Appendix 6B: Operation Phase Assessment

Table of Contents

Contents

6B. Air Quality – Operational Phase Assessment 1
6B.1 Introduction 1
6B.2 Scope 1
6B.3 Methodology 4
6B.4 Baseline Air Quality 15
6B.5 Baseline Assessment 19
6B.6 Future Assessment 37
6B.7 Assessment Limitations and Assumptions 58
6B.8 Conclusions 58
6B.9 References 59
6B.10 Annex 6B.A – Sensitivity Testing of Model Inputs 60
6B.11 Annex 6B.B – Assessment of Visible Plumes 62

Tables

Table 6B.1: Modelled Scenarios for the Assessment 4
Table 6B.2: General ADMS 5 Model Inputs 6
Table 6B.3: Stack Emission Parameters for all Modelled Sources 8
Table 6B.4: Assessed Emission Concentrations and Emission Rates 9
Table 6B.5: Human Health Receptor Locations 10
Table 6B.6: Ecological Receptor Locations 11
Table 6B.7: Buildings Included in the Model Set-up 14
Table 6B.8: Deposition Conversion Rates Ecological Receptors 15
Table 6B.9: Baseline Pollutant Concentrations for Human Health Receptors 15
Table 6B.10: Baseline Pollutant Concentrations for Ecological Receptors 16
Table 6B.11: Baseline Deposition Data for Ecological Receptors 17
Table 6B.12: VPI Baseline – Maximum Human Health Impacts at Any Receptor 19
Table 6B.13: VPI Baseline – Ecological Impacts of NOx 21
Table 6B.14: VPI Baseline – Annual Average Ecological Impacts of SO_2 22
Table 6B.15: VPI Baseline – Nitrogen Deposition at Ecological Receptors 23
Table 6B.16: VPI Baseline – Acid Deposition at Ecological Receptors 24
Table 6B.17: Phillips 66 Baseline – Maximum Human Health Impacts at Any Receptor 25
Table 6B.18: Phillips 66 Baseline – Ecological Impacts of NOx 27
Table 6B.19: Phillips 66 Baseline – Annual Average Ecological Impacts of SO_2 28
Table 6B.20: Phillips 66 Baseline – Annual Average Ecological Impacts of NH_3 28
Table 6B.21: Phillips 66 Baseline – Nitrogen Deposition at Ecological Receptors 30
Table 6B.22: Phillips 66 Baseline – Acid Deposition at Ecological Receptors 31
Table 6B.23: In-Combination Baseline – Maximum Human Health Impacts at Any Receptor 32
Table 6B.24: In-Combination Baseline – Ecological Impacts of NOx 33
Table 6B.25: In-Combination Baseline – Annual Average Ecological Impacts of SO_2 34
Table 6B.26: In-Combination Baseline – Nitrogen Deposition at Ecological Receptors 35
Table 6B.27: In-Combination Baseline – Acid Deposition at Ecological Receptors 36

Table 6B.28: VPI Future – Maximum Human Health Impacts at Any Receptor 38
Table 6B.29: VPI Future – Ecological Impacts of NOx 40
Table 6B.30: VPI Future – Annual Ecological Impacts of SO_2 41
Table 6B.31: VPI Future – Annual Ecological Impacts of NH_3 41
Table 6B.32: VPI Future – Nitrogen Deposition at Ecological Receptors 42
Table 6B.33: VPI Future – Acid Deposition at Ecological Receptors 43
Table 6B.34: Phillips 66 Future – Maximum Human Health Impacts at Any Receptor 45
Table 6B.35: Phillips 66 Future – Ecological Impacts of NOx 47
Table 6B.36: Phillips 66 Future – Annual Average Ecological Impacts of SO_2 48
Table 6B.37: Phillips 66 Future – Annual Ecological Impacts of NH_3 48
Table 6B.38: Phillips 66 Future – Nitrogen Deposition at Ecological Receptors 49
Table 6B.39: Phillips 66 Future – Acid Deposition at Ecological Receptors 50
Table 6B.40: In-Combination Future – Maximum Human Health Impacts at Any Receptor 52
Table 6B.41: In-Combination Future – Ecological Impacts of NOx 54
Table 6B.42: In-Combination Future – Annual Ecological Impacts of SO_2 55
Table 6B.43: In-Combination Future – Annual Ecological Impacts of NH_3 55
Table 6B.44: In-Combination Future – Nitrogen Deposition at Ecological Receptors 56
Table 6B.45: In-Combination Future – Acid Deposition at Ecological Receptors 57
Table 6B.A1: Dispersion Model Sensitivity Analysis – VPI Future Assessment 60
Table 6B.A2: Dispersion Model Sensitivity Analysis – Phillips 66 Future Assessment 61
Table 6B.B1: Visible Plumes from the VPI Absorber Stacks 62
Table 6B.B2: Visible Plumes from the P66 WGS and Absorber Stacks 63

6B. Air Quality – Operational Phase Assessment

6B.1 Introduction

6B.1.1 Emissions associated with the operational Proposed Developments have the potential to affect human health and sensitive ecosystems, if not appropriately managed. This Technical Appendix 6B supports Chapter 6: Air Quality (ES Volume I) and describes the additional details for the dispersion modelling of operational point source emissions from the Proposed Developments. This assessment considers the likely significant effects on air quality as a result of the Proposed VPI Development and the Proposed Phillips 66 Development both in isolation and in-combination (i.e. the Proposed Developments together). For more details about the Proposed Developments, refer to Chapter 3: Project Description, Needs and Alternatives Considered (ES Volume I).

6B.1.2 The magnitude of air quality impacts at sensitive human and ecological receptors has been quantified through detailed dispersion modelling of the pollutants emitted from the main stacks associated with the Proposed VPI Development and the Proposed Phillips 66 Development. The impact of emissions on human health receptors has been considered in the context of the relevant Air Quality Standards (AQS) and Environmental Assessment Levels (EALs), as described in Chapter 6: Air Quality (ES Volume I). The magnitude of air quality impacts at sensitive ecological receptors has been considered in the context of relevant critical levels and critical loads for designated and non-designated ecological sites.

6B.1.3 The assessment has considered emissions from the Proposed Developments during normal operational conditions only. Non routine emissions, such as those which may occur during the commissioning process or other abnormal short-term events would typically only occur on an infrequent basis, would be detected by the process control systems and be rectified within a short time period. Information provided to date by Shell, suggests that during such periods although there may be slight increases in pollutant concentrations, the overall mass release of pollutant present in the release will not increase over those assessed, as stack airflows will be lower during such times.

6B.1.4 The operation of the Proposed VPI Development and the Proposed Phillips 66 Development are tightly regulated by the Environment Agency through the Environmental Permits in place at both the VPI and Phillips 66 Sites. Both sites will require an Environmental Permit variation to include the operation of the PCC plants, and therefore no detailed consideration of impacts associated with the commissioning process or potential abnormal events from the Proposed Developments have been included in this assessment, as it is envisaged that such assessments will be provided during the Environmental Permit Variation process.

6B.1.5 Chapter 16: Major Accidents and Disasters (ES Volume I) includes an assessment of the reasonably foreseeable worst-case environmental consequences potentially arising as a result of the Proposed Developments.

6B.1.6 Annex 6B.A of this Appendix provides a sensitivity analysis of the model input parameters.

6B.1.7 Annex 6B.B of this Appendix provides an assessment of visible plumes from the Proposed Developments' stacks.

6B.2 Scope

Operational Traffic Emissions

6B.2.1 Chapter 8: Traffic and Transport (ES Volume I) sets out that during the operational of the Proposed Development that there would be no more than an additional 10 HDVs and 100

LDVs on the local road network (Para. 8.3.15). Movements of this magnitude are below the IAQM screening criteria set out in paragraph 6.3.11 of Chapter 6: Air Quality, and it is considered that operational traffic would not give rise to significant effects.

Operational Process Emissions

6B.2.2 The Study Area for the operational Proposed Developments point source emissions extends up to 15 km from the sources, in order to assess the potential impacts on ecological receptors, in line with the Environment Agency risk assessment methodology (Defra and Environment Agency, 2016). This includes:

- Special Protection Areas (SPA), Special Areas of Conservation (SAC), Ramsar sites and Sites of Special Scientific Interest (SSSI) within 15 km; and
- Local Nature Sites (including ancient woodlands, Local Wildlife Sites (LWS) and National and Local Nature Reserves (NNR and LNR) within 2 km.

6B.2.3 In terms of human health receptors, impacts from the operational Proposed Developments become negligible within approximately 2 km from the sources and therefore sensitive receptors for the human health impacts are concentrated within a 2 km Study Area.

Existing Emissions (Baseline Assessment)

6B.2.4 The Baseline Assessment has considered the impact of the existing emissions on local air quality under normal operating conditions, with all sources assumed to be operating for 8,760 hours per year, as this represents the worst-case for annual average impacts.

VPI Baseline

6B.2.5 Existing combustion emissions from the VPI Site occur from the Gas Turbines (GT) 1 and 2 and Auxiliary (Aux) Boilers 1 and 2. At present, the emissions from these sources are released to air via dedicated flues held within a single windshield (stack), which is 90 m high.

6B.2.6 In order to determine the impacts associated with the existing emissions (i.e. the 'VPI Baseline Assessment'), these sources have been modelled at the existing emission parameters and emission limit values, as detailed in the Environmental Permit for the VPI Site. Both annual average and hourly average emission limits are provided in the Environmental Permit and therefore the appropriate limit values have been used for the corresponding averaging times within the dispersion modelling assessment.

Phillips 66 Baseline

6B.2.7 Existing emissions from the 115 m high Fluid Catalytic Cracker (FCC) stack on the Phillips 66 Site comprise emissions from the FCC Regenerator and also from the FCC Feed Heater and the Isostripper reboiler.

6B.2.8 The existing emissions from the FCC stack have been modelled in isolation, to determine the impact associated with the current emissions from this source (i.e. the 'Phillips 66 Baseline Assessment'). Emissions from the FCC stack have been modelled at the current emission parameters and emission limit values, as detailed in the Environmental Permit for the Phillips 66 Site. Only monthly mean emission limits values are specified for the FCC stack (with the exception of CO, which is daily) within the Permit and therefore these have been used for all averaging periods.

In-Combination Baseline

6B.2.9 The existing VPI sources and the existing Phillips 66 FCC source have then also been modelled in-combination, in order to determine the existing impacts from both these sources (i.e. the 'In-combination Baseline').

Operational Proposed Developments Emissions (Future Assessment)

6B.2.10 As with the Baseline Assessment, the Future Assessment has considered the impact of the future operational processes for the Proposed VPI Development and the Proposed Phillips 66

Development both in isolation and in-combination to determine the change to local air quality as a result of the PCC plants becoming operational.

6B.2.11 The Future Assessments again assume normal operating conditions, with the PCC plants operating for 8,760 hours per year. The assessment considers impacts in the earliest year in which the Proposed Developments are due to commence operation, 2027.

6B.2.12 The predicted model output concentrations (Process Contributions (or PCs)) of the Baseline Assessment have been compared to the PCs from the Future Assessment, as detailed in Chapter 6: Air Quality (ES Volume I) in order to determine the change between the predicted impacts of the Baseline Assessment and Future Assessment.

VPI Future

6B.2.13 The existing VPI emissions will be re-directed to two VPI PCC plants, and therefore will be released via two new emission points on the VPI Site (i.e. the 'VPI Future Assessment').

6B.2.14 For the VPI Future Assessment, the emission limit values of the pollutants assessed for the VPI Baseline Assessment are assumed to continue to be applicable to the emissions from the PCC plants once these become operational. The emissions from the existing GTs and Aux Boilers are currently at the Best Available Technique-Associated Emission Levels (BAT-AEL) for the relevant technology type, as detailed in the Large Combustion Plant (LCP) Best Available Technique (BAT) Reference document (LCP BRef) (European Commission, 2017) (e.g. due to the differing technologies, Gas Turbines and Boilers have different BAT-AELs). However, as it is intended that each PCC plant will receive the flue gas from one GT and one Aux Boiler, the pollutant emission release rates of both these sources has been combined and used within the model as the release from each PCC absorber stack.

6B.2.15 Emissions of amines have been based on information provided by Shell as achievable emissions limits from Proposed VPI Development.

Phillips 66 Future

6B.2.16 The existing Phillips 66 FCC Regenerator emission will vent to a new PCC plant via a new Selective Catalytic Reduction (SCR) plant and a new Wet Gas Scrubber (WGS), which will reduce the emissions from the FCC Regenerator in order to optimise the PCC process. There may be times when the PCC plant is not operational, specifically when the WGS is first commissioned, as this will be prior to the PCC plant becoming operational, and therefore the emissions from both the WGS and the PCC plant have been assessed individually for the Proposed Phillips 66 Development. The worst-case results for either the WGS or the PCC plant have been presented for the pollutants that will be released from both stacks.

6B.2.17 It is envisaged that the emissions from the FCC Regenerator, the FCC Feed Heater and the Isostripper reboiler will all be directed to the Phillips 66 PCC plant. However, there is some uncertainty as to whether it will be possible to route the FCC Feed Heater and the Isostripper reboiler to the PCC plant due to potential safety and reliability concerns. As such, it may be that these continue to release from the existing FCC stack.

6B.2.18 To take this into account in the assessment, the emissions from the FCC Feed Heater and the Isostripper reboiler have been assumed to continue to be released from the existing FCC stack and they have also been included in the emissions from the WGS/ PCC plant absorber. Therefore, there is a degree of double counting of the emissions from the FCC Feed Heater and the Isostripper reboiler, however as these are only minor sources compared to the FCC Regenerator, it is not considered that the results will be significantly impacted by this emission.

6B.2.19 For the Phillips 66 Future Assessment, due to the addition of the SCR plant and the WGS to reduce the FCC combustion emissions, the concentrations of these pollutants will be lower than the current emission limit values for the FCC Stack. BAT-AELs are defined in the Refining of Mineral Oil and Gas BAT BRef (Refineries BRef) (European Commission, 2015) for oxides of nitrogen (NOx), sulphur dioxide (SO_2), particulates, carbon monoxide (CO) and ammonia (NH_3) emissions from catalytic crackers, and therefore where appropriate these values have been applied to the WGS/ PCC Plant stacks, where appropriate. That said, the lower end of the BAT-AEL range for the FCC associated with the use of WGS for abating SO_2 emissions is

100 mg/Nm^3 however it is envisaged that a lower emission concentration will be achievable, and therefore a suitable emission level is proposed based on the emission concentration that is considered to be achievable from the WGS.

6B.2.20 Emissions of amines have been based on information provided by Shell as achievable emissions levels from the Phillips 66 Proposed Development.

Cumulative Impacts

6B.2.21 Cumulative impacts from existing sources of pollution in the area are accounted for in the adoption of site-specific background pollutant concentrations from archive sources and air quality monitoring in close proximity to the Sites.

6B.2.22 It is recognised, however, that there is a potential impact on local air quality from emission sources which have either received or may receive, planning permission or other consent, but have yet to come into operation.

6B.2.23 The full list of short-listed cumulative schemes to be considered for the Proposed Developments are detailed within Chapter 18: Cumulative and Combined Effects (ES Volume I) and an assessment of the potential for cumulative air impacts to occur with the Proposed Developments is presented in Table 18.6 of that Chapter.

Sources of Information

6B.2.24 The information that has been used within this assessment includes:

- Chapter 3: Proposed Developments Description, Needs and Alternatives (ES Volume I);
- Data on existing emissions to atmosphere taken from the existing Environmental Permits for the VPI Site and the Phillips 66 Site and from emissions monitoring data collated by the Sites;
- Data on future emissions to atmosphere provided by the licensor of the PCC plant technology (Shell);
- Details on Proposed Developments' site layouts;
- Ordnance Survey mapping;
- Baseline air quality data from published sources and Local Authorities;
- Meteorological data supplied by ADM Limited; and
- Data on committed developments presented in Chapter 18: Cumulative and Combined Effects (ES Volume I).

6B.3 Methodology

Introduction

6B.3.1 The dispersion of emissions from both existing and future emission sources has been predicted using the latest version of the atmospheric dispersion model ADMS (currently version 5.2.2). The results are presented in both tabular format within this appendix and as contour plots of predicted ground level Process Contributions (PC) overlaid on mapping of the surrounding area (Figures 6.6 – 6.17 in ES Volume III).

6B.3.2 The modelled scenarios, as detailed in Section 6B.2 of this appendix, are shown in Table 6B.1.

Table 6B.1: Modelled Scenarios for the Assessment

Scenario	Modelled Sources	Emission Parameters
Baseline Assessments		
VPI Baseline	GT1, GT2, Aux Boiler 1 and Aux Boiler 2	Environmental Permit emission limit values for pollutants and monitored airflow parameters.
Phillips 66 Baseline	FCC Regenerator Stack (including FCC Feed Heater	

Scenario	Modelled Sources	Emission Parameters
Baseline Assessments		
	and the Isostripper reboiler sources)	
In-Combination Baseline	GT1, GT2, Aux Boiler 1, Aux Boiler 2 and FCC Regenerator Stack	
Future Assessments		
VPI Future	2 New PCC Plant Absorber Stacks	Environmental Permit emission limit values for existing pollutants. Amines modelled as advised by Shell. Design airflow parameters provided by the project engineers.
Phillips 66 Future	New Phillips 66 PCC Plant Absorber Stack and the FCC heater and Isostripper reboiler from the FCC stack	<u>New Phillips 66 PCC Plant Absorber Stack</u> • Lower end of BAT-AELs for NOx • CO BAT-AEL • SO_2 – Expected emission level • Lower end of BAT-AELs for particulates • Lower end of BAT-AELs for NH_3 • Amines modelled as advised by Shell Airflow parameters for the PCC Plant Absorber Stack provided by Phillips 66 Limited. <u>FCC Stack</u> Environmental Permit emission limit values for pollutants for the FCC heater and Isostripper reboiler and existing airflow parameters.
	New WGS stack and the FCC heater and Isostripper reboiler from the FCC stack	<u>New WGS Stack</u> • Lower end of BAT-AELs for NOx • CO BAT-AEL • SO_2 – Expected emission level • Lower end of BAT-AELs for particulates • Lower end of BAT-AELs for NH_3 Airflow parameters for the WGS Stack provided by VPI Immingham LLP. <u>FCC Stack</u> Environmental Permit emission limit values for pollutants for the FCC heaters and existing airflow parameters.
In-Combination Future	New VPI PCC Plant Absorber Stacks x 2 New Phillips 66 WGS or PCC Plant Absorber Stack and the FCC heater and Isostripper reboiler from the FCC stack	As above.

Baseline Assessment

6B.3.3 The Baseline Assessment has considered the effects from emissions of NOx, CO, particulates and SO_2 associated with the operation of the VPI GTs and Aux Boilers and the Phillips 66 FCC

plant both in isolation and in-combination. In addition, impacts of NH_3 have been considered for the Phillips 66 FCC, as this is present in the current emissions from this source.

Future Assessment

6B.3.4 For the Future Assessments the same pollutants assessed for the Baseline Assessments have been modelled again from the new PCC plant emission sources, both in isolation and in-combination. The different release parameters following the installation of the PCC plants, such as differing stack height, air flow, efflux velocity, release temperature and pollutant concentration will all affect the dispersion of these emissions.

6B.3.5 The stack heights for the Future Assessment have been based on the attainment of impacts that are considered to result in impacts that are acceptable and on engineering designs. This means that they differ from the stack heights of the existing sources. For instance, the current VPI stack for emissions from GT1, GT2, Aux Boiler 1 and Aux Boiler 2 is 90 m above ground level, however the proposed PCC plant stacks are 110 m. This is largely due to the lower temperature of the PCC plant emission meaning that additional stack height is required to achieve a similar level of dispersion as the existing stack.

6B.3.6 The Phillips 66 FCC stack is 115m above ground level, but due to the reduction in the emissions as a result of the SCR and WGS, a lower stack (65 – 70 m) for the WGS and PCC plant is capable of resulting in a similar level of dispersion as the existing FCC stack. The final stack height is still undergoing engineering design, however the impacts have been assessed at the lowest envisaged stack height of 65 m above ground level, as it is considered that this will lead to the worst-case impacts.

6B.3.7 Emissions of amines and their breakdown products have also been modelled due to their potential to be present in the emissions from the PCC Plants Absorber stacks. Breakdown products include NH_3 and amides.

6B.3.8 It is also known that amines can degrade into nitrosamines and nitramines (collectively referred to as N-amines) both within the carbon capture process itself and also in the environment following release.

6B.3.9 The direct release of amines and any other degradation products generated in the process (amides) have been considered in the Future Assessment and the results are presented in this appendix.

6B.3.10 Due to the complex atmospheric processes that occur following release of both amines and directly releases N-amines, the impacts of N-amines are considered in Technical Appendix 6C: Air Quality - Assessment of Amine Degradation Products (ES Volume II).

Model Inputs

6B.3.11 The general model conditions applicable to all the model scenarios assessed are summarised in Table 6B.2.

Table 6B.2: General ADMS 5 Model Inputs

Variable	Model Input
Surface roughness at source	0.5 m
Surface roughness at meteorological site	0.2 m
Receptors	Selected discrete receptors (as detailed in Table 6B.5 and Table 6B.6)
Receptor locations	X, Y co-ordinates determined by GIS
	z (ground level) = 1.5 m for residential receptors
	z = 0 m for ecological receptors
Source locations	X, Y co-ordinates determined by GIS

Meteorological data	5 years of meteorological data, Humberside Airport Meteorological Station (2017 - 2021)
Terrain data	Not required

6B.3.12 The assessment has assumed that all sources operate at continuous design load (8,760 hours per year). No time-based variation in emissions has therefore been accounted for within the model.

6B.3.13 For the VPI Baseline Assessment GT1, GT2, and the two Aux boilers flues have been modelled as a combined flue with an additional input ('.aii file').

Emissions Inventory

6B.3.14 The stack emission parameters for all the modelled sources are shown in Table 6B.3.

Table 6B.3: Stack Emission Parameters for all Modelled Sources

Emission Source	Location (x, y)	Stack Height (m)	Stack Diameter (m)	Release Temp (°C)	Stack Airflow (actual) Am^3/s	Stack H_2O Content (%)	Flue O_2 content (dry) (%)	Reference O_2 (%)	Stack flow at reference conditions (STP, dry, Ref O_2)	Stack gas exit velocity (m/s)
VPI Baseline										
GT1	516560, 417029	90	6.7	93	698	9.5	11.0	15	791	19.8
GT2	516567, 417033	90	6.7	93	698	9.5	11.0	15	791	19.8
Aux Boiler 1	516564, 417025	90	3.2	180	154	17.8	1.7	3	82	19.2
Aux Boiler 2	516568, 417027	90	3.2	180	154	17.8	1.7	3	82	19.2
Phillips 66 Baseline										
FCC	515712, 416838	115	2.8	273	102	9.8	2.8	3	46.5	16.6
VPI Future										
New PCC Plant Stack 1	516762, 417001	110	6	44	620	8.9	10.9	15	828	21.9
New PCC Plant Stack 2	516811, 416921	110	6	44	620	8.9	10.9	15	828	21.9
Phillips 66 Future										
New Phillips 66 PCC Plant Stack	515598, 416841	65 - 70	2.0	49	74.4	7.7	5.4	3	50.4	23.7
New WGS Stack	515604, 416816	65 -70	3.1	42	80.4	4.8	4.0	3	62.6	11.0
FCC Stack	515712, 416838	115	2.8	380	33.4	11.0	9.4	3	7.7	5.4

6B.3.15 The modelled pollutant emission rates (in grams per second (g/s)) have been calculated by multiplying the emission concentration by the volumetric flow rate at normalised reference conditions. The emission concentrations that have been assessed for the existing emission sources and those assumed for the Proposed Developments are shown in Table 6B.4.

6B.3.16 Where applicable, different emission concentrations have been applied to assess the impacts for different averaging periods. The assessment of annual average impacts have been based on annual average emission limits, however hourly mean impacts have been based either on hourly, daily or monthly emission limits, dependent upon what is detailed within the Environmental Permits.

6B.3.17 Where emission concentrations are not specified, this is because the mass emission has been based on the sum of the mass emissions from different sources, which do not have the same emission concentrations (e.g. the FCC Stack, which has different emission limits for the FCC Regenerator and FCC Heaters).

Table 6B.4: Assessed Emission Concentrations and Emission Rates

Emission Source	Pollutant	Annual Average Emissions		Hourly Mean Emissions (where applicable)	
		Emission Concentration (mg/Nm^3)	Release Rate (g/s)	Emission Concentration (mg/Nm^3)	Release Rate (g/s)
VPI Baseline					
GT1 and 2 (each flue)	NOx	40	31.6	100	79.1
	CO	50	39.5	200	158.1
Aux Boiler 1 and 2 (each flue)	NOx	100	8.2	200	16.4
	CO	40	3.3	200	16.4
	Particulates	5	0.4	10	0.8
	SO_2	35	2.9	70	5.7
Phillips 66 Baseline					
FCC Stack	NOx	-	20.9	-	-
	CO	-	14.0	-	-
	Particulates	-	38.8	-	-
	SO_2	-	2.6	-	-
	NH_3	-	0.7	-	-
VPI Future					
New VPI PCC Plant Stack 1 and Stack 2 (each stack)	NOx	-	39.8		95.4
	CO	-	42.8		174.5
	Particulates	-	0.4		0.8
	SO_2	-	2.9		5.7
	NH_3	2	1.7	-	-
	Total Amines	0.3	0.25	-	-
	Amide	0.032	0.027	-	-
Phillips 66 Future					
	NOx	30	1.51	-	-

Emission Source	Pollutant	Annual Average Emissions		Hourly Mean Emissions (where applicable)	
		Emission Concentration (mg/Nm^3)	Release Rate (g/s)	Emission Concentration (mg/Nm^3)	Release Rate (g/s)
New Phillips 66 PCC Plant Stack	CO	100	5.04	-	-
	Particulates	10	0.50	-	-
	SO_2	50	2.52	-	-
	NH_3	5	0.25	-	-
	Total Amines	1.1	0.06	-	-
	Amide	0.032	0.0016	-	-
New Wet Gas Scrubber Stack	NOx	30	1.88	-	-
	CO	100	6.26	-	-
	Particulates	10	0.63	-	-
	SO_2	50	3.13	-	-
	NH_3	5	0.31	-	-
FCC (FCC Heater and Isostripper reboiler)	NOx	150	1.15	300	2.31
	CO	100	0.77	100	0.77
	Particulates	5.0	0.038	5.0	0.038
	SO_2	35.0	0.27	1,000	7.68

Modelled Domain and Discrete Receptors

6B.3.18 The modelling has predicted concentrations of the pollutants relevant to human health at the maximum location anywhere and at discrete air quality sensitive receptors, as listed in Table 6B.5. The locations of these receptors are also shown in **Figure 6.1** (ES Volume III). The receptors are selected to be representative of residential dwellings and schools in the area around the Proposed Developments. (OR = Operational Receptor).

6B.3.19 Table 6B.5 shows the minimum distance of each receptor to the either the VPI or Phillips 66 Proposed Developments' stacks, whichever is the closest.

Table 6B.5: Human Health Receptor Locations

Receptor I.D	Receptor Description	Grid Reference		Minimum Distance and Direction from the Proposed Developments' Stacks
		x	y	
OR1	Hazel Dean, Marsh Lane	517330	417311	680 m east
OR2	Station House, Station Road	517333	418345	1.5 km north-east
OR3	Fairfield House, North Garth	514687	418769	2.1 km north-west
OR4	Old Vicarage, North Garth	514428	418197	1.8 km north-west
OR5	Manor Farm, North Killingholme	514515	417653	1.3 km north-west
OR6	Church Lane, North Killingholme	514763	417331	950 m north-west

Receptor I.D	Receptor Description	Grid Reference x	Grid Reference y	Minimum Distance and Direction from the Proposed Developments' Stacks
OR7	Westfield Farm, North Killingholme	514708	416785	860 m west
OR8	Melrose, South Killingholme	515115	416417	600 m west
OR9	Town Street/ Humber Road, South Killingholme	515516	416120	650 m south
OR10	South Killingholme Primary School	514880	416120	950 m south-west
OR11	East End Farm	515935	415730	900 m south
OR12	Immingham	517765	415255	2 km south-east
OR13	Allerton Primary School, Immingham	518016	414882	2.5 km south-east

6B.3.20 In accordance with the Environment Agency's air emissions risk assessment guidance (Defra and Environment Agency, 2016), the impacts associated with emissions from the Proposed Developments on statutory sensitive ecological sites has been quantified. The assessment considers European designated sites (SACs, SPAs and Ramsar sites) and SSSIs within 15km of the operational Proposed Development, as recommended by the Environment Agency's risk assessment guidance for "large emitters".

6B.3.21 In additional, LWS within 2km of the Proposed Developments have also been included in the assessment.

6B.3.22 Ground-level concentrations of the modelled pollutants relevant to sensitive ecological receptors have been predicted at locations listed in Table 6B.6. The locations of these receptors are also shown in **Figure 6.2** (ES Volume III). The distance reported for each ecology site to the either the VPI or Phillips 66 Proposed Development stack(s), whichever is the closest, is taken to be representative of the worst-case location. (OE = Operational Ecological Receptor).

Table 6B.6: Ecological Receptor Locations

Receptor I.D	Receptor Name	Designation	Grid Reference x	Grid Reference y	Minimum Distance and Direction from the Proposed Developments' Stacks
OE1	Humber Estuary	SAC, SPA, Ramsar, SSSI	517235 - 517868	419385 - 418379	1.8 m north-east
OE2	North Killingholme Haven Pits	SSSI	516851	419535	2.6 km north
OE3	Swallow Wold	SSSI	516950	404990	11.7 km south
OE4	Wrawby Moor	SSSI	503350	411120	13.3 km south-west
E5	Eastfield Road Railway Embankment	LWS	515313	417108	390 m north-west
E6	Burkinshaws Covert	LWS	516432	417874	910 m north
E7	Rosper Road Pools	LWS	517224	416937	500 m east

E8	Chase Hill Wood	LWS	515702	418875	2 km north
E9	Mayflower Wood Meadow	LWS	516000	415920	950 m south-east
E10	Homestead Park Pond	LWS/ SINC	517935	415625	1.8 km south-east
E11	Eastfield Road Pit	SINC	515350	417040	300 m north-west

Modelled Domain – Receptor Grid

6B.3.23 Emissions from the Proposed Developments' stacks have been modelled on a receptor grid that is 7 km by 7 km centred on the Proposed Developments PCC Plant areas. The grid spacing is 81m, which is considered appropriate for the height of the stacks included in the assessment.

6B.3.24 In addition, the receptors detailed in Table 6B.5 and Table 6B.6 have been included as specified points within the model and therefore the predicted Process Contributions at these locations are unaffected by grid spacing.

Meteorological Data

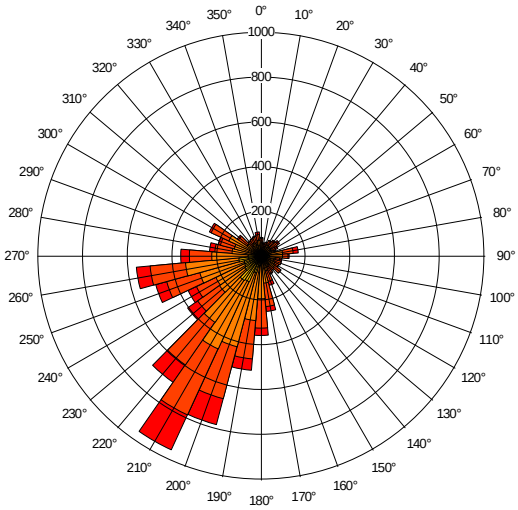
6B.3.25 Actual measured hourly-sequential meteorological data is available for input into dispersion models, and it is important to select data as representative as possible for the site that will be modelled. This is usually achieved by selecting a meteorological station as close to the site as possible, although other stations may be used if the local terrain and conditions vary considerably, or if the station does not provide sufficient data.

6B.3.26 The meteorological site selected for the assessment is Humberside Airport, located approximately 8.4 km south-west of the Sites, at a flat airfield in a principally agricultural area. A surface roughness of 0.2 m (representative of an agricultural area) has been selected for the meteorological site within the model.

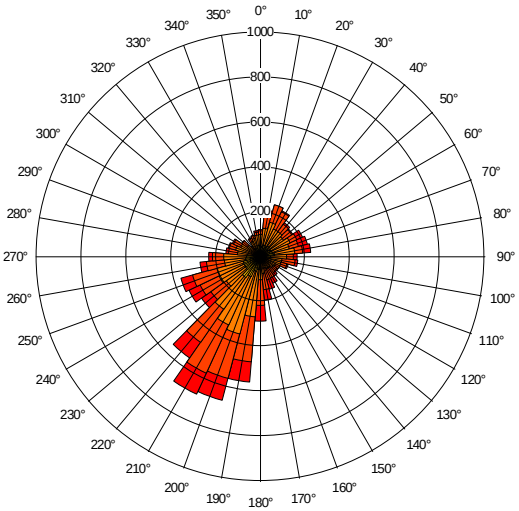
6B.3.27 The modelling for this assessment has utilised 5 years of meteorological data for the period 2017 – 2021. Wind roses for each of the years within this period are shown in Plate 6B.1.

Plate 6B.1: Wind roses for Humberside Airport, 2017 to 2021

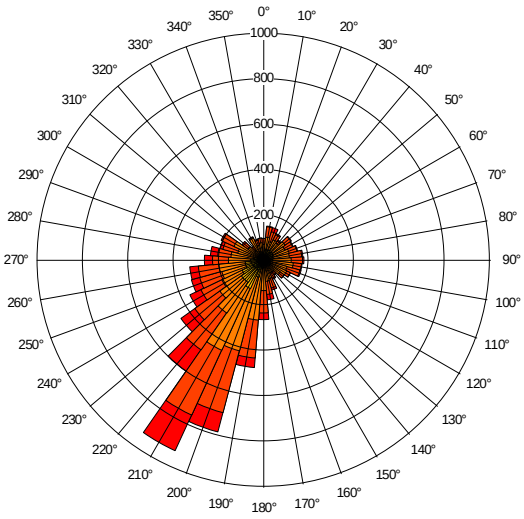
2017



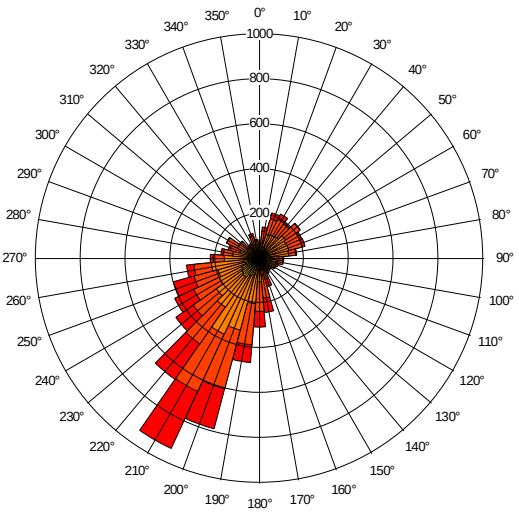
2018



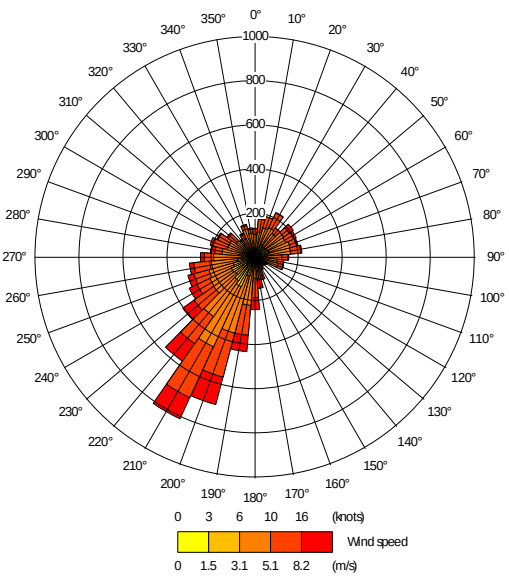
2019



2020



2021



Building Downwash Effects

6B.3.28 The existing buildings on the VPI and Phillips 66 Sites, and those that make up the Proposed Developments, have the potential to affect the dispersion of emissions from the stacks assessed. The ADMS buildings effect module has therefore been used to incorporate building downwash effects as part of the model set up. Buildings greater than one-third of the height of the stack height modelled have been included within the modelling assessment.

6B.3.29 Buildings associated with the Proposed Developments that have been considered to be of sufficient height and volume to potentially impact on the dispersion of emission stacks are shown in Table 6B.7. Plans showing the building layout used in the ADMS simulations are illustrated in Figures 6.4 and 6.5: Air Quality – Model Input Parameters (ES Volume III).

Table 6B.7: Buildings Included in the Model Set-up

Building	Building Centre		Height (m)	Length (m)	Width (m)	Angle (°)
	x	y				
VPI Site						
PCC Absorber 1	516762	417001	66	19	19	58
PCC Absorber 2	516811	416921	66	19	19	58
Phillips 66 Site						
Wet Gas Scrubber	515604	416816	47	6.6	circular	
PCC Absorber	515598	416841	51	7.8	circular	
CO_2 Stripper	515588	416882	50	5.4	circular	

Terrain

6B.3.30 The local area immediate to the Sites is industrial, with the urban area of Immingham to the south and the villages of North and South Killingholme to the west. Due to the largely built-up surroundings, a surface roughness of 0.5 m, corresponding to parkland and open suburbia has been selected to represent the local terrain.

6B.3.31 Site-specific terrain data has not been used in the model, as there are no potentially significant changes in gradient within the Study Area.

NOx to NO_2 Conversion

6B.3.32 Emissions of NOx from industrial point sources are typically dominated by nitric oxide (NO), with emissions from combustion sources typically in the ratio of NO to NO_2 of 9:1. However, it is NO_2 that has specified environmental standards due to its potential impact on human health. In the ambient air, NO is oxidised to NO_2 by the ozone present, and the rate of oxidation is dependent on the relative concentrations of NO and ozone in the ambient air.

6B.3.33 For the purposes of detailed modelling, and in accordance with Environment Agency technical guidance, it is assumed that 70% of NO emitted from the stack is oxidised to NO_2 in the long term and 35% of the emitted NO is oxidised to NO_2 in the local vicinity of the Proposed Developments in the short-term.

Calculation of Deposition at Sensitive Ecological Receptors

6B.3.34 The deposition of nutrient nitrogen and acid at sensitive ecological receptors has been calculated using the modelled PCs predicted at the relevant receptor points. The deposition rates are determined using conversion rates and factors contained within published guidance (Highways England, 2019) (IAQM, 2020), which takes into account variations in the deposition mechanisms for different types of habitat.

6B.3.35 The conversion rates and factors used in the assessment are shown in Table 6B.8.

Table 6B.8: Deposition Conversion Rates Ecological Receptors

Pollutant	Deposition Velocity Grasslands (m/s)	Deposition Velocity Woodlands (m/s)	Deposition Conversion Factors	
			Nutrient Nitrogen (µg/m³/s to kg/ha/yr)	Acid (µg/m³/s to keq/ha/yr)
NOx as NO_2	0.0015	0.003	95.9	6.84
NH_3	0.02	0.03	259.7	18.5
SO_2	0.012	0.024	-	9.84

For the purpose of assessment, the deposition of amine species has been assumed to be equivalent to that of NH_3.

Specialised Model Treatments

6B.3.36 Emissions have been modelled such that they are not subject to dry and wet deposition or depleted through chemical reactions. The assumption of continuity of mass is likely to result in an over-estimation of impacts at receptors, and therefore is considered to be conservative.

6B.4 Baseline Air Quality

Overview

6B.4.1 This section presents the information used to evaluate the background and baseline ambient air quality in the area surrounding the Proposed Developments. The following steps have been taken in the determination of background values:

- Identification of Air Quality Management Areas (AQMA);
- Review of North Lincolnshire Council (NLC) ambient monitoring data;
- Review of data from Defra's background mapping database; and
- Review of ecological receptor background data and site relevant critical loads from the Air Pollution Information System (APIS) website.

6B.4.2 Full details on the baseline air quality are provided in Chapter 6: Air Quality (ES Volume I), however the specific background (ambient) data that has been used for the operational assessment is provided in Tables 6B.9 – 6B.11.

Table 6B.9: Baseline Pollutant Concentrations for Human Health Receptors

Pollutant	Background Concentration used for Assessment (µg/m³)	Source of Data
NO_2	15.0	North Killingholme School Urban Industrial (Automatic) Monitor 2019.
CO	118	Defra background mapping from 2001 (with appropriate adjustment factor applied for 2018). Maximum concentration at all receptor locations.
SO_2	3.4	North Killingholme School Urban Industrial (Automatic) Monitor 2019.
Particulates (PM_{10})	19	North Killingholme School Urban Industrial (Automatic) Monitor 2019.

Pollutant	Background Concentration used for Assessment ($\mu g/m^3$)	Source of Data
Particulates ($PM_{2.5}$)	11.8	Defra background mapping from 2018 (with no future adjustment applied). Maximum concentration at all receptor locations.
NH_3	2.2	APIS website 2018 – 2020. Maximum concentration at all receptor locations.
Amines	No background data available	

Table 6B.10: Baseline Pollutant Concentrations for Ecological Receptors

Receptor I.D.	Ecology Site	NOx ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NH_3 ($\mu g/m^3$)
OE1	Humber Estuary	20.1	3.8	2.1
OE2	North Killingholme Haven Pits	20.1	3.8	2.1
OE3	Swallow Wold	11.3	1.0	2.4
OE4	Wrawby Moor	12.4	1.7	3.1
OE5	Eastfield Road Railway Embankment	15.7	3.6	2.1
OE6	Burkinshaws Covert	16.2	3.4	2.1
OE7	Rosper Road Pools	17.5	3.4	2.1
OE8	Chase Hill Wood	17.2	3.5	2.1
OE9	Mayflower Wood Meadow	14.6	3.3	2.1
OE10	Homestead Park Pond	15.9	3.4	2.1
OE11	Eastfield Road Pit	15.7	3.6	2.1

6B.4.3 Short-term (hourly) background concentrations have been calculated by multiplying the selected annual mean background concentration by a factor of two, in accordance with the Environment Agency Risk Assessment methodology. For daily NOx impacts, the annual mean has been multiplied by a factor of 1.5, as advised by the Environment Agency on previous projects.

Table 6B.11: Baseline Deposition Data for Ecological Receptors

Receptor I.D.	Ecology Site	Habitat Type and Location	Grid Reference x, y	N-Deposition (kg N/Ha/Yr)	Acid Deposition (Keq N/ Ha/Yr)	Acid Deposition (Keq S/ Ha/Yr)
OE1a	Humber Estuary	Coastal stable dunes grasslands - acid type – Cleethorpes	531500, 408013	20.3	1.42	0.18
OE1b		Coastal stable dunes grasslands - calcareous type – Spurn Point	539700, 411020	19.2	1.27	0.15
OE1c		Shifting coastal dunes – Saltfeet	544956, 394570	18.5	1.29	0.13
OE1d		Northern wet heath – North Killingholme Pits	516851, 419535	20.4	1.48	0.31
OE1e		Pioneer, low, mid upper saltmarshes	517353, 419059	20.4	1.48	0.31
OE1f		Low and medium altitude hay meadows	513431, 423906	20.3	1.49	0.22
OE2	North Killingholme Haven Pits	Pioneer, low, mid upper saltmarshes	516851, 419535	20.4	1.48	0.31
OE3	Swallow Wold	Sub-Atlantic semi-dry calcareous grassland	516950, 404990	22.3	1.58	0.17
OE4a	Wrawby Moor	Non-Mediterranean dry acid and neutral closed grassland	503305, 410990	24.9	1.78	0.19
OE4b		Meso- and eutrophic *Quercus* woodland	503280, 411180	42.6	3.04	0.23
OE5	Eastfield Road Railway Embankment	Neutral grassland	515313, 417108	20.4	1.46	0.38
OE6	Burkinshaws Covert	Broadleaved woodland	516432, 417874	34.2	2.44	0.45
OE7	Rosper Road Pools	Broadleaved woodland	517224, 416937	20.4	1.46	0.38

Receptor I.D.	Ecology Site	Habitat Type and Location	Grid Reference x, y	N-Deposition (kg N/Ha/Yr)	Acid Deposition (Keq N/ Ha/Yr)	Acid Deposition (Keq S/ Ha/Yr)
OE8	Chase Hill Wood	Neutral grassland	515702, 418875	34.2	2.44	0.45
OE9	Mayflower Wood Meadow	Standing open water and neutral grassland	516000, 415920	20.4	1.46	0.38
OE10	Homestead Park Pond	Calcareous grassland	517935, 415625	20.4	1.46	0.38
OE11	Eastfield Road Pit	Neutral grassland	515350, 417040	20.4	1.46	0.38

6B.4.4 Data on APIS is only pertinent to statutory ecological sites, however advice from the project ecologists has provided the lowest appropriate critical load for the non-statutory sites included in the assessment (E5 - E11). There are no equivalent values for acid deposition, therefore acid deposition data presented in this report is limited to statutory ecological sites only.

6B.4.5 In order to represent a conservative approach, it has been assumed that background concentrations, particularly of NO_2 and NOx, would not decrease in future years. Therefore, the current background concentrations have been assumed to apply to the projected opening year of 2027.

6B.5 Baseline Assessment

VPI Baseline

Human Health Receptor Results

6B.5.1 The impacts of the existing emissions from GT1, GT2, Aux Boiler 1 and Aux Boiler 2 have been modelled at the emission parameters detailed in Table 6B.3 and Table 6B.4. The results at the worst-case identified receptor are shown in Table 6B.12.

6B.5.2 The modelled PCs have been compared to the AQALs for each pollutant released. The background concentrations (BC) have then been added to the modelled PCs to determine the Predicted Environmental Concentrations (PECs), which is again then compared to the AQAL.

6B.5.3 As the VPI Site existing sources are already operational, their impact will already be presented within the BCs derived for the assessment and therefore there will be some degree of double counting of these emissions in the PECs.

Table 6B.12: VPI Baseline – Maximum Human Health Impacts at Any Receptor

Pollutant	Averaging Period	AQAL (µg/m³)	PC (µg/m³)	PC/ AQAL %	BC (µg/m³)	PEC (µg/m³)	PEC/ AQAL %
NO_2	Annual mean	40	0.93	2.3%	15.0	15.9	40%
	1-hour mean (as the 99.79th %ile of hourly averages)	200	17.2	8.6%	30.0	47.2	24%
CO	1-hour mean (as the 100th %ile of hourly averages)	30,000	104.0	0.3%	236.6	340.6	1%
	Maximum daily running 8-hour mean	10,000	86.9	0.9%	236.6	323.5	3%
PM_{10}	Annual mean	40	0.002	<0.1%	19.0	19.0	48%
	24-hour mean (as the 90.41th %ile of hourly averages)	50	0.10	0.2%	38.0	38.1	76%
$PM_{2.5}$	Annual mean	20	0.002	<0.1%	11.8	11.8	59%
SO_2	15-minute mean (as the 99.9th %ile)	266	3.2	1.2%	6.7	9.9	4%
	1-hour mean (as the 99.73th %ile)	350	2.9	0.8%	6.7	9.6	3%
	24-hour mean (as the 99.18th %ile)	125	0.8	0.6%	3.4	4.2	3%

6B.5.4 The annual average PCs at the worst-case human health receptor are generally less than 1% of the relevant AQAL, and therefore below Environment Agency's threshold for determining

insignificance, or when combined with the background concentration they are well below the 70% threshold to demonstrate that there is not likely to be an exceedance as a result of the VPI Baseline emissions.

6B.5.5 Likewise, all the short-term PC impacts are all less than the 10% of the relevant AQALs and therefore below the short-term screening threshold to demonstrate insignificance.

Ecological Receptor Results

6B.5.6 The results of the dispersion modelling of predicted impacts of the VPI Baseline emissions on sensitive ecological receptors are presented in Table 6B.13 to Table 6B.14. These tables set out the predicted PC compared to the atmospheric concentrations of NOx and SO_2.

6B.5.7 For all receptors, except OE1 and OE2, the predicted annual average NOx concentrations are below 1% of the AQAL and therefore are considered insignificant. At OE2, the PEC is just under the 70% screening threshold, and at OE1 it is 1% over the 70% threshold. Again, it is important to note that the background concentrations already include the existing contribution from the VPI Site, and therefore it is considered that the actual PECs will be below these values.

6B.5.8 The daily mean NOx concentrations represent approximately 10% of the AQAL at all receptors, and therefore existing impacts are largely insignificant. Where impacts are over the 10% threshold, the PECs demonstrate that an exceedance of the AQAL is very unlikely to occur as a result of the existing emissions of the VPI Site.

6B.5.9 For all receptors the predicted annual average SO_2 concentrations are below 1% of the AQAL, therefore demonstrating insignificance.

6B.5.10 Depositional impacts of nutrient nitrogen and acid deposition are shown in Table 6B.15 and Table 6B.16 respectively. The Baseline VPI deposition results show that the existing impacts are less than the 1% threshold to demonstrate insignificance.

Table 6B.13: VPI Baseline – Ecological Impacts of NOx

Receptor ID	Annual Average Impacts						24-hour Average Impacts					
	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %
OE1	30	1.18	3.9%	20.1	21.3	71%	75	12.0	16%	30.2	42.2	56%
OE2		0.50	1.7%	20.1	20.6	69%		9.4	12%	30.2	39.6	53%
OE3		0.07	0.2%	11.3	11.3	38%		1.9	3%	16.9	18.8	25%
OE4		0.09	0.3%	12.4	12.5	42%		2.2	3%	18.6	20.8	28%
OE5		0.18	0.6%	15.7	15.9	53%		7.8	10%	23.6	31.4	42%
OE6		0.27	0.9%	16.2	16.5	55%		6.9	9%	24.3	31.1	42%
OE7		0.15	0.5%	17.5	17.6	59%		4.0	5%	26.2	30.2	40%
OE8		0.21	0.7%	17.2	17.4	58%		8.5	11%	25.7	34.2	46%
OE9		0.26	0.9%	14.6	14.8	49%		7.6	10%	21.9	29.4	39%
OE10		0.10	0.3%	15.9	16.0	53%		8.3	11%	23.8	32.1	43%
OE11		0.19	0.6%	15.7	15.9	53%		8.5	11%	23.6	32.1	43%

Table 6B.14: VPI Baseline – Annual Average Ecological Impacts of SO_2

Receptor ID	AQAL ($\mu g/m^3$)	PC ($\mu g/m^3$)	PC/ AQAL %	BC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PEC/ AQAL %
OE1	20	0.09	0.4%	3.8	3.9	19%
OE2		0.04	0.2%	3.8	3.8	19%
OE3		0.01	<0.1%	1.0	1.0	5%
OE4		0.01	<0.1%	1.7	1.7	8%
OE5		0.01	0.1%	3.6	3.6	18%
OE6		0.02	0.1%	3.4	3.5	17%
OE7		0.01	0.1%	3.4	3.5	17%
OE8		0.02	0.1%	3.5	3.5	17%
OE9		0.02	0.1%	3.3	3.3	16%
OE10		0.01	<0.1%	3.4	3.4	17%
OE11		0.01	0.1%	3.6	3.6	18%

Table 6B.15: VPI Baseline – Nitrogen Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Nitrogen Deposition (kg N/ha/yr)	Lower value of Critical Load Range	PC (kg N/ha/yr)	PC% Critical Load	PEC (kg N/ha/yr)	PEC% Critical Load
OE1a	Coastal stable dunes grasslands - acid type	20.3	8	0.01	0.1%	20.3	254%
OE1b	Coastal stable dunes grasslands - calcareous type	19.2	10	0.01	0.1%	19.2	192%
OE1c	Shifting coastal dunes	18.5	10	0.003	<0.1%	18.5	185%
OE1d	Northern wet heath	20.4	10	0.05	0.5%	20.5	205%
OE1e	Pioneer, low, mid upper saltmarshes	20.4	20	0.12	0.6%	20.6	103%
OE1f	Low and medium altitude hay meadows	20.3	20	0.01	<0.1%	20.3	102%
OE2	Pioneer, low, mid upper saltmarshes	20.4	20	0.05	0.2%	20.5	102%
OE3	Sub-Atlantic semi-dry calcareous grassland	22.3	15	0.01	<0.1%	22.3	148%
OE4a	Non-Mediterranean dry acid and neutral closed grassland	24.9	10	0.01	0.1%	24.9	249%
OE4b	Meso- and eutrophic *Quercus* woodland	42.6	15	0.02	0.1%	42.6	284%
OE5	Neutral grassland	20.4	10	0.02	0.2%	20.4	204%
OE6	Broadleaved woodland	34.2	10	0.06	0.6%	34.3	343%
OE7	Wetland and reedbed	20.4	10	0.01	0.1%	20.4	204%
OE8	Broadleaved woodland	34.2	10	0.04	0.4%	34.2	342%
OE9	Neutral grassland	20.4	10	0.03	0.3%	20.4	204%
OE10	Standing open water and neutral grassland	20.4	10	0.01	0.1%	20.4	204%
OE11	Calcareous grassland	20.4	15	0.02	0.1%	20.4	136%

Table 6B.16: VPI Baseline – Acid Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Deposition (keq ha/yr)	Relevant Critical Load (keq ha/yr)	Background % of Critical Load	PC (keq N/ha/yr)	PC% Critical Load	PEC% Critical Load
OE1a	Acid grassland	N: 1.42 S: 0.18	MinNMinN: 0.223 MinCLMaxS: 0.42 MinCLMaxN: 0.643	248.8%	N: 0.0005 S: 0.0006	0%	248.8%
OE1b	Calcareous grassland	N: 1.27 S: 0.15	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	29.2%	N: 0.0004 S: 0.0005	0%	29.2%
OE1d	Dwarf shrub heath	N: 1.48 S: 0.31	MinNMinN: 0.499 MinCLMaxS: 0.42 MinCLMaxN: 1.312	136.4%	N: 0.004 S: 0.004	0.8%	137.2%
OE2	No critical load assigned in APIS						
OE3	Calcareous grassland	N: 1.58 S: 0.17	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	36.0%	N: 0.0005 S: 0.0006	0%	36.0%
OE4a	Unmanaged broadleaved/ coniferous woodland	N: 3.04 S: 0.23	MinNMinN: 0.285 MinCLMaxS: 0.748 MinCLMaxN: 1.033	316.6%	N: 0.0013 S: 0.0015	0%	316.6%
OE4b	Acid grassland	N: 1.78 S: 0.19	MinNMinN: 0.366 MinCLMaxS: 0.17 MinCLMaxN: 0.536	367.5%	N: 0.0006 S: 0.0008	0%	367.5%

Phillips 66 Baseline

Human Health Receptor Results

6B.5.11 The impacts of the existing emissions from the FCC stack have been modelled at the emission parameters detailed in Table 6B.3 and Table 6B.4. The results at the worst-case identified receptor are shown in Table 6B.17.

6B.5.12 The modelled PCs have been compared to the AQALs for each pollutant released. The background concentrations (BC) have then been added to the PCs to determine the Predicted Environmental Concentrations (PECs), which is again then compared to the AQAL.

6B.5.13 As the FCC stack is already operational, again there will be some degree of double counting of these emissions, as they will already be presented within the BCs derived for the assessment.

Table 6B.17: Phillips 66 Baseline – Maximum Human Health Impacts at Any Receptor

Pollutant	Averaging Period	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %
NO_2	Annual mean	40	0.33	0.8%	15.0	15.3	38%
	1-hour mean (as the 99.79th %ile of hourly averages)	200	4.0	2.0%	30.0	34.0	17%
CO	1-hour mean (as the 100th %ile of hourly averages)	30,000	11.4	<0.1%	236.6	248.0	1%
	Maximum daily running 8-hour mean	10,000	7.0	0.1%	236.6	243.7	2%
PM_{10}	Annual mean	40	0.06	0.1%	19.0	19.1	59%
	24-hour mean (as the 90.41th %ile of hourly averages)	50	0.20	0.4%	38.0	38.2	76%
$PM_{2.5}$	Annual mean	20	0.06	0.3%	11.8	11.8	59%
SO_2	15-minute mean (as the 99.9th %ile)	266	25.3	9.5%	6.7	32.0	12%
	1-hour mean (as the 99.73th %ile)	350	20.1	5.7%	6.7	26.8	8%
	24-hour mean (as the 99.18th %ile)	125	7.2	5.8%	3.4	10.6	8%
NH_3	Annual mean	180	0.02	<0.1%	2.2	2.2	1%
	1-hour mean (as the 100th %ile of hourly averages)	2,500	0.6	<0.1%	4.4	5.0	0.2%

6B.5.14 The annual average PCs of the Phillips 66 Baseline emissions at the worst-case receptor are less than 1% of the relevant AQALs, and therefore below the Environment Agency's threshold for determining insignificance. Likewise, the short-term PC impacts are all less than the 10% screening threshold, or less than 20% when combined with the BC.

Ecological Receptor Results

6B.5.15 The results of the dispersion modelling of predicted impacts on sensitive ecological receptors are presented in Table 6B.18 to Table 6B.20. These tables set out the predicted PC compared to the atmospheric concentrations of NOx, SO_2 and NH_3.

Table 6B.18: Phillips 66 Baseline – Ecological Impacts of NOx

Receptor ID	Annual Average Impacts						24-hour Average					
	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %
OE1		0.49	1.6%	20.1	20.6	69%		3.1	4%	30.2	33.3	44%
OE2		0.50	1.7%	20.1	20.6	69%		3.2	4%	30.2	33.4	45%
OE3		0.03	0.1%	11.3	11.3	38%		0.9	1%	16.9	17.7	24%
OE4		0.04	0.1%	12.4	12.4	41%		0.8	1%	18.6	19.5	26%
OE5		0.02	0.1%	15.7	15.8	53%		6.8	9%	23.6	30.4	41%
OE6	30	0.69	2.3%	16.2	16.9	56%	75	5.4	7%	24.3	29.7	40%
OE7		0.42	1.4%	17.5	17.9	60%		3.9	5%	26.2	30.1	40%
OE8		0.31	1.0%	17.2	17.5	58%		3.6	5%	25.7	29.4	39%
OE9		0.08	0.3%	14.6	14.7	49%		3.8	5%	21.9	25.7	34%
OE10		0.16	0.5%	15.9	16.0	53%		2.7	4%	23.8	26.5	35%
OE11		0.02	0.1%	15.7	15.7	52%		5.8	8%	23.6	29.4	39%

Table 6B.19: Phillips 66 Baseline – Annual Average Ecological Impacts of SO_2

Receptor ID	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %
OE1		0.90	4.5%	3.8	4.7	23%
OE2		0.92	4.6%	3.8	4.7	23%
OE3		0.06	0.3%	1.0	1.1	5%
OE4		0.07	0.3%	1.7	1.7	9%
OE5		0.04	0.2%	3.6	3.7	18%
OE6	20	1.28	6.4%	3.4	4.7	24%
OE7		0.78	3.9%	3.4	4.2	21%
OE8		0.57	2.9%	3.5	4.0	20%
OE9		0.15	0.8%	3.3	3.4	17%
OE10		0.30	1.5%	3.4	3.7	18%
OE11		0.03	0.2%	3.6	3.6	18%

Table 6B.20: Phillips 66 Baseline – Annual Average Ecological Impacts of NH_3

Receptor ID	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %
OE1	3	0.016	0.5%	2.11	2.13	71%
OE2	3	0.017	0.6%	2.11	2.13	71%
OE3	3	0.001	<0.1%	2.37	2.37	79%
OE4	1	0.001	0.1%	3.10	3.10	310%
OE5	3	0.001	<0.1%	2.11	2.11	70%
OE6	3	0.023	0.8%	2.11	2.13	71%
OE7	3	0.014	0.5%	2.11	2.12	71%
OE8	3	0.010	0.3%	2.11	2.12	71%
OE9	3	0.003	0.1%	2.11	2.11	70%
OE10	3	0.005	0.2%	2.11	2.12	71%
OE11	3	0.001	<0.1%	2.11	2.11	70%

6B.5.16 For all receptors, except OE1, OE2, OE6 and OE7 the predicted annual average NOx concentrations are below 1% of the AQAL and therefore would indicate that the existing impacts are insignificant. The PEC is under the 70% threshold for all sites. The background concentrations already include the contribution from the Phillips 66 Site, and therefore the actual PECs will be below these values.

6B.5.17 The daily mean NOx concentrations are below 10% of the relevant AQAL at all receptors and therefore existing impacts are insignificant.

6B.5.18 The annual average SO_2 impacts at OE1, OE2, OE6, OE7, OE8 and OE10 are all over the 1% threshold for insignificance, however the PECs are all well below 70% of the AQAL. Given that the background concentrations already include the contribution from the Phillips 66 Site, it is considered highly unlikely that the SO_2 AQAL would be exceeded as a result of the existing operation.

6B.5.19 For all receptors the predicted annual average NH_3 concentrations are below the 1% screening threshold to demonstrate insignificance.

6B.5.20 Depositional impacts of nutrient nitrogen and acid deposition are shown in Table 6B.21 and Table 6B.21 respectively. The Phillips 66 Baseline nitrogen deposition results show that, on the whole, the existing impacts are less than the 1% threshold to demonstrate insignificance. Nitrogen deposition impacts at OE1d, OE7 and OE8 are only slightly over the 1% threshold. Guidance from the IAQM (2020) clarifies that the 1% threshold is not intended to be precise to a set number of decimal places but to the nearest whole number, and therefore where an increase is shown to be 1.4%, as in the case of nitrogen deposition at Receptor OE1d, for example, this can be rounded down to 1% for the purpose of assessment and therefore the impacts can be considered to still be insignificant.

6B.5.21 The acid depositional impacts at receptors OE1a, OE1d and OE4 are all over the 1% screening threshold for insignificance. The background acid deposition at all these sites is already exceeding the relevant critical loads, and will already include the contribution from the existing Phillips 66 Site sources.

Table 6B.21: Phillips 66 Baseline – Nitrogen Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Nitrogen Deposition (kg N/ha/yr)	Lower value of Critical Load Range	PC (kg N/ha/yr)	PC% Critical Load	PEC (kg N/ha/yr)	PEC% Critical Load
OE1a	Coastal stable dunes grasslands - acid type	20.3	8	0.01	0.1%	20.3	254%
OE1b	Coastal stable dunes grasslands - calcareous type	19.2	10	0.01	0.1%	19.2	192%
OE1c	Shifting coastal dunes	18.5	10	0.003	0.03%	18.5	185%
OE1d	Northern wet heath	20.4	10	0.14	1.4%	20.6	206%
OE1e	Pioneer, low, mid upper saltmarshes	20.4	20	0.11	0.5%	20.6	103%
OE1f	Low and medium altitude hay meadows	20.3	20	0.02	0.1%	20.3	102%
OE2	Pioneer, low, mid upper saltmarshes	20.4	20	0.14	0.7%	20.6	103%
OE3	Sub-Atlantic semi-dry calcareous grassland	22.3	15	0.01	0.1%	22.3	148%
OE4a	Non-Mediterranean dry acid and neutral closed grassland	24.9	10	0.01	0.1%	24.9	249%
OE4b	Meso- and eutrophic *Quercus* woodland	42.6	15	0.02	0.1%	42.6	284%
OE5	Neutral grassland	20.4	10	0.01	0.1%	20.4	204%
OE6	Broadleaved woodland	34.2	10	0.32	3.2%	34.5	345%
OE7	Wetland and reedbed	20.4	10	0.12	1.2%	20.5	205%
OE8	Broadleaved woodland	34.2	10	0.14	1.4%	34.3	343%
OE9	Neutral grassland	20.4	10	0.02	0.2%	20.4	204%
OE10	Standing open water and neutral grassland	20.4	10	0.04	0.4%	20.4	204%
OE11	Calcareous grassland	20.4	15	0.005	0.0%	20.4	136%

Table 6B.22: Phillips 66 Baseline – Acid Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Deposition (keq ha/yr)	Relevant Critical Load (keq ha/yr)	Background % of Critical Load	PC (keq N/ha/yr)	PC% Critical Load	PEC% Critical Load
OE1a	Acid grassland	N: 1.42 S: 0.18	MinNMinN: 0.223 MinCLMaxS: 0.42 MinCLMaxN: 0.643	248.8%	N: 0.0006 S: 0.0062	1.6%	250.4%
OE1b	Calcareous grassland	N: 1.27 S: 0.15	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	29.2%	N: 0.0004 S: 0.0046	0.2%	29.4%
OE1d	Dwarf shrub heath	N: 1.48 S: 0.31	MinNMinN: 0.499 MinCLMaxS: 0.42 MinCLMaxN: 1.312	136.4%	N: 0.0098 S: 0.1092	9.1%	145.5%
OE2	No critical load assigned in APIS						
OE3	Calcareous grassland	N: 1.58 S: 0.17	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	36.0%	N: 0.0006 S: 0.0065	0.2%	36.2%
OE4a	Unmanaged broadleaved/ coniferous woodland	N: 3.04 S: 0.23	MinNMinN: 0.285 MinCLMaxS: 0.748 MinCLMaxN: 1.033	316.6%	N: 0.0012 S: 0.0160	1.9%	318.5%
OE4b	Acid grassland	N: 1.78 S: 0.19	MinNMinN: 0.366 MinCLMaxS: 0.17 MinCLMaxN: 0.536	367.5%	N: 0.0007 S: 0.0080	1.9%	369.4%

In-Combination Baseline

Human Health Receptor Results

6B.5.22 The impacts of the in-combination existing emissions from the VPI Site and the Phillips 66 Site have been modelled at the emission parameters detailed in Table 6B.3 and Table 6B.4. The results at the worst-case identified receptor are shown in Table 6B.23.

6B.5.23 As there are no existing emissions of NH_3 from the VPI Site, the In-Combination Baseline results for NH_3 are the same as the Phillips 66 Baseline results and therefore these have not been included in the in-combination results tables.

Table 6B.23: In-Combination Baseline – Maximum Human Health Impacts at Any Receptor

Pollutant	Averaging Period	AQAL (µg/m³)	PC (µg/m³)	PC/ AQAL %	BC (µg/m³)	PEC (µg/m³)	PEC/ AQAL %
NO_2	Annual mean	40	1.20	3.0%	15.0	16.2	41%
	1-hour mean (as the 99.79th %ile of hourly averages)	200	17.4	8.7%	30.0	47.4	24%
CO	1-hour mean (as the 100th %ile of hourly averages)	30,000	106.7	0.4%	236.6	343.3	1%
	Maximum daily running 8-hour mean	10,000	87.3	0.9%	236.6	324.0	3%
PM_{10}	Annual mean	40	0.06	0.3%	19.0	19.1	59%
	24-hour mean (as the 90.41th %ile of hourly averages)	50	0.23	0.5%	38.0	38.2	76%
$PM_{2.5}$	Annual mean	20	0.06	0.3%	11.8	11.8	59%
SO_2	15-minute mean (as the 99.9th %ile)	266	25.7	9.7%	6.7	32.4	12%
	1-hour mean (as the 99.73th %ile)	350	21.3	6.1%	6.7	28.0	8%
	24-hour mean (as the 99.18th %ile)	125	7.3	5.9%	3.4	10.7	9%

6B.5.24 The in-combination results are in-line with the maximum PCs for the individual pollutant species that represent the worst-case PCs for the two Sites modelled independently. For example, the VPI Site leads to the worst case NO_2 impacts with an hourly mean PC of 17.2µg/m³, which is comparable with the 17.4µg/m³ PC predicted for the in-combination impacts. For SO_2 impacts, the Phillips 66 Site leads to the worst-case impacts, with a PC of 25.3µg/m³ (for the 15-minute averaging period), comparable with the 25.7µg/m³ predicted for the In-combination impacts.

Ecological Receptor Results

Table 6B.24: In-Combination Baseline – Ecological Impacts of NOx

Receptor ID	Annual Average Impacts						24-hour Average					
	AQAL ($\mu g/m^3$)	PC ($\mu g/m^3$)	PC/ AQAL %	BC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PEC/ AQAL %	AQAL ($\mu g/m^3$)	PC ($\mu g/m^3$)	PC/ AQAL %	BC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PEC/ AQAL %
OE1		1.55	5.2%	20.1	21.7	72%		12.9	17%	30.2	43.1	57%
OE2		0.99	3.3%	20.1	21.1	70%		10.2	14%	30.2	40.4	54%
OE3		0.10	0.3%	11.3	11.3	38%		2.6	3%	16.9	19.5	26%
OE4		0.13	0.4%	12.4	12.5	42%		3.0	4%	18.6	21.6	29%
OE5		0.19	0.6%	15.7	15.9	53%		7.8	10%	23.6	31.4	42%
OE6	30	0.96	3.2%	16.2	17.2	57%	75	6.9	9%	24.3	31.2	42%
OE7		0.56	1.9%	17.5	18.0	60%		6.2	8%	26.2	32.4	43%
OE8		0.51	1.7%	17.2	17.7	59%		9.1	12%	25.7	34.8	46%
OE9		0.33	1.1%	14.6	14.9	50%		7.6	10%	21.9	29.5	39%
OE10		0.25	0.8%	15.9	16.1	54%		9.0	12%	23.8	32.9	44%
OE11		0.20	0.7%	15.7	15.9	53%		8.5	11%	23.6	32.1	43%

Table 6B.25: In-Combination Baseline – Annual Average Ecological Impacts of SO_2

Receptor ID	AQAL ($\mu g/m^3$)	PC ($\mu g/m^3$)	PC/ AQAL %	BC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PEC/ AQAL %
OE1		0.96	4.8%	3.8	4.7	24%
OE2		0.96	4.8%	3.8	4.7	24%
OE3		0.06	0.3%	1.0	1.1	5%
OE4		0.07	0.4%	1.7	1.7	9%
OE5		0.05	0.3%	3.6	3.7	18%
OE6	20	1.30	6.5%	3.4	4.7	24%
OE7		0.79	3.9%	3.4	4.2	21%
OE8		0.59	2.9%	3.5	4.0	20%
OE9		0.17	0.8%	3.3	3.4	17%
OE10		0.31	1.5%	3.4	3.7	19%
OE11		0.04	0.2%	3.6	3.7	18%

6B.5.25 The In-combination Baseline for NH_3 impacts is the same as the Phillips 66 Baseline, as there is no existing emission of NH_3 from the VPI Site.

6B.5.26 As for the human health, the in-combination NOx impacts are largely comparable with those presented for the VPI Site, as the VPI Site has the larger mass emission of NOx from the existing operations, with the SO_2 impacts being largely comparable with those presented for the Phillips 66 Site, as the Phillips 66 Site has the larger SO_2 mass emission.

6B.5.27 As the acid deposition impacts are largely influenced by the Phillips 66 Site emissions of SO_2 and NH_3, the depositional impacts of the in-combination assessment are comparable with those presented for the Phillips 66 Baseline Assessment.

Table 6B.26: In-Combination Baseline – Nitrogen Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Nitrogen Deposition (kg N/ha/yr)	Lower value of Critical Load Range	PC (kg N/ha/yr)	PC% Critical Load	PEC (kg N/ha/yr)	PEC% Critical Load
OE1a	Coastal stable dunes grasslands - acid type	20.3	8	0.02	0.2%	20.3	254%
OE1b	Coastal stable dunes grasslands - calcareous type	19.2	10	0.01	0.1%	19.2	192%
OE1c	Shifting coastal dunes	18.5	10	0.01	0.1%	18.5	185%
OE1d	Northern wet heath	20.4	10	0.19	1.9%	20.6	206%
OE1e	Pioneer, low, mid upper saltmarshes	20.4	20	0.24	1.2%	20.6	103%
OE1f	Low and medium altitude hay meadows	20.3	20	0.02	0.1%	20.3	102%
OE2	Pioneer, low, mid upper saltmarshes	20.4	20	0.19	0.9%	20.6	103%
OE3	Sub-Atlantic semi-dry calcareous grassland	22.3	15	0.01	0.1%	22.4	148%
OE4a	Non-Mediterranean dry acid and neutral closed grassland	24.9	10	0.02	0.2%	24.9	249%
OE4b	Meso- and eutrophic *Quercus* woodland	42.6	15	0.03	0.2%	42.6	284%
OE5	Neutral grassland	20.4	10	0.02	0.2%	20.4	204%
OE6	Broadleaved woodland	34.2	10	0.37	3.7%	34.6	346%
OE7	Wetland and reedbed	20.4	10	0.13	1.3%	20.5	205%
OE8	Broadleaved woodland	34.2	10	0.18	1.8%	34.4	344%
OE9	Neutral grassland	20.4	10	0.05	0.5%	20.4	204%
OE10	Standing open water and neutral grassland	20.4	10	0.05	0.5%	20.5	205%
OE11	Calcareous grassland	20.4	15	0.02	0.2%	20.4	136%

Table 6B.27: In-Combination Baseline – Acid Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Deposition (keq ha/yr)	Relevant Critical Load (keq ha/yr)	Background % of Critical Load	PC (keq N/ha/yr)	PC% Critical Load	PEC% Critical Load
OE1a	Acid grassland	N: 1.42 S: 0.18	MinNMinN: 0.223 MinCLMaxS: 0.42 MinCLMaxN: 0.643	248.8%	N: 0.0011 S: 0.0069	1.6%	250.4%
OE1b	Calcareous grassland	N: 1.27 S: 0.15	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	29.2%	N: 0.0008 S: 0.0051	0.2%	29.4%
OE1d	Dwarf shrub heath	N: 1.48 S: 0.31	MinNMinN: 0.499 MinCLMaxS: 0.42 MinCLMaxN: 1.312	136.4%	N: 0.0133 S: 0.113	9.9%	146.3%
OE2	No critical load assigned in APIS						
OE3	Calcareous grassland	N: 1.58 S:0.17	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	36.0%	N: 0.0011 S: 0.0071	0.2%	36.2%
OE4a	Unmanaged broadleaved/ coniferous woodland	N: 3.04 S: 0.23	MinNMinN: 0.285 MinCLMaxS: 0.748 MinCLMaxN: 1.033	316.6%	N: 0.0025 S: 0.0175	1.9%	318.5%
OE4b	Acid grassland	N: 1.78 S: 0.19	MinNMinN: 0.366 MinCLMaxS: 0.17 MinCLMaxN: 0.536	367.5%	N: 0.0014 S: 0.0088	1.9%	369.4%

6B.6 Future Assessment

VPI Future

Human Health Receptor Results

6B.6.1 The future results for the VPI Proposed Development are shown for the worst-case receptor location in Table 6B.28.

6B.6.2 The predicted increases at the worst-case receptor location for all pollutant species released from the Proposed VPI Development result in only 'imperceptible' to 'low' changes in ambient pollutant concentrations, which are considered '**negligible**'. The effect is therefore considered to be '**not significant**'.

Table 6B.28: VPI Future – Maximum Human Health Impacts at Any Receptor

Pollutant	Averaging Period	AQAL ($\mu g/m^3$)	PC ($\mu g/m^3$)	PC/ AQAL %	BC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PEC/ AQAL %	Change in PC over VPI Baseline Assessment	Impact Descriptor
NO_2	Annual mean	40	1.9	4.7%	15.0	16.9	42%	+ 2.3%	Negligible
	1-hour mean (as the 99.79th %ile of hourly averages)	200	31.5	15.7%	30.0	61.7	31%	+ 7.1%	Negligible
CO	1-hour mean (as the 100th %ile of hourly averages)	30,000	239.6	0.8%	236.6	476.3	2%	+ 0.4%	Negligible
	Maximum daily running 8-hour mean	10,000	165.6	1.7%	236.6	402.3	4%	+ 0.8%	Negligible
PM_{10}	Annual mean	40	0.03	0.1%	19.0	19.0	48%	+ 0.1%	Negligible
	24-hour mean (as the 90.41th %ile of hourly averages)	50	0.17	0.3%	38.0	38.2	76%	+ 0.1%	Negligible
$PM_{2.5}$	Annual mean	20	0.03	0.1%	11.8	11.8	59%	+ 0.1%	Negligible
SO_2	15-minute mean (as the 99.9th %ile)	266	6.3	2.4%	6.7	13.0	5%	+ 1.2%	Negligible
	1-hour mean (as the 99.73th %ile)	350	5.2	1.5%	6.7	11.9	3%	+ 0.6%	Negligible
	24-hour mean (as the 99.18th %ile)	125	1.2	0.9%	3.4	4.5	4%	+ 0.3%	Negligible
NH_3	Annual mean	180	0.1	0.1%	2.2	2.3	1%	+ 0.1%	Negligible
	1-hour mean (as the 100th %ile of hourly averages)	2,500	2.3	0.1%	4.4	6.7	0.3%	+ 0.1%	Negligible
Total Amines	Daily mean (as the 100th %ile of daily averages)	100	0.1	0.1%	-	0.1	0.1%	+ 0.1%	Negligible
	Hourly Mean (as the 100th %ile of hourly averages)	400	0.3	0.1%	-	0.02	0.1%	+ 0.1%	Negligible
Amide	Annual mean	0.6	0.002	0.3%	-	0.002	0.3%	+ 0.3%	Negligible
	1-hour mean (as the 100th %ile of hourly averages)	18	0.04	0.2%	-	0.04	0.2%	+ 0.2%	Negligible

Ecological Receptor Results

6B.6.3 The results in Table 6B.29 show that the maximum increase at any ecological receptor occurs at the Humber Estuary (OE1). The increase in the annual average NOx PC at this receptor represents +4.7% of the AQAL. According to the significance criteria detailed in Chapter 6 (Table 6-4, ES Volume I) this represent a 'low' magnitude of change, however as the PEC is 76% of the AQAL this represents a 'minor' adverse impact. The background concentration used in the assessment will include the contribution from the existing VPI Site sources, and therefore these is some double counting of this in the results. In addition, this level of impact only occurs at the worst-case location of the ecological receptor, and over the majority of the Humber Estuary site the predicted PCs will be lower. It is therefore considered that the effects over the site as a whole will be '**not significant**'.

6B.6.4 All other receptors experience lower impacts, that are considered to represent a 'very low' to 'low' magnitude of change, but due to the lower background concentrations at these receptors, the impacts are considered to be '**negligible**' and therefore the effects are '**not significant**'.

6B.6.5 The daily NOx impacts, shown in Table 6B.29, demonstrate that at all receptors (except for OE5 and OE11) there is a less than 10% increase over the VPI Baseline Assessment. The VPI Proposed Development is therefore considered to result in '**negligible**' impacts at these receptors, that are '**not significant'**.

6B.6.6 At OE5 and OE11 the increase in the Daily NOx impacts are only slightly over 10%, (10.5% and 10.9% respectively), and therefore are still considered to be '**negligible**' and '**not significant**'.

6B.6.7 SO_2 impacts in Table 6B.30 show increases of 0.5% or less at all receptors and therefore the magnitude of change is considered to be 'imperceptible' or 'very low' and therefore the impacts are '**negligible**' and '**not significant'**.

6B.6.8 The results in Table 6B.31 show that increases in NH_3 emissions from the VPI Proposed Development result in 'very low' to 'low' magnitude of change at all but one ecological receptor, and even with the high background concentrations of NH_3, the impacts are still considered to be '**negligible**' and therefore the effects are '**not significant'** at these sites.

6B.6.9 The E4 Wrawby Moor receptor, however, has the lower critical level for NH_3 applied for the protection of lichens and bryophytes and therefore the background concentration at this site is already exceeding the AQAL applied. That said, as the increase at this receptor site is only 0.5% of the AQAL, the magnitude of change is considered to be 'imperceptible' and therefore the impacts can still be considered to be '**negligible**' and '**not significant'**, even with the high background concentration taken into consideration.

6B.6.10 The increase in the depositional impacts from the VPI Proposed Development are either below the 1% insignificance threshold defined by the Environment Agency and Natural England or only slightly above it. Again, the IAQM (2020) guidance clarifies that the 1% threshold is not intended to be precise to a set number of decimal places but to the nearest whole number. Therefore, where an increase is shown to be 1.4%, this can be rounded down to 1% for the purpose of assessment. Impacts at OE1d and OE1e are both 1.5% and given that the background concentrations are already significantly exceeding the critical load, the impacts are still considered to be '**negligible**' and the effect on the receptor '**not significant'**.

Table 6B.29: VPI Future – Ecological Impacts of NOx

Rec ID	Annual Average Impacts						Change in PC over VPI Baseline Assessment	Impact Descriptor	24-hour Average						Change in PC over VPI Baseline Assessment	Impact Descriptor
	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %			AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %		
OE1		2.53	8.4%	20.1	22.7	76%	+ 4.7%	Minor		17.7	24%	30.2	47.9	64%	+ 8.9%	Negligible
OE2		1.01	3.4%	20.1	21.2	71%	+ 1.7%	Negligible		10.8	14%	30.2	41.0	55%	+ 2.0%	Negligible
OE3		0.10	0.3%	11.3	11.3	38%	+ 0.1%	Negligible		2.7	4%	16.9	19.6	26%	+ 1.1%	Negligible
OE4		0.12	0.4%	12.4	12.5	42%	+ 0.1%	Negligible		2.8	4%	18.6	21.5	29%	+ 0.9%	Negligible
OE5		0.62	2.1%	15.7	16.3	54%	+ 1.5%	Negligible		15.7	21%	23.6	39.3	52%	+ 10.5%	Negligible
OE6	30	0.52	1.7%	16.2	16.7	56%	+ 0.8%	Negligible	75	13.5	18%	24.3	37.8	50%	+ 8.9%	Negligible
OE7		0.13	0.4%	17.5	17.6	59%	- 0.1%	Negligible		3.7	5%	26.2	30.0	40%	- 0.3%	Negligible
OE8		0.40	1.3%	17.2	17.6	59%	+ 0.6%	Negligible		11.2	15%	25.7	36.9	49%	+ 3.6%	Negligible
OE9		0.78	2.6%	14.6	15.4	51%	+ 1.7%	Negligible		12.5	17%	21.9	34.4	46%	+ 6.6%	Negligible
OE10		0.35	1.2%	15.9	16.2	54%	+ 0.8%	Negligible		13.4	18%	23.8	37.2	50%	+ 6.9%	Negligible
OE11		0.65	2.2%	15.7	16.4	55%	+ 1.5%	Negligible		16.7	22%	23.6	40.3	54%	+ 10.9%	Negligible

Table 6B.30: VPI Future – Annual Ecological Impacts of SO_2

Receptor ID	AQAL (µg/m³)	PC (µg/m³)	PC/ AQAL %	BC (µg/m³)	PEC (µg/m³)	PEC/ AQAL %	Change in PC over VPI Baseline	Impact Descriptor
OE1		0.18	0.9%	3.8	3.9	20%	+ 0.5%	Negligible
OE2		0.07	0.4%	3.8	3.8	19%	+ 0.2%	Negligible
OE3		0.01	0.0%	1.0	1.0	5%	0.0%	Negligible
OE4		0.01	0.0%	1.7	1.7	8%	0.0%	Negligible
OE5		0.05	0.2%	3.6	3.7	18%	+ 0.2%	Negligible
OE6	20	0.04	0.2%	3.4	3.5	17%	+ 0.1%	Negligible
OE7		0.01	0.0%	3.4	3.4	17%	0.0%	Negligible
OE8		0.03	0.1%	3.5	3.5	17%	+ 0.1%	Negligible
OE9		0.06	0.3%	3.3	3.3	17%	+ 0.2%	Negligible
OE10		0.03	0.1%	3.4	3.4	17%	+ 0.1%	Negligible
OE11		0.05	0.2%	3.6	3.7	18%	+ 0.2%	Negligible

Table 6B.31: VPI Future – Annual Ecological Impacts of NH_3

Receptor ID	AQAL (µg/m³)	PC (µg/m³)	PC/ AQAL %	BC (µg/m³)	PEC (µg/m³)	PEC/ AQAL %	Change in PC over VPI Baseline	Impact Descriptor
OE1	3	0.11	4%	2.11	2.22	74%	+ 3.5%	Negligible
OE2	3	0.04	1.4%	2.11	2.15	72%	+ 1.4%	Negligible
OE3	3	0.004	0.1%	2.37	2.37	79%	+ 0.1%	Negligible
OE4	1	0.005	0.5%	3.1	3.10	311%	+ 0.5%	Negligible
OE5	3	0.03	0.9%	2.11	2.14	71%	+ 0.9%	Negligible
OE6	3	0.02	0.7%	2.11	2.13	71%	+ 0.7%	Negligible
OE7	3	0.005	0.2%	2.11	2.12	71%	+ 0.2%	Negligible
OE8	3	0.02	0.6%	2.11	2.13	71%	+ 0.6%	Negligible
OE9	3	0.03	1.1%	2.11	2.14	71%	+ 1.1%	Negligible
OE10	3	0.01	0.5%	2.11	2.12	71%	+ 0.5%	Negligible
OE11	3	0.03	0.9%	2.11	2.14	71%	+ 0.9%	Negligible

Table 6B.32: VPI Future – Nitrogen Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Nitrogen Deposition (kg N/ha/yr)	Lower value of Critical Load Range	PC (kg N/ha/yr)	PC% Critical Load	PEC (kg N/ha/yr)	PEC% Critical Load	Change in PC over VPI Baseline Assessment	Impact Descriptor
OE1a	Coastal stable dunes grasslands - acid type	20.30	8	0.02	0.2%	20.3	254%	+ 0.1%	Negligible
OE1b	Coastal stable dunes grasslands - calcareous type	19.18	10	0.01	0.1%	19.2	192%	+ 0.1%	Negligible
OE1c	Shifting coastal dunes	18.48	10	0.01	0.1%	18.5	185%	+ <0.1%	Negligible
OE1d	Northern wet heath	20.44	10	0.2	2.0%	20.6	206%	+ 1.5%	Negligible
OE1e	Pioneer, low, mid upper saltmarshes	20.44	20	0.4	2.1%	20.6	104%	+ 1.5%	Negligible
OE1f	Low and medium altitude hay meadows	20.30	20	0.03	0.1%	20.3	102%	+ 0.1%	Negligible
OE2	Pioneer, low, mid upper saltmarshes	20.44	20	0.2	1.0%	20.6	103%	+ 0.7%	Negligible
OE3	Sub-Atlantic semi-dry calcareous grassland	22.26	15	0.02	0.1%	22.3	149%	+ 0.1%	Negligible
OE4a	Non-Mediterranean dry acid and neutral closed grassland	24.92	10	0.02	0.2%	25.2	252%	+ 0.1%	Negligible
OE4b	Meso- and eutrophic *Quercus* woodland	42.6	15	0.04	0.3%	42.6	284%	+ 0.1%	Negligible
OE5	Neutral grassland	20.4	10	0.1	1.2%	20.5	205%	+ 1.0%	Negligible
OE6	Broadleaved woodland	34.2	10	0.2	1.8%	34.4	344%	+ 1.2%	Negligible
OE7	Wetland and reedbed	20.4	10	0.02	0.2%	20.4	204%	+ 0.1%	Negligible
OE8	Broadleaved woodland	34.2	10	0.1	1.4%	34.3	343%	+ 0.9%	Negligible
OE9	Neutral grassland	20.4	10	0.1	1.5%	20.5	205%	+ 1.2%	Negligible
OE10	Standing open water and neutral grassland	20.4	10	0.07	0.7%	20.5	205%	+ 0.6%	Negligible
OE11	Calcareous grassland	20.4	15	0.1	0.8%	20.5	137%	+ 0.7%	Moderate

Table 6B.33: VPI Future – Acid Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Deposition (keq ha/yr)	Relevant Critical Load (keq ha/yr)	Background % of Critical Load	PC (keq N/ha/yr)	PC% Critical Load	PEC% Critical Load	Change in PC over VPI Baseline Assessment	Impact Descriptor
OE1a	Acid grassland	N: 1.42 S: 0.18	MinNMinN: 0.223 MinCLMaxS: 0.42 MinCLMaxN: 0.643	248.8%	N: 0.001 S: 0.0008	0%	248.8%	0%	Negligible
OE1b	Calcareous grassland	N: 1.27 S: 0.15	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	29.2%	N: 0.0009 S: 0.0006	0%	29.2%	0%	Negligible
OE1d	Dwarf shrub heath	N: 1.48 S: 0.31	MinNMinN: 0.499 MinCLMaxS: 0.42 MinCLMaxN: 1.312	136.4%	N: 0.014 S: 0.009	1.5%	137.9%	+ 0.7%	Negligible
OE2	No critical load assigned in APIS								
OE3	Calcareous grassland	N: 1.58 S:0.17	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	36.0%	N: 0.001 S: 0.0009	0%	36.0%	0%	Negligible
OE4a	Unmanaged broadleaved/ coniferous woodland	N: 3.04 S: 0.23	MinNMinN: 0.285 MinCLMaxS: 0.748 MinCLMaxN: 1.033	316.6%	N: 0.003 S: 0.002	1.0%	317.6%	+ 1.0%	Negligible
OE4b	Acid grassland	N: 1.78 S: 0.19	MinNMinN: 0.366 MinCLMaxS: 0.17 MinCLMaxN: 0.536	367.5%	N: 0.002 S: 0.001	0%	367.5%	0%	Negligible

Phillips 66 Future

Human Health Receptor Results

6B.6.11 The future results for the Phillips 66 Proposed Development are shown for the worst-case receptor location in Table 6B.34. The results for modelling of the WGS future emission result in worst case impacts of NOx, SO_2, CO, PM and NH_3 than the modelling of the future PCC plant absorber emissions, and therefore these are the reported results in Table 6B.34. Impacts of amines and amide are from the PCC plant absorber, as these species are only released from this future source.

6B.6.12 The predicted PCs at the worst-case receptor location for all pollutant species that will be released from the Proposed Phillips 66 Development result in a '**negligible**' impact that is '**not significant'**. Due to the reduction in emission concentrations of some species, the impacts at some receptors are actually slightly lower than those reported in the Phillips 66 Baseline Assessment.

Table 6B.34: Phillips 66 Future – Maximum Human Health Impacts at Any Receptor

Pollutant	Averaging Period	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %	Change in PC over P66 Baseline Assessment	Impact Descriptor
NO_2	Annual mean	40	0.12	0.3%	15.0	15.1	38%	- 0.5%	Negligible
	1-hour mean (as the 99.79th %ile of hourly averages)	200	2.6	1.3%	30.0	32.6	16%	- 0.7%	Negligible
CO	1-hour mean (as the 100th %ile of hourly averages)	30,000	21.6	0.1%	236.6	258.2	1%	0%	Negligible
	Maximum daily running 8-hour mean	10,000	16.1	0.2%	236.6	252.7	3%	+ 0.1%	Negligible
PM_{10}	Annual mean	40	0.28	0.7%	19.0	19.3	48%	+ 0.6%	Negligible
	24-hour mean (as the 90.41th %ile of hourly averages)	50	0.26	0.5%	38.0	38.3	77%	+ 0.1%	Negligible
$PM_{2.5}$	Annual mean	20	0.28	1.4%	11.8	12.1	60%	+ 1.1%	Negligible
SO_2	15-minute mean (as the 99.9th %ile)	266	18.1	6.8%	6.7	24.8	9%	- 2.7%	Negligible
	1-hour mean (as the 99.73th %ile)	350	15.4	4.4%	6.7	22.1	6%	- 1.4%	Negligible
	24-hour mean (as the 99.18th percentile)	125	3.2	2.6%	3.4	6.6	5%	- 3.2%	Negligible
NH_3	Annual mean	180	0.03	<0.1%	2.2	2.2	1%	0%	Negligible
	1-hour mean (as the 100th %ile of hourly averages)	2,500	1.0	<0.1%	4.4	5.4	0.2%	0%	Negligible
Total Amines	Daily mean (as the 100th %ile of daily averages)	100	0.06	0.1%	-	0.06	0.1%	+ 0.1%	Negligible
	Hourly Mean (as the 100th %ile of hourly averages)	400	0.2	<0.1%	-	0.2	<0.1%	+ <0.1%	Negligible
Amide	Annual mean	0.6	0.0001	<0.1%	-	0.0001	<0.1%	+ <0.1%	Negligible
	1-hour mean (as the 100th %ile of hourly averages)	18	0.005	<0.1%	-	0.005	<0.1%	+ <0.1%	Negligible

Ecological Receptor Results

6B.6.13 The results in Table 6B.35 for the Phillips 66 Proposed Development are shown for the worst-case WGS future emissions of NOx, SO_2, NH_3, as these are slightly higher than the modelling of the future PCC Absorber emission and therefore result in a worst-case assessment.

6B.6.14 The results at all receptors show a decrease in the NOx impacts of the Future Assessment against those reported for the Phillips 66 Baseline Assessment, due to the reduction in the NOx emission concentration. All annual average NOx impacts show a decrease of 1% or less, whereas the daily impacts reduce by up to 4.8% of the AQAL at one site. The decrease in impacts therefore result in a 'very low' or 'imperceptible' magnitude of change with '**negligible**' impact that is '**not significant'**.

6B.6.15 SO_2 impacts in Table 6B.36 show decreases of up to 4.4% or less at all receptors and therefore the magnitude of change is considered to be 'low' or 'very low' with '**negligible**' impact and therefore are considered to be '**not significant'**.

6B.6.16 The results in Table 6B.37 show very slight increases in NH_3 emissions from the Proposed Phillips 66 Development however as the increases are <0.5% they are considered to be 'imperceptible' and therefore '**negligible**' and '**not significant'**.

6B.6.17 The changes in the depositional impacts from the Proposed Phillips 66 Development are either below the 1% threshold for insignificance defined by the Environment Agency and Natural England or slightly over it. As the 1% threshold is not intended to be precise to a set number of decimal places but to the nearest whole number, and no change is over ±1.4%, then all the predicted changes are considered to be '**negligible**' and '**not significant'**.

Table 6B.35: Phillips 66 Future – Ecological Impacts of NOx

Receptor ID	Annual Average Impacts						Change in PC over P66 Baseline Assess-ment	24-hour Average						Change in PC over P66 Baseline Assess-ment
	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %		AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %	
OE1		0.15	0.5%	20.1	20.3	68%	- 1.1%		0.80	1%	30.2	31.0	41%	- 2.9%
OE2		0.16	0.5%	20.1	20.3	68%	- 1.1%		0.80	1%	30.2	31.0	41%	- 3.2%
OE3		0.01	<0.1%	11.3	11.3	38%	- 0.1%		0.22	0.3%	16.9	17.1	23%	- 0.9%
OE4		0.01	<0.1%	12.4	12.4	41%	- 0.1%		0.24	0.3%	18.6	18.9	25%	- 0.8%
OE5		0.04	0.1%	15.7	15.8	53%	+ 0.1%		3.94	5%	23.6	27.5	37%	- 3.9%
OE6	30	0.30	1.0%	16.2	16.5	55%	- 1.3%	75	1.77	2%	24.3	26.1	35%	- 4.8%
OE7		0.16	0.5%	17.5	17.6	59%	- 0.9%		1.43	2%	26.2	57.6	37%	- 3.3%
OE8		0.13	0.4%	17.2	17.3	58%	- 0.6%		1.16	2%	25.7	26.9	36%	- 3.3%
OE9		0.07	0.2%	14.6	14.7	49%	0%		2.04	3%	21.9	23.9	32%	- 2.3%
OE10		0.05	0.2%	15.9	15.9	53%	- 0.4%		0.73	1%	23.8	24.6	33%	- 2.6%
OE11		0.03	0.1%	15.7	15.8	53%	- 0.1%		4.56	6%	23.6	28.2	38%	- 1.7%

Table 6B.36: Phillips 66 Future – Annual Average Ecological Impacts of SO_2

Receptor ID	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %	Change in PC over P66 Baseline Assessment
OE1		0.20	1.0%	3.8	4.0	20%	- 3.5%
OE2		0.22	1.1%	3.8	4.0	20%	- 3.5%
OE3		0.01	<0.1%	1.0	1.0	5%	- 0.2%
OE4		0.01	0.1%	1.7	1.7	8%	- 0.3%
OE5		0.07	0.4%	3.6	3.7	18%	- 0.1%
OE6	20	0.41	2.0%	3.4	3.8	19%	- 4.4%
OE7		0.22	1.1%	3.4	3.7	18%	- 2.8%
OE8		0.19	0.9%	3.5	3.6	18%	- 1.9%
OE9		0.11	0.5%	3.3	3.4	17%	- 0.2%
OE10		0.07	0.4%	3.4	3.5	17%	- 1.1%
OE11		0.08	0.3%	3.6	3.7	18%	+ 0.1%

Table 6B.37: Phillips 66 Future – Annual Ecological Impacts of NH_3

Receptor ID	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %	Change in PC over P66 Baseline Assessment
OE1	3	0.019	0.6%	2.11	2.13	71%	+ 0.1%
OE2	3	0.021	0.7%	2.11	2.13	71%	+ 0.1%
OE3	3	0.001	<0.1%	2.37	2.37	79%	0.0%
OE4	1	0.001	0.1%	3.1	3.10	310%	0.0%
OE5	3	0.007	0.2%	2.11	2.12	71%	+ 0.2%
OE6	3	0.04	1.3%	2.11	2.15	72%	+ 0.5%
OE7	3	0.02	0.7%	2.11	2.13	71%	+ 0.2%
OE8	3	0.02	0.6%	2.11	2.13	71%	+ 0.3%
OE9	3	0.01	0.4%	2.11	2.12	71%	+ 0.3%
OE10	3	0.007	0.2%	2.11	2.12	71%	0.0%
OE11	3	0.005	0.2%	2.11	2.12	71%	+ 0.2%

Table 6B.38: Phillips 66 Future – Nitrogen Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Nitrogen Deposition (kg N/ha/yr)	Lower value of Critical Load Range	PC (kg N/ha/yr)	PC% Critical Load	PEC (kg N/ha/yr)	PEC% Critical Load	Change in PC over P66 Baseline Assessment
OE1a	Coastal stable dunes grasslands - acid type	20.30	8	0.005	0.1%	20.3	254%	0%
OE1b	Coastal stable dunes grasslands - calcareous type	19.18	10	0.003	<0.1%	19.2	192%	0%
OE1c	Shifting coastal dunes	18.48	10	0.002	0.02%	18.5	185%	0%
OE1d	Northern wet heath	20.44	10	0.14	1.4%	20.6	206%	+ 0.1%
OE1e	Pioneer, low, mid upper saltmarshes	20.44	20	0.13	0.6%	20.6	103%	0%
OE1f	Low and medium altitude hay meadows	20.30	20	0.01	0.1%	20.3	102%	0%
OE2	Pioneer, low, mid upper saltmarshes	20.44	20	0.14	0.7%	20.6	103%	0%
OE3	Sub-Atlantic semi-dry calcareous grassland	22.26	15	0.006	<0.1%	22.3	148%	0%
OE4a	Non-Mediterranean dry acid and neutral closed grassland	24.92	10	0.007	0.1%	24.9	249%	0%
OE4b	Meso- and eutrophic *Quercus* woodland	42.6	15	0.01	0.1%	42.6	284%	0%
OE5	Neutral grassland	20.4	10	0.05	0.5%	20.4	204%	+ 0.4%
OE6	Broadleaved woodland	34.2	10	0.41	4.1%	34.6	346%	+ 1.0%
OE7	Wetland and reedbed	20.4	10	0.14	1.4%	20.5	205%	+ 0.3%
OE8	Broadleaved woodland	34.2	10	0.19	1.9%	34.4	344%	+ 0.5%
OE9	Neutral grassland	20.4	10	0.07	0.7%	20.5	205%	+ 0.5%
OE10	Standing open water and neutral grassland	20.4	10	0.05	0.5%	20.4	204%	0%
OE11	Calcareous grassland	20.4	15	0.03	0.2%	20.4	136%	+ 0.2%

Table 6B.39: Phillips 66 Future – Acid Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Deposition (keq ha/yr)	Relevant Critical Load (keq ha/yr)	Background % of Critical Load	PC (keq N/ha/yr)	PC% Critical Load	PEC% Critical Load	Change in PC over P66 Baseline Assessment
OE1a	Acid grassland	N: 1.42 S: 0.18	MinNMinN: 0.223 MinCLMaxS: 0.42 MinCLMaxN: 0.643	248.8%	N: 0.0003 S: 0.0008	0%	248.8%	- 1.6%
OE1b	Calcareous grassland	N: 1.27 S: 0.15	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	29.2%	N: 0.0002 S: 0.0006	0%	29.2%	- 0.2%
OE1d	Dwarf shrub heath	N: 1.48 S: 0.31	MinNMinN: 0.499 MinCLMaxS: 0.42 MinCLMaxN: 1.312	136.4%	N: 0.010 S: 0.026	3.0%	139.4%	- 6.1%
OE2	No critical load assigned in APIS							
OE3	Calcareous grassland	N: 1.58 S: 0.17	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	36.0%	N: 0.0004 S: 0.0010	0.0%	36.0%	- 0.2%
OE4a	Unmanaged broadleaved/ coniferous woodland	N: 3.04 S: 0.23	MinNMinN: 0.285 MinCLMaxS: 0.748 MinCLMaxN: 1.033	316.6%	N: 0.0005 S: 0.024	0.0%	316.6%	- 1.9%
OE4b	Acid grassland	N: 1.78 S: 0.19	MinNMinN: 0.366 MinCLMaxS: 0.17 MinCLMaxN: 0.536	367.5%	N: 0.0005 S: 0.0012	0.0%	367.5%	- 1.9%

In-Combination Future

Human Health Receptor Results

6B.6.18 The future results for the Proposed Developments operating in-combination are shown for the worst-case receptor location in Table 6B.40. The results are based on the model scenarios that resulted in the worst-case results that are presented in the previous sections (i.e. for the Phillips 66 Proposed Development the WGS future emission for impacts of NOx, SO_2, CO, PM and NH_3 and impacts of amines and amide from the PCC plant absorber).

6B.6.19 As per the In-Combination Baseline results, the individual pollutant impacts are dominated by the existing source that has the highest mass emission. For example, the increase in NOx impacts for the Future In-Combination Assessment is in line with the increase in impacts for the VPI Future Assessment, as the mass emission of NOx from the VPI Site is greater than the Phillips 66 site.

6B.6.20 The predicted PCs at the worst-case receptor location for all pollutant species that will be released from the Proposed Developments result in a '**negligible'** impacts that result in effects that are considered '**not significant'**. Again, due to the reduction in emission concentrations of some species (namely SO_2) from the Phillips 66 Site, the impacts are actually slightly lower than those reported in the In-Combination Baseline Assessment.

Table 6B.40: In-Combination Future – Maximum Human Health Impacts at Any Receptor

Pollutant	Averaging Period	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %	Change in PC over In-Combination Baseline	Impact Descriptor
NO_2	Annual mean	40	1.9	4.8%	15.0	16.9	42%	+ 1.8%	Negligible
	1-hour mean (as the 99.79th %ile of hourly averages)	200	31.5	15.7%	30.0	61.5	31%	+ 7.0%	Negligible
CO	1-hour mean (as the 100th %ile of hourly averages)	30,000	241.6	0.8%	236.6	478.2	2%	+ 0.4%	Negligible
	Maximum daily running 8-hour mean	10,000	162.2	1.6%	236.6	398.8	4%	+ 0.7%	Negligible
PM_{10}	Annual mean	40	0.06	0.2%	19.0	19.1	48%	- 0.2%	Negligible
	24-hour mean (as the 90.41th %ile of hourly averages)	50	0.34	0.7%	38.0	38.3	77%	+ 0.2%	Negligible
$PM_{2.5}$	Annual mean	20	0.06	0.1%	11.8	11.8	59%	0.0%	Negligible
SO_2	15-minute mean (as the 99.9th %ile)	266	20.1	7.5%	6.7	26.8	10%	- 2.1%	Negligible
	1-hour mean (as the 99.73th %ile)	350	17.6	5.0%	6.7	24.3	7%	- 1.1%	Negligible
	24-hour mean (as the 99.18th percentile)	125	3.4	2.7%	3.4	6.7	5%	- 3.2%	Negligible
NH_3	Annual mean	180	0.1	0.1%	2.2	2.3	1%	+ 0.1%	Negligible
	1-hour mean (as the 100th %ile of hourly averages)	2,500	2.6	0.1%	4.4	7.0	0.3%	+ 0.1%	Negligible
Total Amines	Daily mean (as the 100th %ile of daily averages)	100	0.15	0.2%	-	0.15	0.2%	+ 0.2%	Negligible
	Hourly Mean (as the 100th %ile of hourly averages)	400	0.4	0.1%	-	0.4	0.1%	+ 0.1%	Negligible
Amide	Annual mean	0.6	0.002	0.3%	-	0.002	0.3%	+ 0.3%	Negligible
	1-hour mean (as the 100th %ile of hourly averages)	18	0.04	0.2%	-	0.04	0.2%	+ 0.2%	Negligible

Ecological Receptor Results

6B.6.21 The results in Table 6B.41 for the In-Combination Future Assessment show increases in NOx impacts at some receptors and decreases at other receptors, depending on whether impacts at each site are dominated by the Proposed VPI or Phillips 66 Developments. All changes in the impacts of NOx and SO_2 are in-line with those described for the individual VPI Future or Phillips 66 Future Assessments.

6B.6.22 The Future In-combination impacts of NH_3 are in-line with those presented for the VPI Future Assessment.

6B.6.23 The nitrogen deposition impacts show greater increases at a number of receptors, particularly at a number of the LWS receptors (OE5 – OE11) in close proximity to the Proposed Developments Sites'. The greatest increase is experienced at OE6 (Burkinshaws Covert), with an increase in nitrogen deposition of 3.6% at this location. The background nitrogen deposition at this location is already 342% of the lower critical load applied to this location, and therefore the increase is considered to be small (generally defined as less than 5% of the critical load) in comparison to the existing background at the site. Further consideration of the potential effects of this increase in nitrogen deposition is provided in Chapter 13: Ecology and Biodiversity (ES Volume I).

6B.6.24 In terms of the designated sites, increases at the Humber Estuary are up to 2.9% of the lower critical load for Northern Wet Heath habitats at the assessed location, and up to 3.6% at the Pioneer, low, mid upper saltmarshes location. Again, the background concentrations at these locations are already exceeding the lower critical load and the increase is considered to be small in comparison.

6B.6.25 As the existing nitrogen deposition already far exceeds the minimum critical load for this habitat, it is considered that additional nitrogen will have a limited effect as there is likely to already be ample nitrogen for more competitive plants to respond. Therefore, any botanical effect, while it might occur, is likely to be significantly less than it would be if background nitrogen deposition rates were lower. This is supported by Natural England commissioned report (NE 2016), Table 21 and Appendix 5 of which show that the scale of change in various parameters from adding a given dose of nitrogen is smaller when the existing deposition rates are higher.

6B.6.26 Further consideration of the potential effects of this increase in nitrogen deposition at these locations is provided in Chapter 13: Ecology and Biodiversity (ES Volume I).

6B.6.27 Due to the reductions in SO_2 emissions from the P66 Site, and this being the dominant source of acid deposition from the two Sites, the In-Combination Future acid deposition impacts show a reduction over the In-Combination Baseline Assessment.

Table 6B.41: In-Combination Future – Ecological Impacts of NOx

Rec ID	Annual Average Impacts						Change in PC over In-Combination Baseline Assessment	Impact Descriptor	24-hour Average						Change in PC over In-Combination Baseline Assessment	Impact Descriptor
	AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %			AQAL (µg/m^3)	PC (µg/m^3)	PC/ AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %		
OE1		2.63	8.8%	20.1	22.8	76%	+ 3.9%	Minor		17.7	24%	30.2	47.9	64%	+ 6.8%	Negligible
OE2		1.12	3.7%	20.1	21.3	71%	+ 0.4%	Negligible		10.8	14%	30.2	41.0	55%	+ 0.8%	Negligible
OE3		0.11	0.4%	11.3	11.4	38%	+ 0.1%	Negligible		2.9	4%	16.9	19.8	26%	+ 0.4%	Negligible
OE4		0.12	0.4%	12.4	12.5	42%	0%	Negligible		2.5	3%	18.6	21.1	28%	- 0.6%	Negligible
OE5		0.64	2.1%	15.7	16.4	55%	+ 1.5%	Negligible		15.6	21%	23.6	39.2	52%	+ 10.4%	Negligible
OE6	30	0.82	2.7%	16.2	17.0	57%	- 0.5%	Negligible	75	15.2	20%	24.3	39.5	53%	+ 11.1%	Minor
OE7		0.29	1.0%	17.5	17.8	59%	- 2.5%	Negligible		4.2	6%	26.2	30.4	41%	- 9.0%	Negligible
OE8		0.55	1.8%	17.2	17.7	59%	- 0.1%	Negligible		11.5	15%	25.7	37.2	50%	+ 7.0%	Negligible
OE9		0.84	2.8%	14.6	15.4	51%	+ 1.1%	Negligible		12.6	17%	21.9	34.5	46%	+ 4.6%	Negligible
OE10		0.41	1.4%	15.9	16.3	54%	+ 0.3%	Negligible		13.9	18%	23.8	37.7	50%	+ 8.4%	Negligible
OE11		0.64	2.2%	15.7	16.4	55%	+ 1.4%	Negligible		16.6	22%	23.6	40.2	54%	+ 10.1%	Negligible

Table 6B.42: In-Combination Future – Annual Ecological Impacts of SO_2

Receptor ID	AQAL (µg/m³)	PC (µg/m³)	PC/ AQAL %	BC (µg/m³)	PEC (µg/m³)	PEC/ AQAL %	Change in PC over In-Combination Baseline Assessment	Impact Descriptor
OE1	20	0.31	1.6%	3.8	4.1	20%	- 1.9%	Negligible
OE2		0.28	1.4%	3.8	4.0	20%	- 3.4%	Negligible
OE3		0.02	0.1%	1.0	1.0	5%	- 0.2%	Negligible
OE4		0.02	0.1%	1.7	1.7	8%	- 0.3%	Negligible
OE5		0.11	0.6%	3.6	3.7	19%	+ 0.3%	Negligible
OE6		0.44	2.2%	3.4	3.9	19%	- 4.3%	Negligible
OE7		0.23	1.1%	3.4	3.7	18%	- 5.1%	Negligible
OE8		0.21	1.0%	3.5	3.7	18%	- 2.9%	Negligible
OE9		0.16	0.8%	3.3	3.4	17%	- 2.1%	Negligible
OE10		0.09	0.5%	3.4	3.5	17%	- 0.4%	Negligible
OE11		0.09	0.5%	3.6	3.7	19%	- 1.1%	Negligible

Table 6B.43: In-Combination Future – Annual Ecological Impacts of NH_3

Receptor ID	AQAL (µg/m³)	PC (µg/m³)	PC/ AQAL %	BC (µg/m³)	PEC (µg/m³)	PEC/ AQAL %	Change in PC over In-Combination Baseline Assessment	Impact Descriptor
OE1	3	0.12	3.9%	2.11	2.23	74%	+ 3.6%	Negligible
OE2	3	0.06	2.0%	2.11	2.17	72%	+ 1.4%	Negligible
OE3	3	0.005	0.2%	2.37	2.38	79%	+ 0.1%	Negligible
OE4	1	0.006	0.6%	3.1	3.11	311%	+ 0.4%	Negligible
OE5	3	0.03	1.1%	2.11	2.14	71%	+ 1.0%	Negligible
OE6	3	0.06	2.0%	2.11	2.17	72%	+ 1.3%	Negligible
OE7	3	0.03	0.9%	2.11	2.14	71%	+ 0.1%	Negligible
OE8	3	0.03	1.1%	2.11	2.14	71%	+ 0.7%	Negligible
OE9	3	0.04	1.3%	2.11	2.15	72%	+ 1.0%	Negligible
OE10	3	0.02	0.7%	2.11	2.13	71%	+ 0.6%	Negligible
OE11	3	0.03	1.0%	2.11	2.14	71%	+ 0.8%	Negligible

Table 6B.44: In-Combination Future – Nitrogen Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Nitrogen Deposition (kg N/ha/yr)	Lower value of Critical Load Range	PC (kg N/ha/yr)	PC% Critical Load	PEC (kg N/ha/yr)	PEC% Critical Load	Change in PC over In-Combination Baseline Assessment
OE1a	Coastal stable dunes grasslands - acid type	20.30	8	0.04	0.5%	20.3	254%	+ 0.3%
OE1b	Coastal stable dunes grasslands - calcareous type	19.18	10	0.03	0.3%	19.2	192%	+ 0.2%
OE1c	Shifting coastal dunes	18.48	10	0.01	0.1%	18.5	185%	+ 0.1%
OE1d	Northern wet heath	20.44	10	0.48	4.8%	20.9	209%	+ 2.9%
OE1e	Pioneer, low, mid upper saltmarshes	20.44	20	0.97	4.8%	20.9	107%	+ 3.6%
OE1f	Low and medium altitude hay meadows	20.30	20	0.06	0.3%	20.4	102%	+ 0.2%
OE2	Pioneer, low, mid upper saltmarshes	20.44	20	0.48	2.4%	20.9	105%	+ 1.4%
OE3	Sub-Atlantic semi-dry calcareous grassland	22.26	15	0.04	0.3%	22.3	149%	+ 0.2%
OE4a	Non-Mediterranean dry acid and neutral closed grassland	24.92	10	0.05	0.5%	25.0	250%	+ 0.3%
OE4b	Meso- and eutrophic *Quercus* woodland	42.6	15	0.07	0.5%	42.7	284%	+ 0.3%
OE5	Neutral grassland	20.4	10	0.25	2.5%	20.7	207%	+ 2.3%
OE6	Broadleaved woodland	34.2	10	0.72	7.2%	34.9	349%	+ 3.4%
OE7	Wetland and reedbed	20.4	10	0.19	1.9%	20.6	206%	+ 0.6%
OE8	Broadleaved woodland	34.2	10	0.42	4.2%	34.6	346%	+ 2.4%
OE9	Neutral grassland	20.4	10	0.33	3.3%	20.7	207%	+ 2.8%
OE10	Standing open water and neutral grassland	20.4	10	0.17	1.7%	20.6	206%	+ 1.1%
OE11	Calcareous grassland	20.4	15	0.25	1.7%	20.6	138%	+ 1.5%

Table 6B.45: In-Combination Future – Acid Deposition at Ecological Receptors

Receptor ID	Most Stringent Critical Load Class for the Site	Background Deposition (keq ha/yr)	Relevant Critical Load (keq ha/yr)	Background % of Critical Load	PC (keq N/ha/yr)	PC% Critical Load	PEC% Critical Load	Change in PC over In-Combination Baseline Assessment	Impact Descriptor
OE1a	Acid grassland	N: 1.42 S: 0.18	MinNMinN: 0.223 MinCLMaxS: 0.42 MinCLMaxN: 0.643	248.8%	N: 0.003 S: 0.002	0%	248.8%	- 1.6%	Negligible
OE1b	Calcareous grassland	N: 1.27 S: 0.15	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	29.2%	N: 0.002 S: 0.001	0%	29.2%	- 0.2%	Negligible
OE1d	Dwarf shrub heath	N: 1.48 S: 0.31	MinNMinN: 0.499 MinCLMaxS: 0.42 MinCLMaxN: 1.312	136.4%	N: 0.03 S: 0.03	5.3%	141.7%	- 4.6%	Negligible
OE2	No critical load assigned in APIS								
OE3	Calcareous grassland	N: 1.58 S:0.17	MinNMinN: 0.856 MinCLMaxS: 4.00 MinCLMaxN: 4.856	36.0%	N: 0.003 S: 0.002	0.2%	36.2%	0%	Negligible
OE4a	Unmanaged broadleaved/ coniferous woodland	N: 3.04 S: 0.23	MinNMinN: 0.285 MinCLMaxS: 0.748 MinCLMaxN: 1.033	316.6%	N: 0.004 S: 0.004	1.0%	317.6%	- 0.9%	Negligible
OE4b	Acid grassland	N: 1.78 S: 0.19	MinNMinN: 0.366 MinCLMaxS: 0.17 MinCLMaxN: 0.536	367.5%	N: 0.003 S: 0.002	1.9%	369.4%	0%	Negligible

6B.7 Assessment Limitations and Assumptions

6B.7.1 The greatest uncertainty associated with any dispersion modelling assessment arises through the inherent uncertainty of the dispersion modelling process itself. Nevertheless, the use of dispersion modelling is a widely applied and accepted approach for the prediction of impacts from industrial sources.

6B.7.2 In order to minimise the likelihood of under-estimating the PC to ground level concentrations from the Proposed Developments, the following conservative assumptions have been made within the assessment:

- the operational Proposed Developments have been assumed to operate on a continuous basis i.e. for 8,760 hour per year, although in practice the plants would require routine maintenance periods;
- the modelling predictions are based on the use of five full years of meteorological data from Humberside Airport meteorological station for the years 2017 to 2021 inclusive, with the highest result being reported for all years assessed; and
- emission concentrations for the process are calculated based on the use of BAT-AEL concentrations, Environmental Permit Emission Limit Values or licensor maximum envisaged emission concentrations; in practice annual average rates would be below these values to enable continued compliance with Environmental Permit requirements.

6B.8 Conclusions

6B.8.1 This appendix has detailed the assessment carried out to determine the impact on local air quality of the operation of the Proposed Developments. The assessment has used the dispersion model ADMS to predict the increases in pollutant species released from the operational Proposed Developments to the local study area.

6B.8.2 Emissions from the Proposed Developments result in small changes in ground-level concentrations over the Baseline assessments, which can be considered to result in largely '**negligible**' impacts leading to effects that are '**not significant'**.

6B.8.3 Taking into account available information on background concentrations within the modelled domain, predicted operational concentrations of the modelled pollutants would be within current environmental standards for the protection of human health.

6B.8.4 The modelling of impacts at designated ecological sites (SSSI/ SAC/ SPA/ Ramsar) has predicted that emissions would give rise to **no significant effects** with regard to increases in atmospheric concentrations of NOx, with impacts of SO2 and NH3 also being insignificant.

6B.8.5 Depositional impacts of nutrient nitrogen and acid are considered to be **not significant**.

6B.9 References

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6B.10 Annex 6B.A – Sensitivity Testing of Model Inputs

6B.10.1 The maximum predicted concentrations of NO_2 at the worst-affected human health receptor and NOx at the worst-affected statutory designated ecological receptor (OE1) associated with the variable input parameters, are presented in Table 6B.A1 as the percentage of maximum reported values in the main assessment for the VPI Future Assessment.

Table 6B.A1: Dispersion Model Sensitivity Analysis – VPI Future Assessment

Model Input Variable	Human Health Receptor		Ecological Receptor	
	Short-term	Long-term	Short-term	Long-term
Result Presented in Main Assessment (µg/m^3)	31.7	1.9	17.8	2.54
Meteorological data (5-year min-max)	70%	78%	75%	76%
Surface roughness representation (1.0m)	101%	121%	99%	111%
Surface roughness representation (0.3m)	94%	87%	96%	92%

6B.10.2 The main uncertainty associated with the model is considered to be the meteorological data, with a NO_2 process contribution variation of 70% in the hourly mean NO_2 results for the VPI site; this is equivalent to an overall uncertainty at the worst-affected receptor of -9.5 µg/m^3 (or -5% of the relevant AQAL).

6B.10.3 The annual average NO_2 process contribution varies by 78%, equivalent to an overall uncertainty at the worst-affected receptor of -1.9 µg/m^3 (or -5% of the relevant AQAL).

6B.10.4 The surface roughness representation in the main model has been assessed at 0.5m, representative of the Parkland and Open Suburbia. This is consistent with modelling carried out previously for the VPI Site for the VPI-B OCGT Power Station DCO and VPI-A Gas Engine Peaking Plant Section 36 Consent and relevant Environmental Permit applications. Therefore, it is considered to be the most appropriate surface roughness to represent the Sites.

6B.10.5 The surface roughness has been varied and it was found that a higher surface roughness (1.0 m), on the whole resulted in either equivalent or higher impacts at the worst-case receptor for the VPI Site, however for receptors further away from the source, the impacts would be reduced over those reported in the main assessment.

6B.10.6 The lower surface roughness of 0.1 m resulted in lower impacts.

6B.10.7 The maximum predicted concentrations of NO_2 at the worst-affected human health receptor and NOx at the worst-affected statutory designated ecological receptor (OE11 for short term impacts and OE6 for long term impacts) associated with the variable input parameters, are presented in Table 6B.A2 as the percentage of maximum reported values in the main assessment for the Phillips 66 Future Assessment.

Table 6B.A2: Dispersion Model Sensitivity Analysis – Phillips 66 Future Assessment

Model Input Variable	Human Health Receptor		Ecological Receptor	
	Short-term	Long-term	Short-term	Long-term
Result Presented in Main Assessment (µg/m^3)	2.6	0.12	4.6	0.3
Meteorological data (5-year min-max)	62%	37%	18%	84%
Surface roughness representation (1.0m)	100%	123%	100%	106%
Surface roughness representation (0.3m)	99%	87%	99%	97%

6B.10.8 The main uncertainty associated with the model is considered to be the meteorological data, with a NO_2 process contribution variation of 62% in the hourly mean NO_2 results for the Phillips 66 site; this is equivalent to an overall uncertainty at the worst-affected receptor of -1 µg/m^3 (or -0.5% of the relevant AQAL).

6B.10.9 The annual average NO_2 process contribution varies by 37%, equivalent to an overall uncertainty at the worst-affected receptor of -0.1 µg/m^3 (or -0.3% of the relevant AQAL).

6B.10.10 The surface roughness has been varied and it was found that a higher surface roughness (1.0 m), on the whole resulted in either equivalent or higher impacts at the worst-case receptor for the Phillips 66 Site, however for receptors further away from the source, the impacts would be reduced over those reported in the main assessment.

6B.10.11 The lower surface roughness of 0.1 m resulted in lower impacts.

6B.11 Annex 6B.B – Assessment of Visible Plumes

6B.11.1 Due to the initial water content of the emission from the absorber stack, and the relatively low temperature of the release, there is potential for the plume released from the stack to be visible. The ADMS module can assess the potential for visible plumes to form, based on the initial water content of the release, and the humidity of the ambient air.

6B.11.2 The plume from a stack is described by the model developers as being 'visible' when liquid water is present in the plume above a critical threshold of 0.002 kg/kg.

6B.11.3 The original version of the Environment Agency H1 Risk Assessment Guidance published in 2003 included a methodology for the assessment of the impacts of visible plumes, however this guidance is now superseded. Nevertheless, an assessment has been carried out so that the outputs can be reported and discussed in Chapter 11: Landscape and Visual (ES Volume I).

VPI Absorber Stacks

6B.11.4 The ADMS model set up is identical to that used for the main assessment of pollutant emission from the Proposed VPI Development, except for the selection of plume visibility in the model set-up and the input of initial water content in the plume. The initial water vapour mixing ratio of the plume from the VPI Absorber Stacks is 0.061 kg/kg (mass of water vapour per unit mass of dry release at the stack), based on a water content of 8.9% by volume. ADMS 5 defines the plume to be 'visible' at a particular downwind distance if the ambient humidity at the plume centreline is below 98%, above which it is considered the plume would be indistinguishable from clouds. All other model inputs are identical to those detailed for the main assessment.

6B.11.5 The results from the model are shown in Table 6B.B1. The results show that the plumes are predicted to be visible for up to 85% of the time, with average plumes being up to 123 m long, which is only slightly longer than the stack height. Plumes are predicted to be longer than the stack height for up to 34% of the time.

Table 6B.B1: Visible Plumes from the VPI Absorber Stacks

Met Year	Percentage of Time Plume is Visible	Longest Visible Plume Length	Average Visible Plume Length (m)	Percentage of Year Visible Plume is Over 110 m
2017	83%	1,791m	117m	32%
2018	81%	1,648m	123m	33%
2019	82%	1,648m	117m	34%
2020	82%	1,648m	117m	34%
2021	85%	1,648m	113m	30%

Phillips 66 WGS and Absorber Stack

6B.11.6 The ADMS model set up is identical to that used for the main assessment of pollutant emission for the Proposed Phillips 66 Development, except for the selection of plume visibility in the model set-up and the input of initial water content in the plume. The initial water vapour mixing ratio of the plume is 0.031 kg/kg for the WGS release point and 0.052 kg/kg for the PCC Plant absorber stack. As the PCC Plant stack has the higher water content, this results in the worst-case visible plumes from the two sources, and it should be noted that emissions will only occur from one of these stacks at any one time. As such, only the PPC plant absorber stack results are presented in Table 6B.B2.

6B.11.7 The results show that the plumes are predicted to be visible for up to 22% of the time, with average plumes being up to 12 m. Occasional longer plumes are predicted (up to 241 m), however these are predicted to occur for less than 1% of the time.

Table 6B.B2: Visible Plumes from the P66 WGS and Absorber Stacks

Met Year	Percentage of Time Plume is Visible	Longest Visible Plume Length	Average Visible Plume Length (m)	Percentage of Year Visible Plume is Over 65m
2017	18%	194m	12m	1%
2018	22%	241m	12m	1%
2019	19%	174m	8m	<1%
2020	16%	147m	7m	<1%
2021	20%	174m	11m	1%

6B.11.8