum impact (µg/m³)	as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
99.79th %ile of hourly mean nitrogen dioxide				
AQAL (µg/m³)				**200**
Baseline(1)	41.52	20.76%	-	-
Facility	5.21	2.61%	46.73	23.37%
Damhead Creek II Power Station(2)	53.7	26.85%	95.22	47.61%
Total cumulative impact	58.91	29.46%	100.43	50.22%
8-hour running mean carbon monoxide				
AQAL (µg/m³)				**10,000**
Baseline(1)	878.00	8.78%	-	-
Facility	5.69	0.06%	883.69	8.84%
Damhead Creek II Power Station	270.51	2.71%	1148.51	11.49%
Total cumulative impact	276.20	2.76%	1154.20	11.54%
Hourly mean carbon monoxide				
AQAL (µg/m³)				**30,000**
Baseline(1)	878.00	2.93%	-	-
Facility	19.45	0.06%	897.45	2.99%
Damhead Creek II Power Station	486.49	1.62%	1364.49	4.55%
Total cumulative impact	505.94	1.69%	1383.94	4.61%

(1) *Assumed to be twice the long-term background concentration detailed in section 4.*

(2) *PC obtained from Table 1 of EP variation decision notice (Ref: EPR/DP3933DN/V002)*

As demonstrated in Table 38, the inclusion of the Damhead Creek II cumulative development would not change the conclusion that all short term impacts are not significant; the cumulative PC for carbon monoxide remains well below 10% of the AQAL and can be screened out as 'insignificant'. The cumulative PC for hourly mean nitrogen dioxide exceeds 10% of the AQAL so cannot be screened out as 'insignificant'; however, the PEC remains well below the AQAL so there is no risk of cumulative emissions causing an exceedance of the AQAL.

10.3 Results – Ecology

10.3.1 Medway Estuary & Marshes Ramsar and SPA

Table 39: Cumulative Analysis - Airborne Impacts - Medway Estuary & Marshes Ramsar and SPA

Source	at point of maximum impact (µg/m³)	as % of Critical Level	PEC (PC +Bg)	PEC as % of Critical Level
Annual Mean Oxides of Nitrogen				
Critical Level (µg/m³)				**30**
Baseline(1)	15.60	52.00%	-	-
Facility	0.45	1.50%	16.05	53.50%
Damhead Creek II Power Station(2)	2.86	9.53%	18.46	61.53%
Total cumulative PC	3.31	11.03%	18.91	63.03%
Daily Mean Oxides of Nitrogen				
Critical Level (µg/m³)				**75**
Baseline(1)	31.20	41.60%	-	-
Facility	6.10	8.13%	37.30	49.73%
Damhead Creek II Power Station(2)	29.58	39.44%	60.78	81.04%
Total cumulative PC	35.68	47.57%	66.88	89.17%
(1) *Background concentration from APIS for point of maximum impact*				
(2) *PC obtained from Table 4 of EP variation decision notice (Ref: EPR/DP3933DN/V002)*				

Whilst the maximum annual mean impact of oxides of nitrogen exceeds the 1% screening criteria, as stated in section 9.2, the resultant maximum PEC as a result of the Facility is well below the 70% screening criteria and can be screened out as 'insignificant'. When considered cumulatively with the proposed Damhead Creek II power station, the resultant maximum cumulative PEC is 63.03% of the Critical Level and can be screened out as 'not significant'.

The daily mean impact cannot be screened out as 'insignificant' when considered cumulatively, although the maximum cumulative PEC is of 89.17% of the short-term Critical Level so no exceedance of the Critical Level is predicted. The PC from the Facility alone is 8.13% which demonstrates the cumulative short term impact is dominated by the contribution from Damhead Creek II power station.

Table 40: Cumulative Analysis - Deposition Impacts- Medway Estuary & Marshes Ramsar and SPA

Nitrogen Deposition	at point of maximum impact (kgN/ha/yr)	as % of Critical Load	PEC (PC +Bg)	PEC as % of Critical Load
Nitrogen Deposition Impacts				
Lower Critical Load (kgN/ha/yr)				**10**
Baseline[(1)]	13.65	136.52%	-	-
Facility	0.24	2.40%	13.89	138.92%
Damhead Creek II Power Station	0.41	4.10%	14.06	140.62%
Total cumulative PC	0.65	6.50%	14.30	143.02%
[(1)] *Maximum deposition rate from APIS site specific information*				
[(2)] *PC obtained from Table 4 of EP variation decision notice (Ref: EPR/DP3933DN/V002)*				

As shown in Table 43, the baseline nitrogen deposition rate at the Facility's point of maximum impact (obtained from the APIS site specific information GIS tool) is in excess of the 10 kg N/ha/yr lower Critical Load. The PEC of the Facility would increase the baseline from 136.52% to 138.92%, whilst the cumulative impact including Damhead Creek II power station would result in a PEC of 143.02% of the lower Critical Load.

As the cumulative PC exceeds 1% of the Critical Load and the PEC exceeds the Critical Load, further assessment has been undertaken by Fayrewood Ecology and is presented in Appendix J of the Application Pack. This has concluded that cumulative emissions from the Facility and the Damhead Creek II power station will have "no likely significant effects" on the identified habitats within the designated site.

10.3.2 Thames Estuary Ramsar and SPA

Table 41: Cumulative Analysis - Airborne Impacts - Thames Estuary & Marshes Ramsar and SPA

Source	at point of maximum impact (µg/m³)	as % of Critical Level	PEC (PC +Bg)	PEC as % of Critical Level
Annual Mean Oxides of Nitrogen				
Critical Level (µg/m³)				**30**
Baseline[(1)]	15.70	52.33%	-	-
Facility	0.08	0.27%	15.78	52.60%
Damhead Creek II Power Station[(2)]	1.06	3.53%	16.76	55.87%
Total cumulative PC	1.14	3.80%	16.84	56.14%
Daily Mean Oxides of Nitrogen				
Critical Level (µg/m³)				**75**
Baseline[(1)]	31.40	41.87%	-	-
Facility	2.02	2.69%	33.42	44.56%

Source	at point of maximum impact (µg/m³)	as % of Critical Level	PEC (PC +Bg)	PEC as % of Critical Level
Damhead Creek II Power Station[2]	14.41	19.21%	45.81	61.08%
Total cumulative PC	16.43	21.91%	47.83	63.77%

[1] *Background concentration from APIS for point of maximum impact*

[2] *PC obtained from Table 4 of EP variation decision notice (Ref: EPR/DP3933DN/V002)*

At Thames Estuary Ramsar and SPA, both the annual mean and short-term daily mean oxides of nitrogen impacts of the Facility screen out as 'insignificant'. When incorporating the cumulative impact of Damhead Creek II power station, the resultant maximum PCs exceed 1% of the long-term and 10% of the short-term Critical Levels, so cannot be screened out as 'insignificant'. However, the cumulative annual mean PEC is less than 70% of the Critical Level so is 'not significant', and the cumulative short-term PEC is well below the Critical Level. Therefore, no significant effects are predicted.

Table 42: Cumulative Analysis - Deposition Impacts- Thames Estuary & Marshes Ramsar and SPA

Nitrogen Deposition	at point of maximum impact (kgN/ha/yr)	as % of Critical Load	PEC (PC +Bg)	PEC as % of Critical Load
Nitrogen Deposition Impacts				
Lower Critical Load (kgN/ha/yr)				**10**
Baseline[1]	13.52	135.18%	-	-
Facility	0.12	1.23%	13.64	136.41%
Damhead Creek II Power Station	0.15	1.50%	13.67	136.68%
Total cumulative PC	0.27	2.73%	13.79	137.91%

[1] *Maximum deposition rate from APIS site specific information*

[2] *PC obtained from Table 4 of EP variation decision notice (Ref: EPR/DP3933DN/V002)*

Similarly to Medway Estuary & Marshes Ramsar and SPA, the baseline nitrogen deposition rate at point of maximum impact within Thames Estuary Ramsar and SPA is in excess of the 10 kg N/ha/yr lower Critical Load. The PEC of the Facility would increase the baseline from 135.18% to 136.41%, whilst the cumulative impact including Damhead Creek II power station would result in a PEC of 137.91% of the lower Critical Load. As the cumulative PC exceeds 1% of the Critical Load and the PEC exceeds the Critical Load, further assessment has been undertaken by Fayrewood Ecology and is presented in Appendix J of the Application Pack. This has concluded that cumulative emissions from the Facility and the Damhead Creek II power station will have "no likely significant effects" on the identified habitats within the designated site.

11 Conclusions

This Dispersion Modelling Assessment has been undertaken to support an application for an EP for the Facility. This has been undertaken based on the assumption that the Facility will operate continually at the emission limits compliant with the BAT-AELs set out in the WI BREF for new plants, with the exception of oxides of nitrogen for which an emission limit lower than the upper end of the BAT-AEL range is being applied for.

This assessment has included a review of baseline pollution levels, dispersion modelling of emissions and quantification of the impact of these emissions on local air quality.

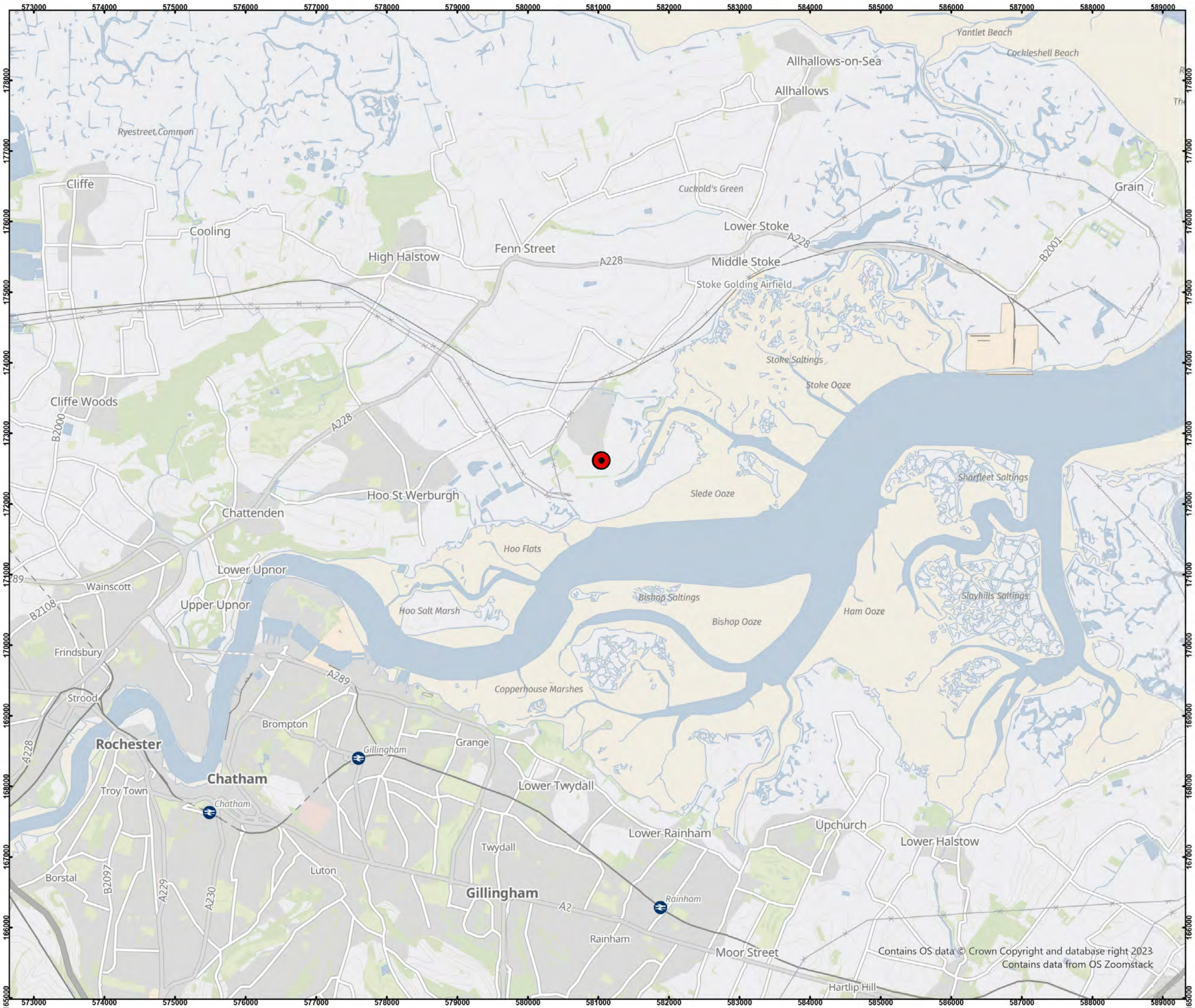
The primary conclusions of the assessment are presented below.

1. In relation to the impact on human health:
    a. Emissions from the operation of the Facility will not cause a breach of any AQAL.
    b. The overall impact of long-term process emissions associated with the operation of the Facility can be considered ‘insignificant’ or ‘not significant’ in accordance with EA screening criteria at the point of maximum impact and at all identified human sensitive receptors.
    c. The overall impact of short-term process emissions associated with the operation of the Facility can be screened out as ‘insignificant’ in accordance with EA screening criteria at the point of maximum impact , except for 15-minute mean sulphur dioxide. However, as the PC is less than 20% of the headroom, there is little risk of exceedance of the AQAL so the impact is ‘not significant’.
2. In relation to the impact on ecologically sensitive sites, all impacts can be screened out as ‘insignificant’ or ‘not significant’, except for nitrogen deposition impacts at the Medway Estuary SPA/Ramsar Site/SSSI. Further analysis undertaken by the project ecologist has concluded no significant effects are likely.
3. Emissions from the Damhead Creek II power station, which has been permitted but not constructed, would not result in a significant cumulative impact on human health or ecology.

In summary, the assessment has shown that the operation of the Facility will not cause a breach of any AQAL, and the overall impact of process emissions can be screened out as ‘not significant’ at the point of maximum impact and at all sensitive receptor locations. As such, there should be no air quality constraint in granting an EP to operate the Facility.

Appendices

A Figures



Legend

Stack location

Title:

Figure 1. Site Location

Drawn by: MJC | Date: 11/12/2023

Map data © OpenStreetMap

0 0.5 1 2 km

Scale: 1:50,000

N

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Consulting Engineers Limited

Kingsgate, Wellington Road North,
Stockport, Cheshire, SK4 1LW
Tel: 0161 476 0032
Fax: 0161 474 0618

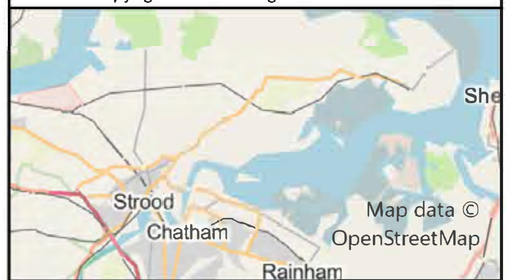
Legend

- Stack location
- Human Sensitive Receptors
- AQMAs

Title:

Figure 2. Human Sensitive Receptors and AQMAs

Drawn by: MJC | Date: 11/12/2023



0 0.25 0.5 1 km

N

Scale: 1:25,000

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Kingsgate, Wellington Road North,
Stockport, Cheshire, SK4 1LW
Tel: 0161 476 0032
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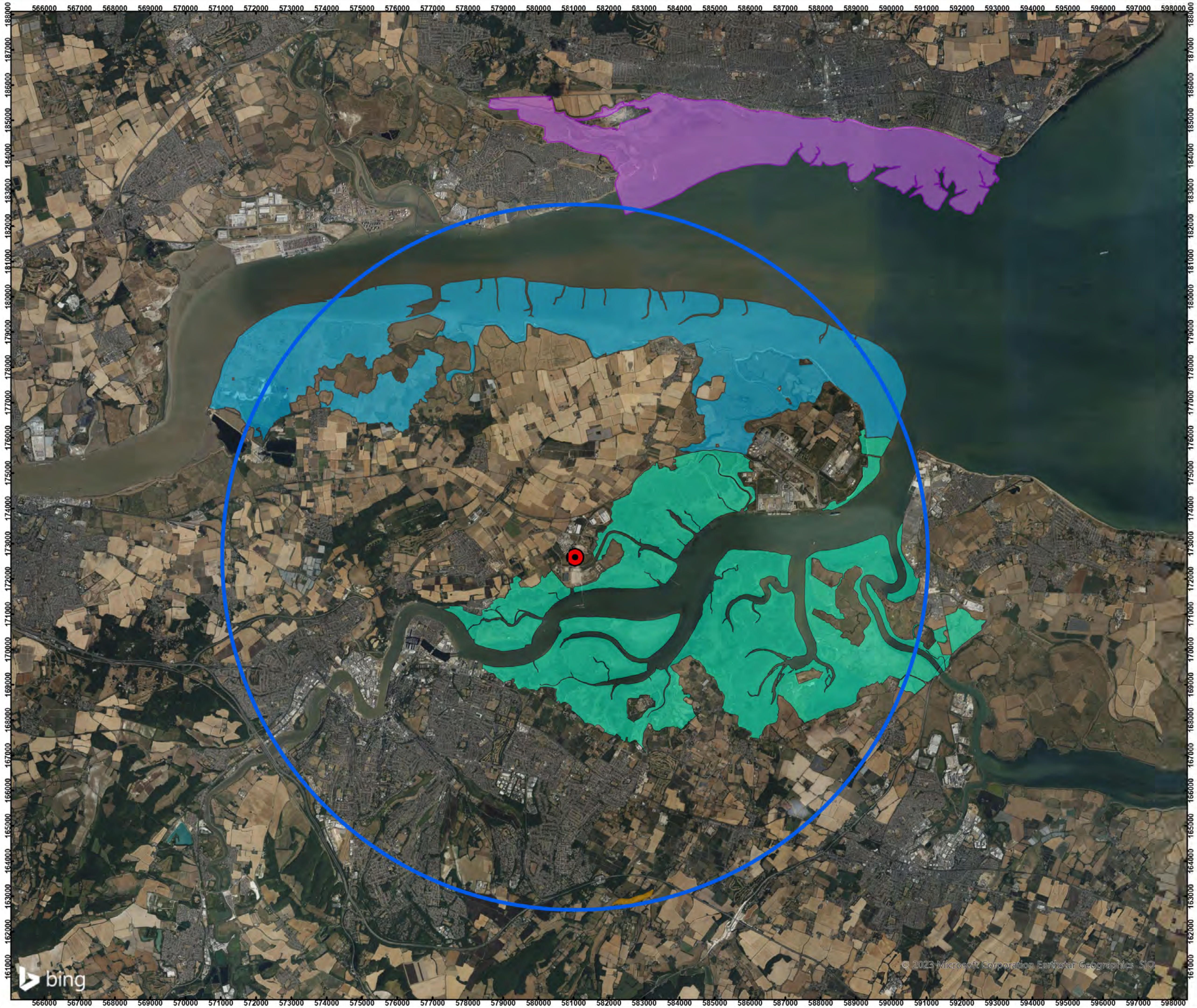

Legend

- Stack
- 10km Ecological Screening Distance
- Medway Estuary and Marshes SPA/Ramsar/SSSI
- Thames Estuary and Marshes SPA/Ramsar
- Benfleet and Southend Marshes SPA/Ramsar
- Queendown Warren SAC

Title:

Figure 3. Ecological Sensitive Receptors

Drawn by: MJC	Date: 11/12/2023

0 1 2 4 km

Scale: 1:100,000

N

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Legend

Stack

10km x 10km wide output grid extent

Title:

Figure 4. Modelling Domain

Drawn by: MJC	Date: 11/12/2023

0 0.4 0.8 1.6 km

Scale: 1:40,000

N

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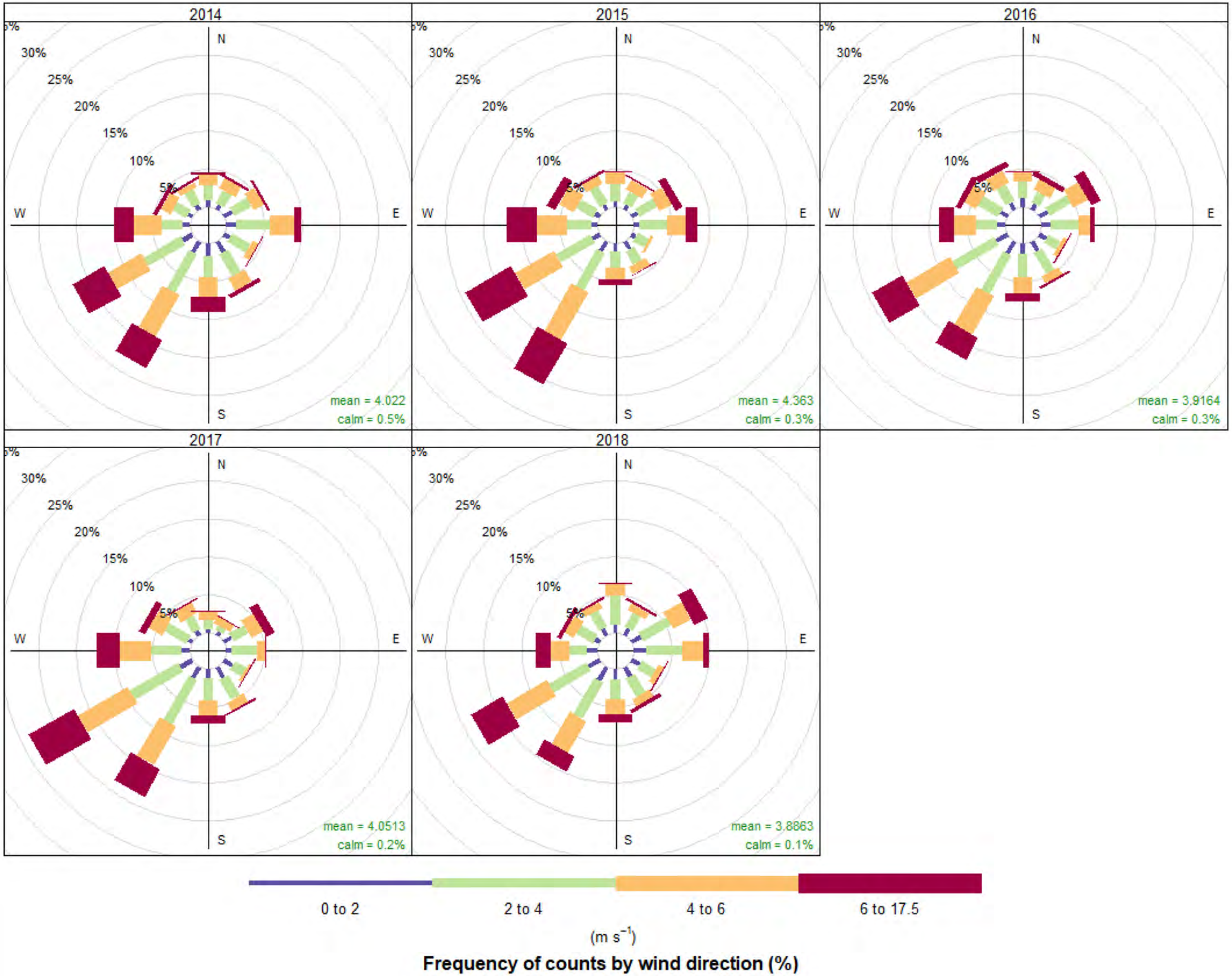
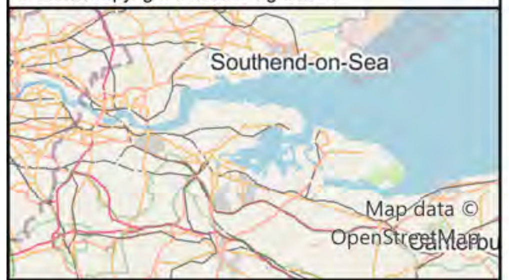


Title:

Figure 5. Gravesend Broadness Wind Roses

Drawn by: MJC

Date: 14/12/2023



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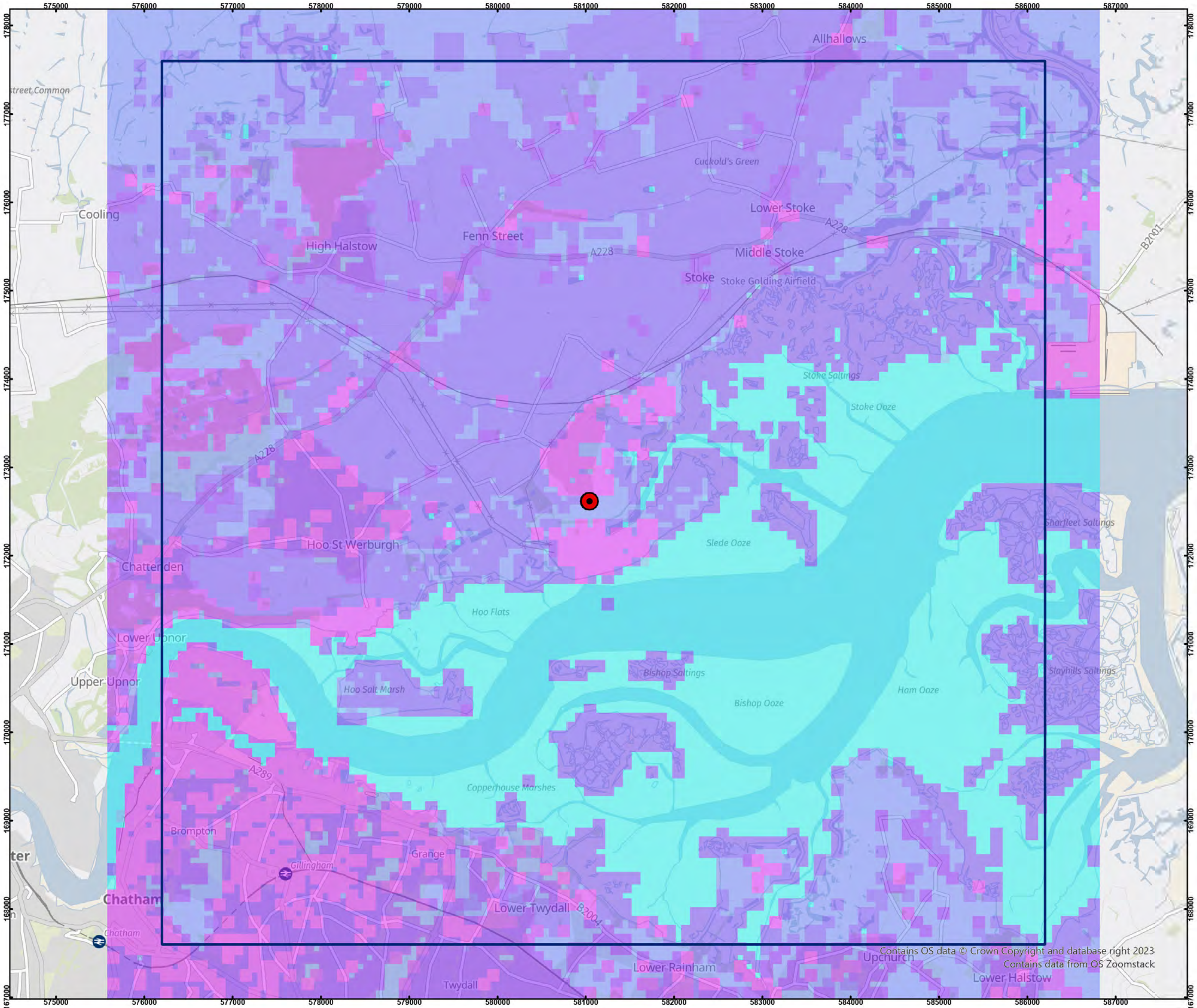

Legend

- Stack location
- 10km x 10km wide output grid extent

Surface Roughness Length (m)

- 0.0001
- 0.0005
- 0.03
- 0.05
- 0.5
- 0.75
- 1.2

Title:

Figure 6. Surface Roughness File

Drawn by: MJC	Date: 11/12/2023

0 0.4 0.8 1.6 km

N

Scale: 1:40,000

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Stockport, Cheshire, SK4 1LW
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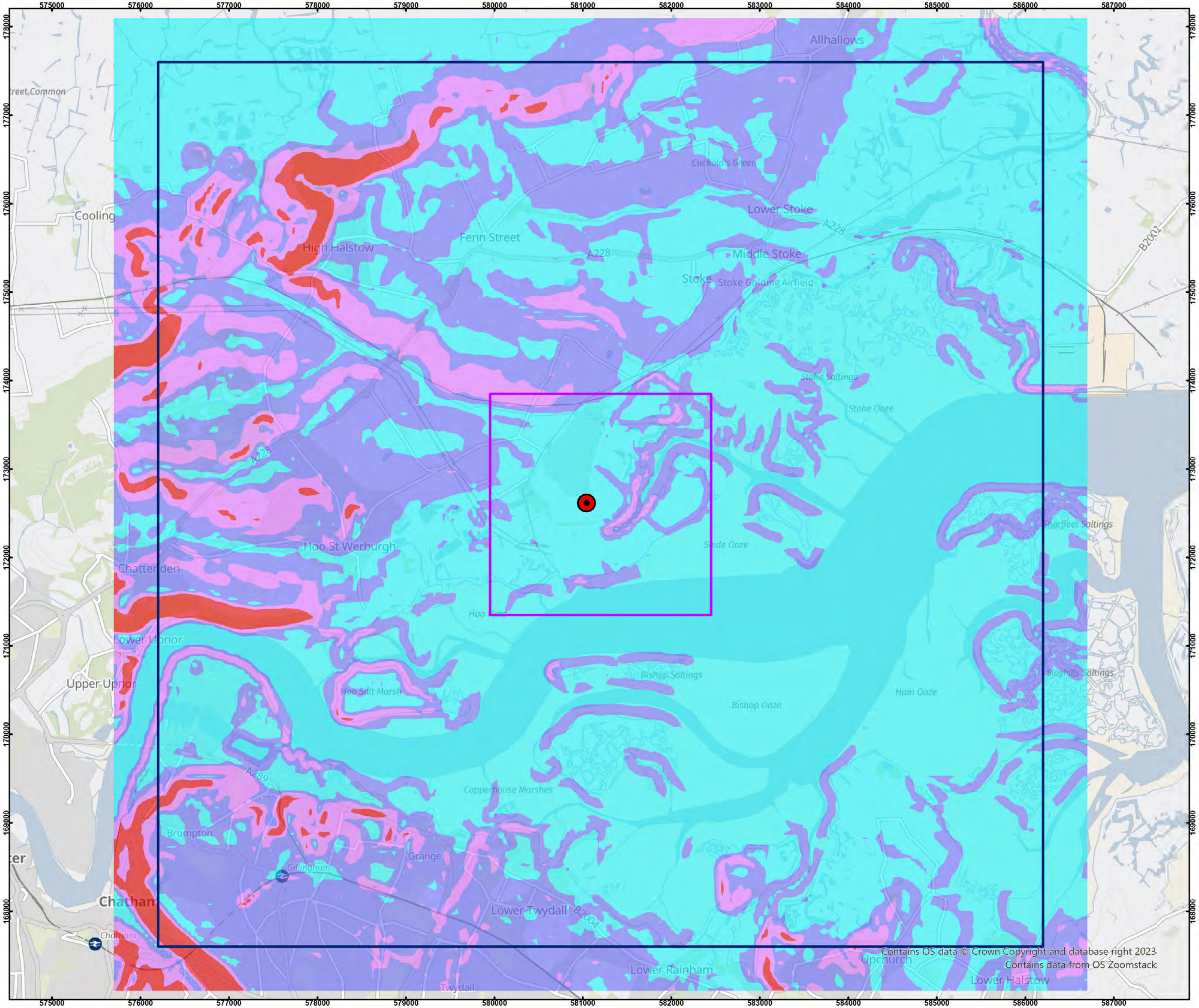

Legend

- Stack location
- 2.5km x 2.5km nested grid extent
- 10km x 10km wide output grid extent

Terrain Slope Gradient (%)

- 0 - 2
- 2 - 5
- 5 - 10
- >10

Title:

Figure 7. Terrain File

Drawn by: MJC | Date: 13/12/2023

0 0.4 0.8 1.6 km

Scale: 1:40,000

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Legend

Stack location

Buildings

Title:

Figure 8. Buildings Modelled

Drawn by: MJC | Date: 12/12/2023

0 0.03 0.05 0.1 km

Scale: 1:2,500

N

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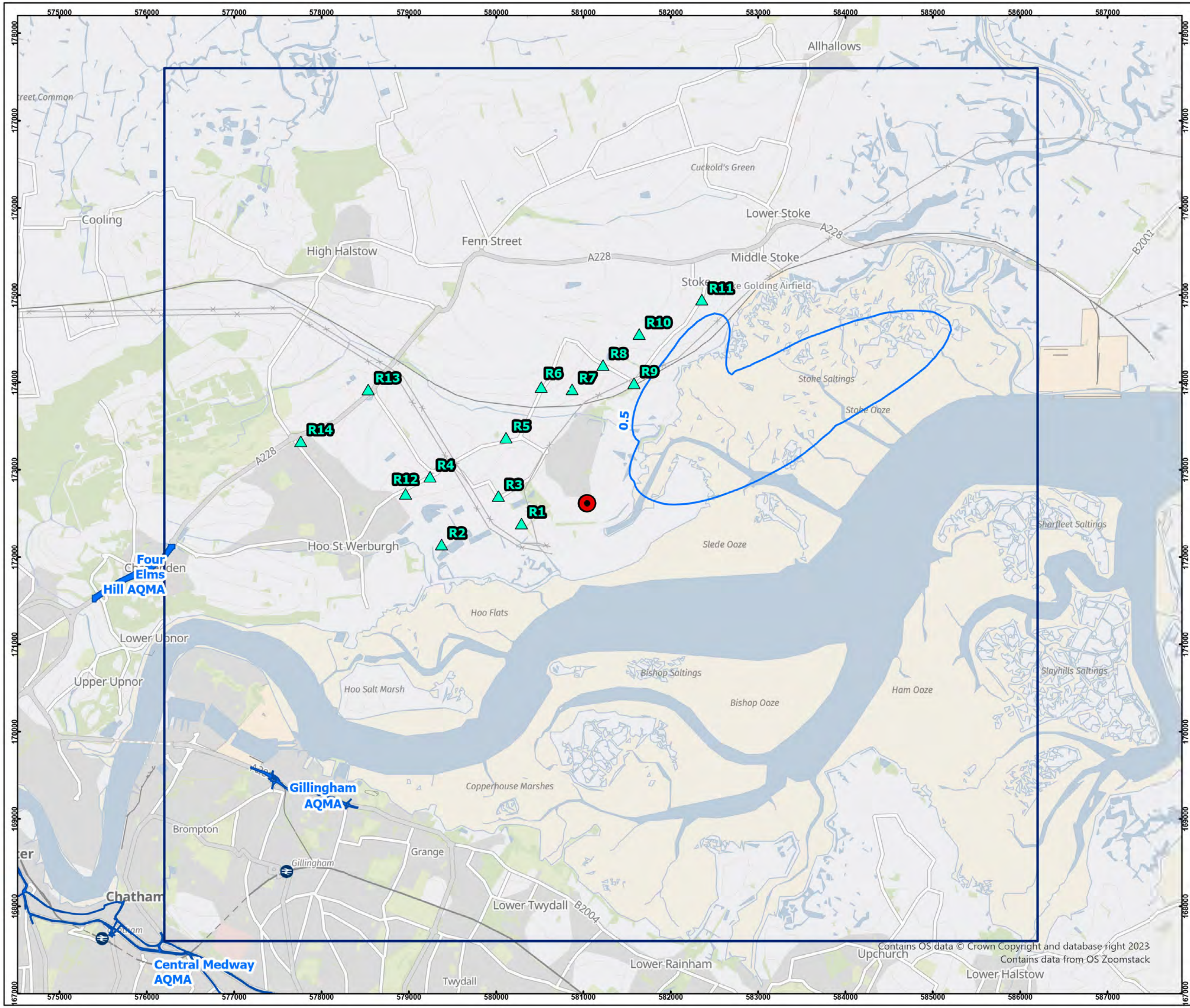

Legend

- Stack
- 10km x 10km wide output grid extent
- AQMAs
- Human Sensitive Receptors
- Annual Mean Nitrogen Dioxide (% of AQAL)

Note:

All PCs presented as % of AQAL
Assumes 70% conversion rate of NOx to NO2

Title:

Figure 9. Annual Mean Nitrogen Dioxide

Drawn by: MJC | Date: 13/12/2023

Scale: 1:40,000

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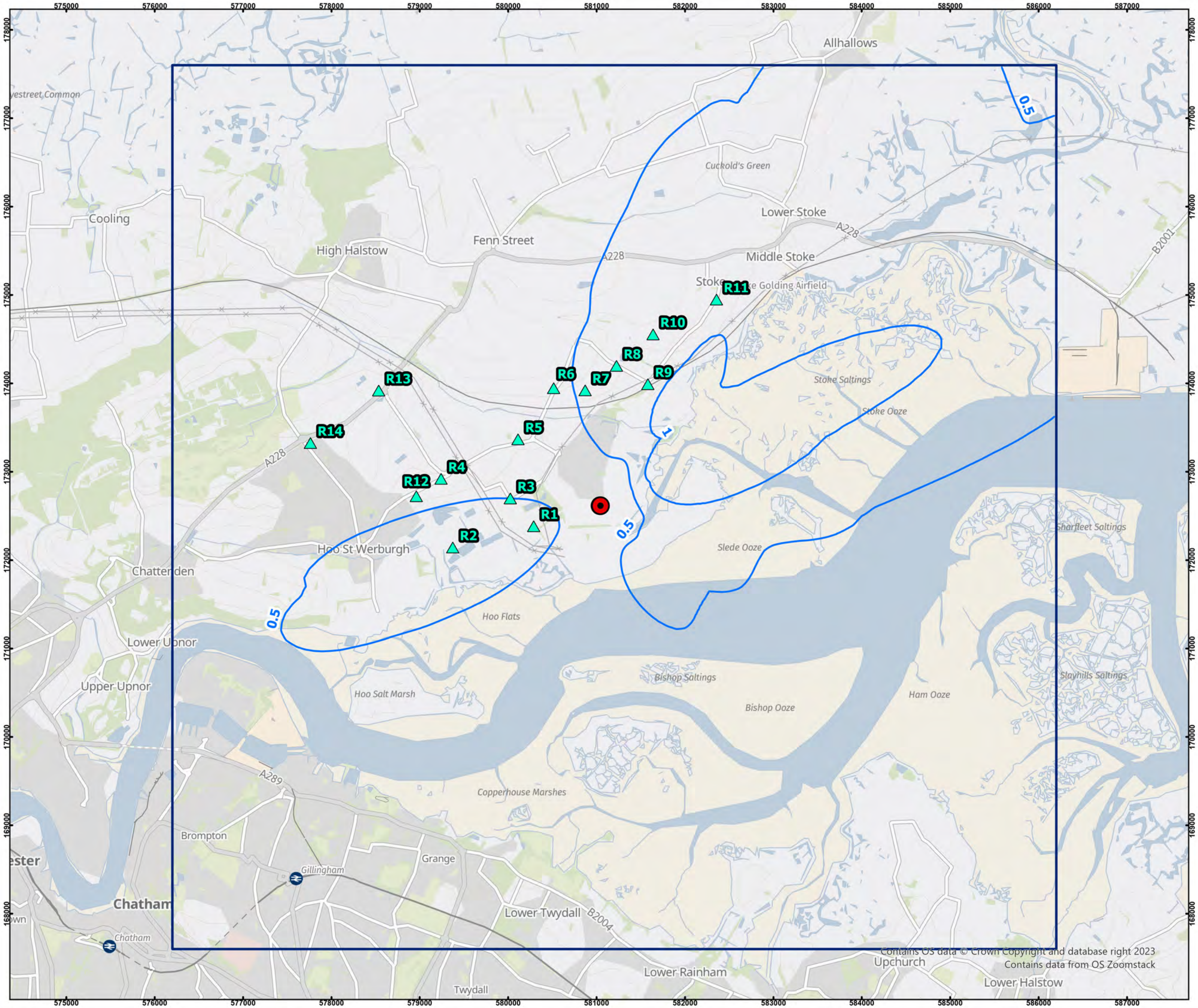

Legend

- Stack
- 10km x 10km wide output grid extent
- Human Sensitive Receptors
- Annual Mean Cadmium (% of AQAL)

Note:

All PCs presented as % of AQAL
Assumes 100% emitted as Cadmium

Title:

Figure 10. Annual Mean Cadmium

Drawn by: MJC	Date: 14/12/2023

0 0.4 0.8 1.6 km

Scale: 1:40,000

N

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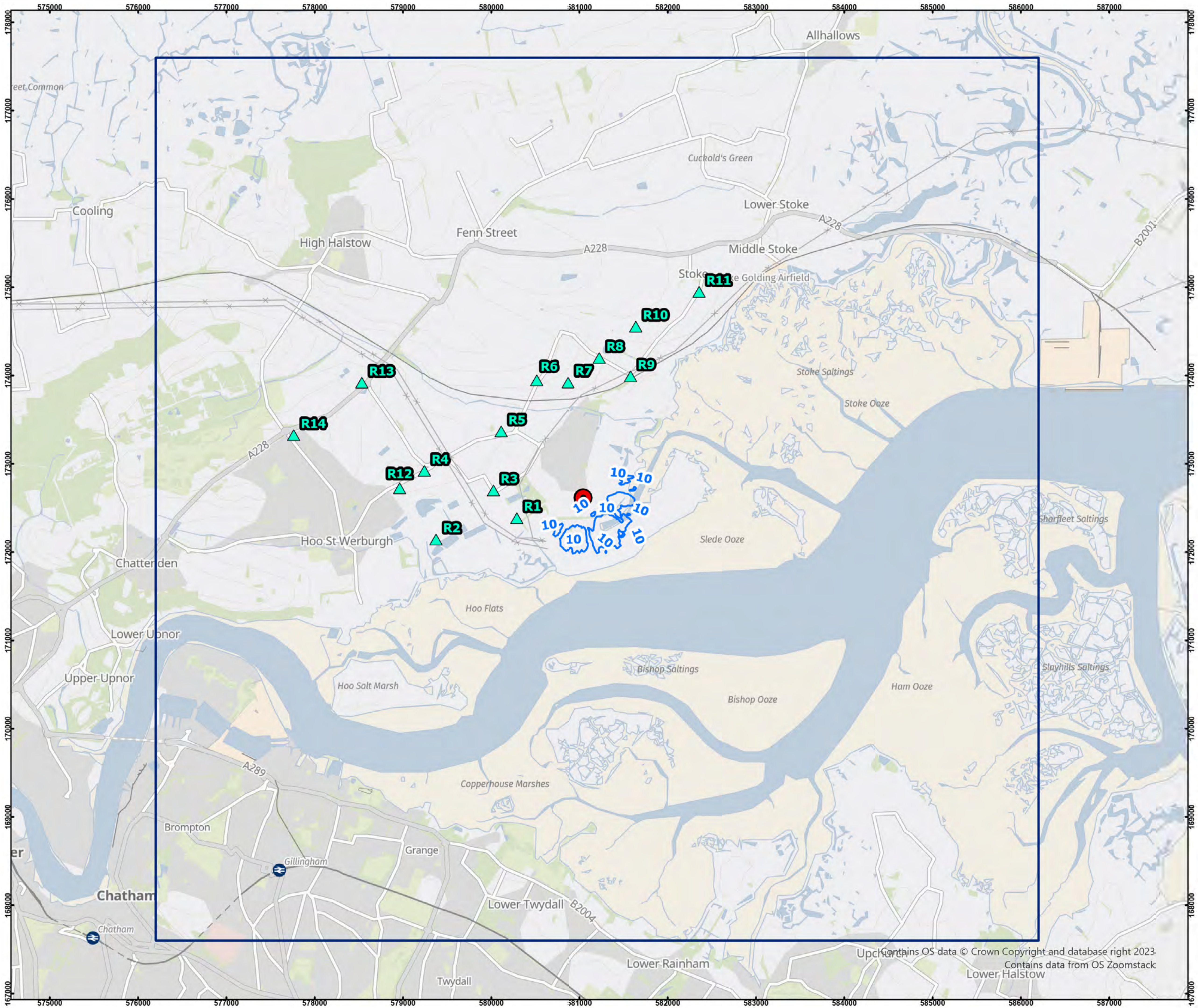

Legend

- Stack
- 10km x 10km wide output grid extent
- Human Sensitive Receptors
- 99.9th Percentile of 15-Minute Mean Sulphur Dioxide (% of AQAL)

Note:

All PCs presented as % of AQAL

Title:

Figure 11. 15-Minute Mean Sulphur Dioxide

Drawn by: MJC	Date: 13/12/2023

0 0.4 0.8 1.6 km

N

Scale: 1:40,000

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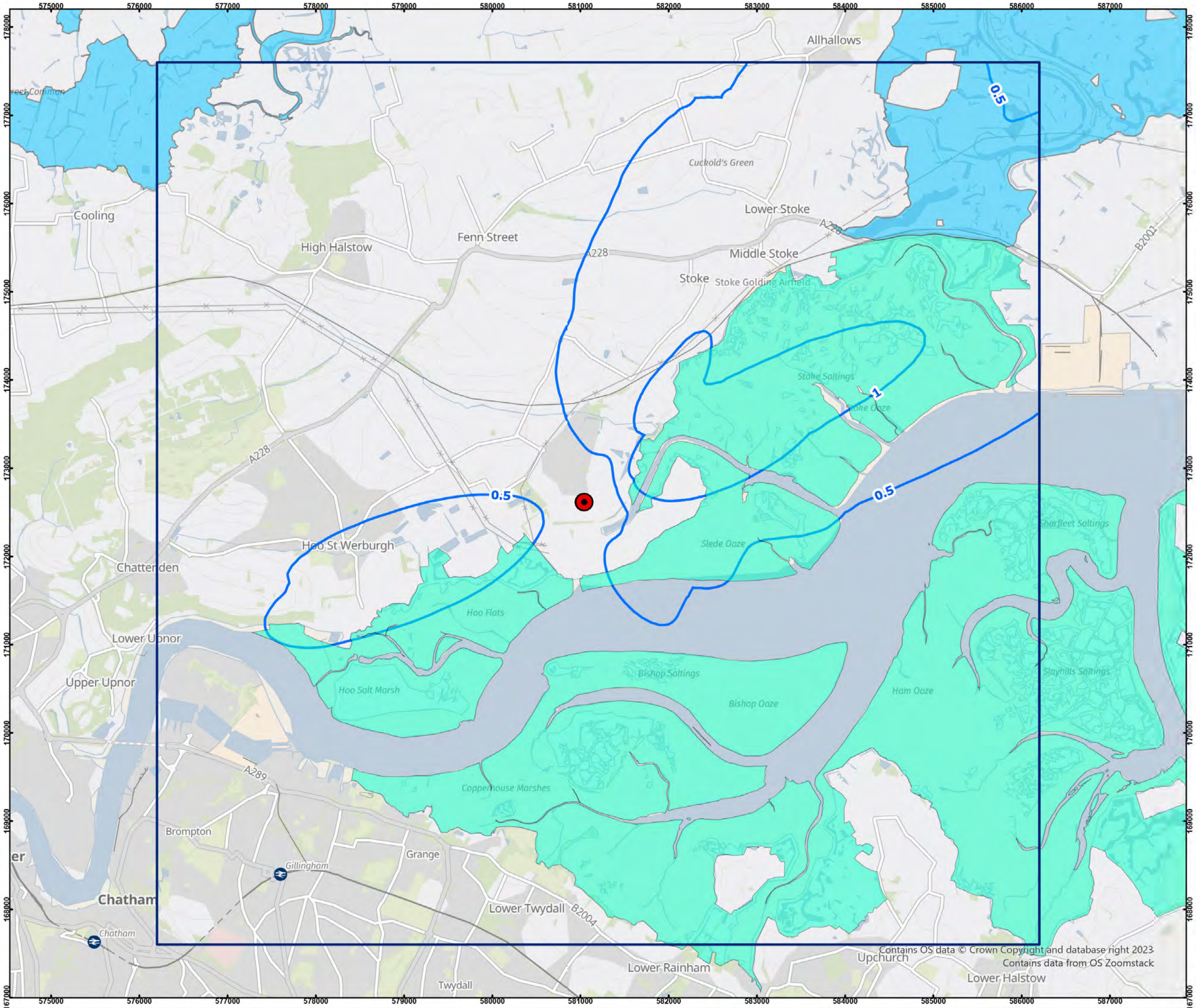

Legend

- Stack
- 10km x 10km wide output grid extent
- Medway Estuary and Marshes SPA/Ramsar/SSSI
- Thames Estuary and Marshes SPA/Ramsar
- Benfleet and Southend Marshes SPA/Ramsar
- Queendown Warren SAC
- Annual Mean Oxides of Nitrogen (% of CL30)

Note:

All PCs presented as % of Critical Level (30 µg/m3)

Title:

Figure 12. Annual Mean Oxides of Nitrogen

Drawn by: MJC	Date: 13/12/2023

0 0.4 0.8 1.6 km

Scale: 1:40,000

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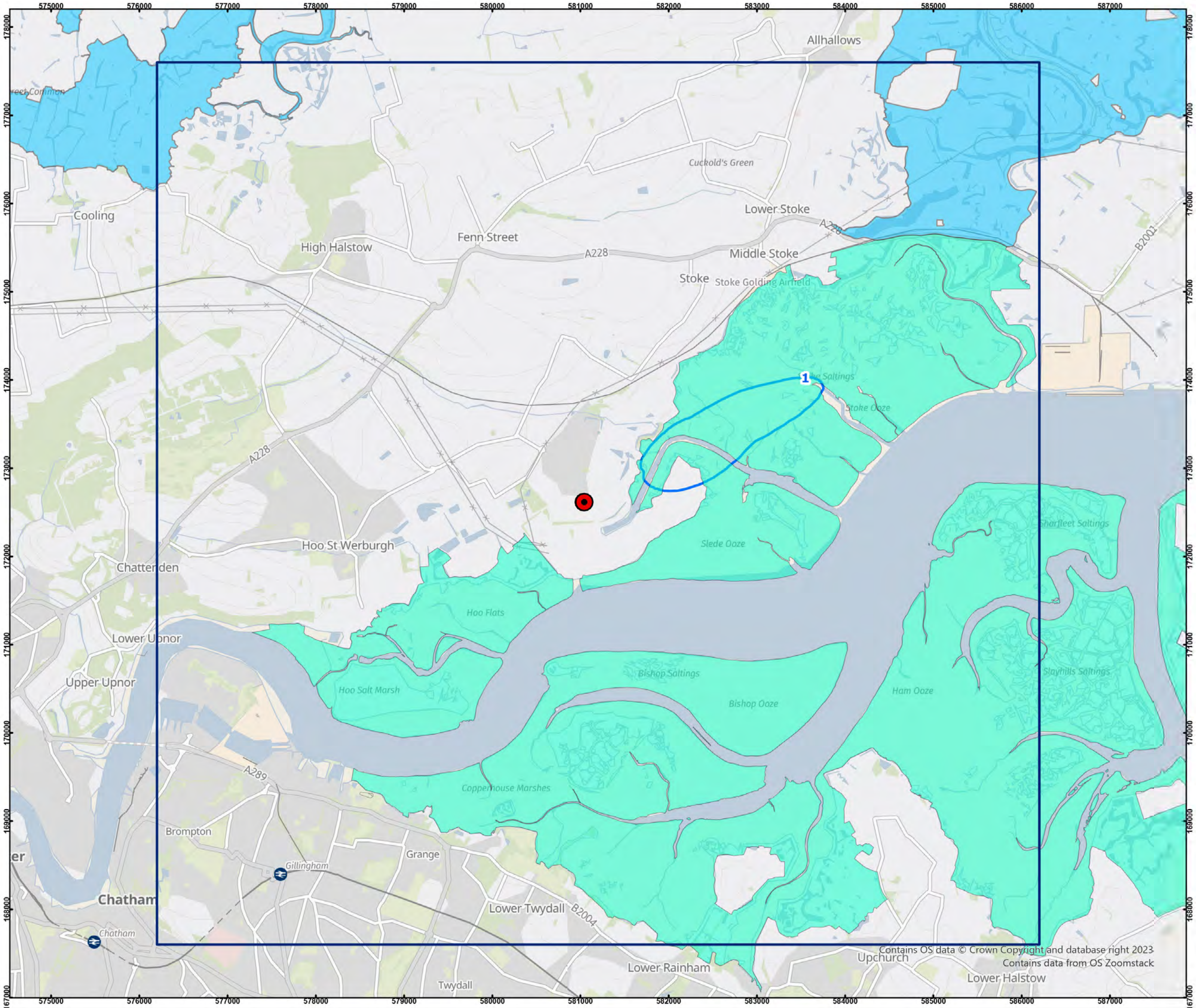

Legend

- Stack
- 10km x 10km wide output grid extent
- Medway Estuary and Marshes SPA/Ramsar/SSSI
- Thames Estuary and Marshes SPA/Ramsar
- Benfleet and Southend Marshes SPA/Ramsar
- Queendown Warren SAC
- Annual Mean Ammonia (% of CL3)

Note:

All PCs presented as % of Critical Level (3 μg/m3)

Title:

Figure 13. Annual Mean Ammonia

Drawn by: MJC | Date: 13/12/2023

Scale: 1:40,000 (0, 0.4, 0.8, 1.6 km)

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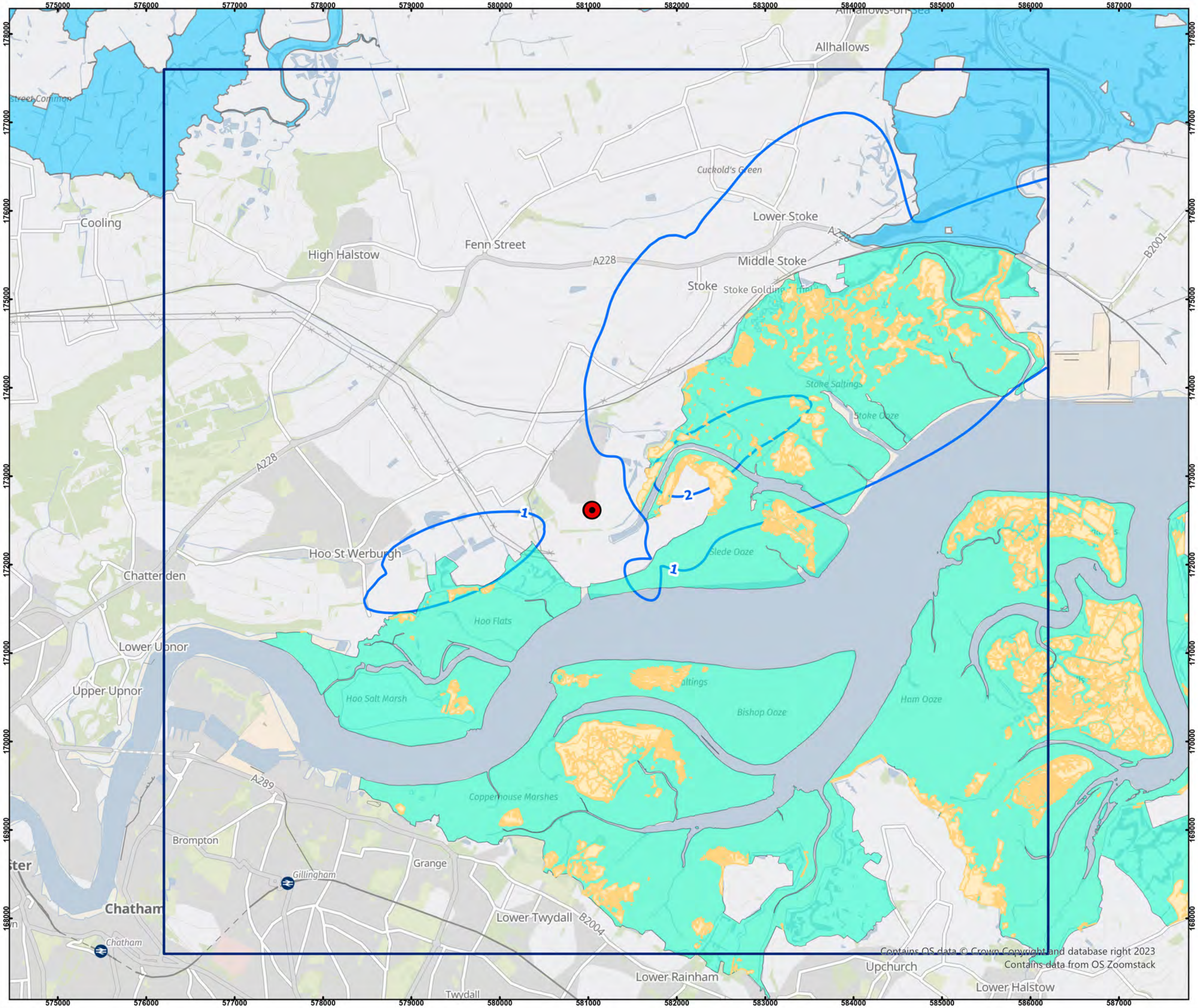

Legend

- Stack
- 10km x 10km wide output grid extent
- Coastal Saltmarsh Habitat Identified
- Medway Estuary and Marshes SPA/Ramsar/SSSI
- Thames Estuary and Marshes SPA/Ramsar
- N Deposition as % of CL 10 kgN/ha/yr

Notes:
All PCs presented as % of the Critical Load of 10 kgN/ha/yr
Includes contribution from NO2 and NH3

Title:

Figure 14. Nitrogen Deposition

Drawn by: SMN | Date: 18/12/2023

Map data © OpenStreetMap

Scale: 1:40,000 (0, 0.4, 0.8, 1.6 km)

N

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B APIS Critical Loads

Table 43: Nitrogen Deposition Critical Loads

Site	Species/Habitat Type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Maximum Background (kgN/ha/yr)
European and UK Statutory Designated Sites					
Medway Estuary and Marshes SPA/Ramsar/SSSI	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	10	20	13.652
Thames Estuary and Marshes SPA/Ramsar	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	10	20	13.518
Queendown Warren SAC	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	Sub-atlantic semi-dry calcareous grassland	15	25	14.261
	Asperulo-Fagetum beech forests	Fagus forest on non-acid and acid soils	10	15	25.306
Benfleet and Southend Marshes SPA/Ramsar	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	10	20	13.188

Table 44: Acid Deposition Critical Loads

Site	Species/Habitat Type	Acidity Class	Critical Load Function (keq/ha/yr)			Maximum Background N+S (keq/ha/yr)
			CLminN	CLmaxN	CLmaxS	
European and UK Statutory Designated Sites						
Medway Estuary and Marshes SPA/Ramsar/SSSI	No sensitive features	-	-	-	-	-
Thames Estuary and Marshes SPA/Ramsar	No sensitive features	-	-	-	-	-
Queendown Warren SAC	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	Calcareous Grassland	0.856	4.856	4	1.059
	Asperulo-Fagetum beech forests	Unmanaged Broadleafed/Coniferous Woodland	0.142	2.076	1.934	1.868
Benfleet and Southend Marshes SPA/Ramsar	No sensitive features	-	-	-	-	-

C Deposition Analysis at Ecological Sites

Table 45: Annual Mean PC used for Deposition Analysis

Site	Annual Mean PC (ng/m^3)			
	Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia
European and UK Statutory Designated Sites				
Medway Estuary and Marshes SPA/Ramsar/SSSI	315.0	112.5	22.5	37.4
Thames Estuary and Marshes SPA/Ramsar	161.4	57.6	11.5	19.2
Queendown Warren SAC	21.0	7.5	1.5	2.5
Benfleet and Southend Marshes SPA/Ramsar	34.6	12.4	2.5	4.1

Table 46: Deposition Calculation

Site	Deposition Velocity	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
		NO_2	SO_2	HCl	NH_3		N	S
European and UK Statutory Designated Sites								
Medway Estuary and Marshes SPA/Ramsar/SSSI	Grassland	0.045	0.213	0.345	0.194	0.240	0.017	0.023
Thames Estuary and Marshes SPA/Ramsar	Grassland	0.023	0.109	0.177	0.100	0.123	0.009	0.012
Queendown Warren SAC	Grassland	0.003	0.014	0.023	0.013	0.016	0.001	0.002
	Woodland	0.006	0.028	0.055	0.019	0.025	0.002	0.003
Benfleet and Southend Marshes SPA/Ramsar	Grassland	0.005	0.023	0.038	0.021	0.026	0.002	0.003

Table 47: Detailed Results – Nitrogen Deposition

Site	NCL Class	Deposition Velocity	PC			PEC		
			PC N dep kgN/ha/yr	% of Lower CL	% of Upper CL	PEC N dep kgN/ha/yr	% of Lower CL	% of Upper CL
European and UK Statutory Designated Sites								
Medway Estuary and Marshes SPA/Ramsar/SSSI	Pioneer, low-mid, mid-upper saltmarshes	Grassland	0.24	**2.40%**	**1.20%**	13.9	**138.9%**	69.5%
Thames Estuary and Marshes SPA/Ramsar	Pioneer, low-mid, mid-upper saltmarshes	Grassland	0.12	**1.23%**	0.61%	13.6	**136.4%**	68.2%
Queendown Warren SAC	Sub-atlantic semi-dry calcareous grassland	Grassland	0.02	0.11%	0.06%	14.3	95.2%	57.1%
	Fagus forest on non-acid and acid soils	Woodland	0.03	0.25%	0.17%	25.3	253.3%	168.9%
Benfleet and Southend Marshes SPA/Ramsar	Pioneer, low-mid, mid-upper saltmarshes	Grassland	0.03	0.26%	0.13%	13.2	132.1%	66.1%

Table 48: Detailed Results – Acid Deposition

Site	Acidity Class	Deposition Velocity	PC			PEC	
			N keq/ ha/yr	S keq/ ha/yr	% of CL Function	N+S keq/ ha/yr	% of CL Function
European and UK Statutory Designated Sites							
Medway Estuary and Marshes SPA/Ramsar/SSSI	No sensitive features	-	-	-	-	-	-
Thames Estuary and Marshes SPA/Ramsar	No sensitive features	-	-	-	-	-	-
Queendown Warren SAC	Calcareous Grassland	Grassland	0.001	0.002	0.06%	1.06	21.9%
	Unmanaged Broadleafed/Coniferous Woodland	Woodland	0.002	0.003	0.25%	1.87	90.2%
Benfleet and Southend Marshes SPA/Ramsar	No sensitive features	-	-	-	-	-	-

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