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Appendix 8.3 - Baseline Analysis

Document approval

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Contents

1	Introduction.....	4
2	Local Authority Air Quality Review and Assessment.....	5
2.1	Overview	5
2.2	Air quality action plan	5
3	National Modelling – Mapped Background Data	6
4	AURN and LAQM Monitoring	8
4.1	Overview	8
5	Other National Monitoring Networks	11
5.1	Hydrogen chloride.....	11
5.2	Hydrogen fluoride	11
5.3	Ammonia.....	11
5.4	Volatile Organic Compounds	11
5.5	Metals	12
5.6	Dioxins, furans and polychlorinated biphenyl (PCBs)	13
5.7	Polycyclic Aromatic Hydrocarbons (PAHs).....	14
6	Baseline Conditions at Ecological Sites	15
7	Summary	17
Annex19		
A	Figures	20

1 Introduction

This Appendix has been produced to support Chapter 8 – Air Quality, Odour and Human Health, of the Environmental Impact Assessment Report (EIAR) to support the planning application for an Energy Recovery Park (ERP) (the Proposed Development) at Killoch, East Ayrshire.

This Appendix contains a review of the baseline air quality and defines appropriate baseline concentrations to describe the existing air quality conditions in the local area. As part of this review, national modelling data, local authority and national monitoring networks have been considered. This has included all pollutants covered in the EIAR Chapter 8.

2 Local Authority Air Quality Review and Assessment

2.1 Overview

Under Section 82 of the Environment Act (1995) (Part IV), local authorities are required to undertake an ongoing exercise to review air quality within their area of jurisdiction. The application site is located within East Ayrshire Council area.

A review of Department for Environment Food and Rural Affairs (DEFRA) UK Air Information Resource has shown that there are no Air Quality Management Areas (AQMA) declared within the authority area or within 10 km of the Proposed Development.

2.2 Air quality action plan

Under Section 82 of the Environment Act (1995) (Part IV) local authorities have a duty to produce an Air Quality Action Plan where an AQMA has been declared. The purpose of the Air Quality Action Plan is to set out the strategic and locally generated actions that will be implemented to improve air quality and work towards meeting the air quality objectives. There are no AQMA identified in East Ayrshire, and the 2020 Air Quality Annual Progress Report (APR) for East Ayrshire Council states the 'generally good' state of air quality, with relatively low concentrations of particulate matter (as PM₁₀ and PM_{2.5}), nitrogen dioxide and other pollutants'. Despite this, the APR makes clear that there remains a continuous aim within East Ayrshire to improve air quality. The APR identifies concern associated with vehicular traffic tailpipe emissions (principally from diesel engines), particulate matter (particularly with regard to the fine particulate matter fraction) and oxides of nitrogen emissions in four locations. One of these areas of concern, due to oxides of nitrogen, is in Mauchline, approximately 7 km to the north east of the Proposed Development. It is not anticipated for process emissions from the Proposed Development to be of significant impact at this distance. However, it is expected that some of the HDV traffic associated with the operation of the Proposed Development would travel through Mauchline. This will be considered within the assessment of effects section of the EIAR Chapter 8.

3 National Modelling – Mapped Background Data

In order to assist local authorities with their responsibilities under Local Air Quality Management, the Scottish Government provides modelled background concentrations of pollutants across Scotland on a 1 km by 1 km grid. This model is based on known pollution sources and Scottish background measurements and is used by local authorities in lieu of suitable monitoring data. Mapped background concentrations have been downloaded for the grid squares containing the Proposed Development and the immediate surroundings. In addition to this Scotland specific data set, DEFRA provides modelled background concentrations of pollutants throughout the UK on a 1 km by 1 km grid. Mapped atmospheric concentrations of ammonia are also available from DEFRA via the National Environment Research Council (NERC) Centre for Ecology and Hydrology (CEH) throughout the UK on a 5 km by 5 km grid.

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

Pollutant concentrations will vary over the modelling domain area. Therefore, the maximum mapped background concentration within 5 km of the application site has been calculated for each pollutant. These are presented in Table 1 alongside the concentration at the application site. A comparison has been made between the DEFRA and Scottish specific dataset.

Table 1: Mapped Background Analysis

Pollutant	Annual mean concentration ($\mu\text{g}/\text{m}^3$)			Dataset
	AQAL	At application site	Maximum within 5 km of application site	
Nitrogen dioxide	40	4.02	4.79	Scottish 2018
		3.88	4.67	DEFRA 2018
Oxides of nitrogen	-	5.62	6.71	Scottish 2018
		4.81	5.83	DEFRA 2018
Sulphur dioxide	-	2.55	3.38	DEFRA 2001
Particulate matter (as PM10)	40	9.66	11.08	Scottish 2018
		9.32	10.64	DEFRA 2018
Particulate matter (as PM2.5)	25	5.52	5.81	DEFRA 2018
Carbon monoxide	-	171.00	177.00	DEFRA 2001
Benzene	5	0.20	0.23	DEFRA 2001
1,3-butadiene	2.25	0.07	0.08	DEFRA 2001
Ammonia	180	2.92	3.18	DEFRA (CEH) 2014

The mapped background data shows that concentrations at the application site and the maximum concentrations within the study area (i.e. within 5km of the application site) are well within the AQALs.

4 AURN and LAQM Monitoring

4.1 Overview

The UK Automatic Urban and Rural Network (AURN) is a country-wide network of air quality monitoring stations operated on behalf of DEFRA. This includes automatic monitoring of oxides of nitrogen, nitrogen dioxide, sulphur dioxide, ozone, carbon monoxide and fine particulate matter. In addition, as part of their commitment local authorities undertake monitoring of nitrogen dioxide, particulate matter, carbon monoxide and sulphur dioxide if deemed necessary.

There are no AURN monitoring stations within 10 km of the application site. The closest AURN monitoring stations to the Proposed Development are in Glasgow city centre, approximately 45 km to the north. Due to the different air quality expected in a city centre to the rural area around the site, and the distance from the application site, data from the AURN sites are not considered representative of concentrations in the vicinity of the Site and have not been considered further in this analysis.

East Ayrshire Council operate two automatic and 23 non-automatic monitoring sites. One Automatic site and 6 non-automatic monitoring sites are found within 10 km of the Proposed Development, within the towns of Mauchline and Cumnock. All of the sites are classified as roadside sites in towns. Monitored concentrations at these sites are predominately determined by emissions from nearby traffic and are only representative of air quality for the immediate area of the analyser. The remaining sites monitored by East Ayrshire Council are at least 17 km away and are not considered representative of concentrations in the vicinity of the application site.

A summary of monitoring data from the automatic and non-automatic (diffusion tube) monitoring sites within 10 km of the Proposed Development is provided in Table 2 and presented in Figure 1.

Table 2: Summary of Nitrogen Dioxide Monitoring Results

Site Name	Type*	Mapped Bg ($\mu\text{g}/\text{m}^3$)	Annual mean concentration ($\mu\text{g}/\text{m}^3$)				
			2015	2016	2017	2018	2019
A4	R	5.17	-	-	-	-	14
DT6	R	5.22	20.7	23.3	22.8	19.4	22
DT24	R	5.22	26.5	29.7	28.5	22.3	24
DT52	R	5.12	-	-	15.2	10	17 ¹
DT53	R	5.12	-	-	14	11.5	14 ¹
DT54	R	5.17	-	-	11.5	11.3	10
DT55	R	5.17	-	-	10	10.4	11

Note:
 *UB = Urban Background, UI = Urban Industrial, R = Roadside, O = Other
 Exceedances of the NO₂ AQAL of 40 $\mu\text{g}/\text{m}^3$ are shown in bold
 1 All means have been "annualised" as per LAQM.TG(16) if valid data capture for the full calendar year is less than 75%.

Source: East Ayrshire Council LAQM Annual Progress Report 2020

All monitoring sites have recorded nitrogen dioxide to be higher than the mapped background data for their locations which is expected as they are roadside sites. However, even the roadside sites have nitrogen dioxide concentrations well below the annual mean AQAL of 40 µg/m³.

5 Site Monitoring

Independent monitoring of particulate matter has been undertaken at the Proposed Development site between June 2016 and June 2017. The monitoring was undertaken by Ricardo Energy and Environment and commissioned by Barr Environmental Limited.

The study found the mean concentrations over the year to be 12.81 $\mu\text{g}/\text{m}^3$ for PM_{10} and 6.75 $\mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$. These values are slightly greater than, but similar to the mapped background values from the Scottish 2018 Dataset. They are well below the AQALs.

This on site monitoring has not flagged up any huge discrepancies between the mapped background data and monitored data, and so supports the representativity of the mapped background data. As it is more recent, the mapped background data has been used within this assessment for particulate matter as PM_{10} and $\text{PM}_{2.5}$.

6 Other National Monitoring Networks

6.1 Hydrogen chloride

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

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

6.2 Hydrogen fluoride

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

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

6.3 Ammonia

Ammonia is also measured as part of the UKEAP project at rural background locations. The nearest UKEAP monitoring location is in Auchincruive, approximately 10 km to the north west of the application site. At this site the maximum gaseous ammonia (passive) measured for 2019 was $3.03 \mu\text{g}/\text{m}^3$. As shown in Table 1, the maximum mapped background value from within 5 km of the application site is $3.18 \mu\text{g}/\text{m}^3$. This is higher than that monitored at Auchincruive. In lieu of any more local monitoring, the maximum mapped background concentrations within 5 km of the application site has been used.

6.4 Volatile Organic Compounds

As part of the Automatic and Non-Automatic Hydrocarbon Network, benzene concentrations are measured at sites co-located with the AURN across the UK. In 2007, due to low monitored concentrations of 1,3-butadiene at non-automatic sites, DEFRA took the decision to cease non-automatic monitoring of 1,3-butadiene. There are no monitoring locations within 10 km of the application site. The nearest monitoring sites are in Glasgow city centre, approximately 45 km to the north.

In lieu of any local monitoring of 1,3-butadiene, the maximum mapped background concentration within the modelling domain has been used as the baseline concentration for the purpose of this assessment as set out in Table 1. This value is $0.08 \mu\text{g}/\text{m}^3$.

6.5 Metals

Metals are measured as part of the Rural Metals and UK Urban/Industrial Networks (previously the Lead, Multi-Element and Industrial Metals Networks). There are no metals monitoring locations within 10 km of the application site. The nearest monitoring site is at Eskdalemuir, a rural background site approximately 80 km to the east. Due to its distance from the application site, it is not considered representative of the conditions at the Proposed Development.

The area surrounding the application site is a predominantly rural, with the exception of the immediate surrounding Barr Killoch site which includes an asphalt and road surfacing plant. This is not expected to be a source of emissions of metals to air and is only required to monitor emissions of particulate matter from its operations. As such concentrations are expected to be similar to that monitored at rural background sites. However, as a conservative assumption, the maximum metal concentrations across all background sites across the UK (excluding Sheffield Tinsley and Swansea Coedgwilym for nickel) between 2015 and 2019 have been used as the baseline concentration. Sheffield Tinsley and Scunthorpe Town have been excluded as they are located in residential areas close to significant sources of metals.

A summary of the maximum annual data across all UK urban and rural background monitoring sites is presented in the following table.

Table 3: Metals Monitoring Maximum of all Background Sites – Urban and Rural

Substance	Annual mean concentration (ng/m ³)						Max (as % of AQAL)
	AQAL	2015	2016	2017	2018	2019	
Cadmium	5	0.45	0.57	0.49	0.43	0.35	11.4%
Thallium	1,000	-	-	-	-	-	-
Mercury	250	2.50	2.50	2.70	2.80	-	1.1%
Antimony	5,000	-	-	-	-	-	-
Arsenic	3	1.00	1.00	1.10	1.00	1.00	36.7%
Chromium	5,000	29.00	31.00	34.00	39.00	25.00	0.8%
Cobalt	200	0.62	0.60	0.84	0.92	0.56	0.5%
Copper	10,000	20.00	33.00	20.00	26.00	22.00	0.3%
Lead	250	16.00	11.00	12.00	12.00	11.00	6.4%
Manganese	150	28.00	30.00	35.00	36.00	26.00	24.0%
Nickel	20	1.90	2.70	1.70	2.20	1.80	13.5%
Vanadium	5,000	1.50	1.40	1.30	1.70	1.50	0.03%
NOTES: Excludes data from Sheffield Tinsley and Swansea Coedgwilym for nickel – although this is a background site it is located close to industrial areas and as such has high levels of these pollutants far greater than that monitored at other sites.							

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As shown, the concentrations monitored between 2015 and 2019 were significantly lower than the AQALs at all monitoring sites considered. The maximum between 2015 and 2019 will be used for the purpose of this assessment.

6.6 Dioxins, furans and polychlorinated biphenyl (PCBs)

Dioxins, furans and PCBs are monitored on a quarterly basis at a number of urban and rural stations in the UK as part of the Toxic Organic Micro Pollutants (TOMPs) network. There are no monitoring locations within 10 km of the application site. The closest site is Auchencorth Moss, 83 km away.

A summary of dioxin and furan and PCB concentrations from all monitoring sites across the UK is presented in Table 4 and Table 5. Note that monitoring data for dioxins and furans is only available up to the end of 2016 from the UK-Air website. For PCBs data is only available up to the end of 2018 from the UK-Air website.

Table 4: TOMPS – Dioxin and Furans Monitoring

Site	Annual mean concentration (fgTEQ/m ³)				
	2012	2013	2014	2015	2016
Auchencorth Moss	0.13	0.86	0.01	0.01	0.13
Hazelrigg	8.75	2.02	2.61	5.27	4.59
High Muffles	4.32	0.6	1.07	0.54	2.73
London Nobel House	15.42	3.47	2.89	4.34	21.27
Manchester Law Courts	32.99	10.19	16.52	5.94	12.23
Weybourne	9.30	2.34	1.61	1.42	16.32

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Table 5: TOMPS – PCB Monitoring

Site	Annual mean concentration (pg/m ³)				
	2014	2015	2016	2017	2018
Auchencorth Moss	23.23	24.27	25.32	19.09	12.31
Hazelrigg	25.84	41.68	52.58	33.15	22.22
High Muffles	26.11	33.43	37.76	31.63	8.86
London Nobel House	107.49	121.39	110.46	121.87	46.63
Manchester Law Courts	128.93	97.99	92.60	97.27	40.10
Weybourne	17.00	20.95	38.61	32.26	11.23

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

6.7 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) are monitored at a number of stations in the UK as part of the PAH network. There are no monitoring locations within 10 km of the application site. The closest sites are located in Glasgow city centre, approximately 45 km to the north.

For the purpose of this assessment, benzo(a)pyrene is considered as this is the only PAH which an AQAL has been set. A summary of benzo(a)pyrene concentrations from all urban background monitoring sites within the UK is presented in Table 6.

Table 6: National Monitoring - Benzo(a)pyrene

Site Type	Quantity	AQAL (ng/m ³)	Annual mean concentration (ng/m ³)				
			2015	2016	2017	2018	2019
All sites	Min	0.25	0.12	0.13	0.05	0.08	0.08
	Max		0.65	0.98	0.70	0.55	0.70
	Average		0.29	0.36	0.24	0.23	0.29

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As shown the monitored concentration exceeds the AQAL at a number of urban background sites. The AQAL goes beyond the requirement of the European Directive (Commission Decision 2004/107/EC) which sets a target value of 1 ng/m³. None of the background sites exceed this value. In lieu of any local monitoring of PAHs or any mapped background datasets, the maximum of the UK average concentration from any urban background site has been used (0.98 ng/m³ – 2016).

7 Baseline Conditions at Ecological Sites

The Air Pollution Information System (APIS) database sets out the baseline concentrations on a grid across the UK. Atmospheric concentrations of oxides of nitrogen and sulphur dioxide are provided on a 1 km x 1 km grid whilst ammonia concentrations, nitrogen deposition and sulphur deposition are provided on a 5 km x 5 km grid. Data is provided for the maximum across the ecological site.

Table 7: APIS Data for Ecological Sites

ID	Site	Maximum concentration ($\mu\text{g}/\text{m}^3$)		
		Oxides of nitrogen	Sulphur dioxide	Ammonia
Critical Level		30	10 / 20	1 / 3
E1 and E2	Airds Moss	4.6	0.55	1.47
E3-E7	Muirkirk and North Lowther Uplands	4.6	0.55	1.9
E8	River Ayr Gorge	5.05	0.5	2.48
E9 and E10	Muirkirk Uplands	4.34	0.46	1.23
E11 and E12	Barlosh Moss	4.35	0.44	1.97
E13	Dalmellington Moss	3.9	0.39	0.74
E14	Bogton Loch	3.7	0.39	0.74
E16	Martnaham Loch and Wood	4.61	0.44	1.96
E17	Burnock Water	5.19	0.5	2.48
E18	Ancient woodland 1	5.19	0.5	2.48
E19	Ancient woodland 2	5.22	0.5	2.48
E20	Ancient woodland 3	5.22	0.5	2.48
E21	Ancient woodland 4	4.82	0.5	2.48
E22	Ancient woodland 5	4.97	0.5	2.48
Notes: Where a site is not included in APIS, the search by location function in APIS has been used to find the mapped background sites.				

Source: APIS

As shown the baseline data presented in APIS shows that concentrations of oxides of nitrogen and sulphur dioxide are well below the Critical Level. However, concentrations of ammonia exceed the lower Critical Level applicable for lichen sensitive communities at all but two sites.

Table 8: APIS data for Ecological Sites - Deposition

ID	Site	Habitat type	N deposition	Acid N deposition	Acid S deposition
			kgN/ha/yr	keqN/ha/yr	keqS/ha/yr
E1 and E2	Airds Moss	Grassland	16.9	1.2	0.1
E3-E7	Muirkirk and North Lowther Uplands	Grassland	19.9	1.4	0.2
E8	River Ayr Gorge	Woodland	34.3	2.45	0.15
E9 and E10	Muirkirk Uplands	Grassland	14.56	1.04	0.12
E11 and E12	Barlosh Moss	Grassland	20.58	1.47	0.15
E13	Dalmellington Moss	Grassland	16.8	1.2	0.19
E14	Bogton Loch	Grassland	16.8	1.2	0.19
E16	Martnaham Loch and Wood	Woodland	29.54	2.11	0.16
E17	Burnock Water	Woodland	34.3	2.45	0.15
E18	Ancient woodland 1	Woodland	34.3	2.45	0.15
E19	Ancient woodland 2	Woodland	34.3	2.45	0.15
E20	Ancient woodland 3	Woodland	34.3	2.45	0.15
E21	Ancient woodland 4	Woodland	34.3	2.45	0.15
E22	Ancient woodland 5	Woodland	34.3	2.45	0.15

Notes: Where a site is not included in APIS, the search by location function in APIS has been used to find the mapped background sites.

Source: APIS

The values presented in the preceding tables are grid square averaged values based provided as a rolling 3-year mean and are derived from a mixture of interpolation from measured data, and modelled data as set out in the APIS. The APIS explains that the use of a 3-year mean has been demonstrated to be a suitable time period to smooth out some of the inter-annual variations in deposition which occur due to the natural variability in annual weather patterns.

8 Summary

The preceding sections have provided a review of the local and national monitoring data and national modelled background concentrations.

The analysis has shown that although there are 7 nitrogen dioxide monitoring sites within 10 km of the application site, they are all roadside sites and are not be considered representative of background concentrations at the site. Monitoring of other pollutants is limited. Therefore, it is considered appropriate to use the mapped background concentrations as the baseline concentrations in lieu of any local monitoring for all pollutants. Where there are discrepancies between the Scottish and UK wide DEFRA dataset, the larger value has been used as to be conservative. For some pollutants there are no mapped background datasets. In these instances, the maximum concentration from national monitoring datasets for sites in a similar setting has been used as the baseline concentration.

The assessment methodology for annual mean impacts on air quality is based on the contribution from the Proposed Development in relation to a future baseline. Where the annual mean contribution from the Proposed Development is less than 0.5% of the long term AQAL, the magnitude of change is described as negligible irrespective of the total concentration. The Predicted Environmental Concentration (PEC) will be calculated by adding the contribution from the Proposed Development to the baseline concentration presented in Table 9. Where the baseline concentration is needed to determine the magnitude of change further discussion will be included on the choice of baseline concentration.

Table 9: Summary of Baseline Concentrations

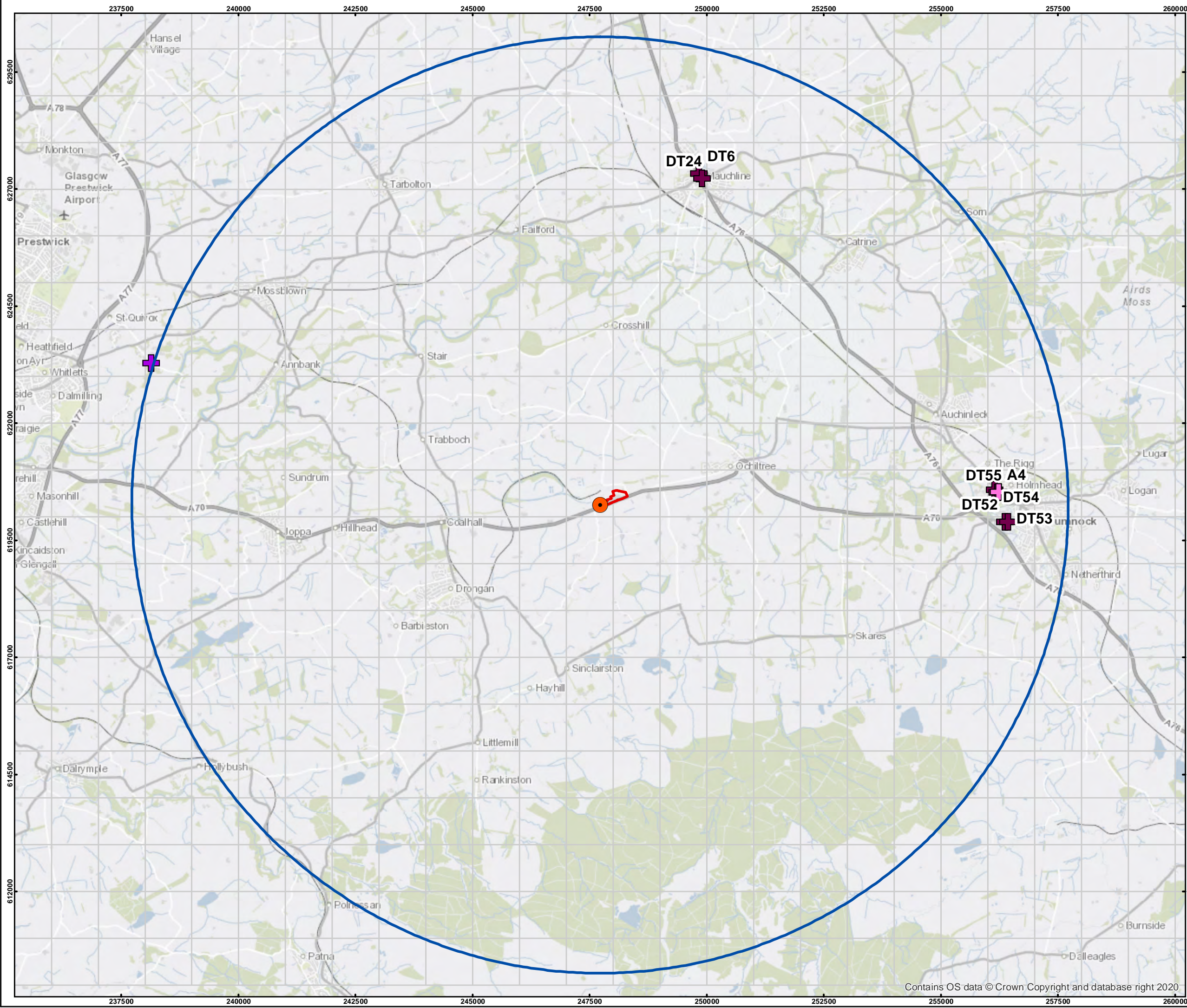
Pollutant	Concentration	Units	Justification
Nitrogen dioxide	4.79	µg/m ³	Maximum mapped background concentration from within 5 km of site- Scottish 2018 dataset.
Oxides of nitrogen	6.7	µg/m ³	Maximum mapped background concentration from within 5 km of site- Scottish DEFRA 2018 dataset.
Sulphur dioxide	3.38	µg/m ³	Maximum mapped background concentration from within 5 km of site- DEFRA 2001 dataset.
Particulate matter (as PM10)	11.08	µg/m ³	Maximum mapped background concentration from within 5 km of site- Scottish 2018 dataset.
Particulate matter (as PM2.5)	5.81	µg/m ³	Maximum mapped background concentration from within 5 km of site- DEFRA 2018 dataset.
Carbon monoxide	177.00	µg/m ³	Maximum mapped background concentration from within 5 km of site- DEFRA 2001 dataset.

Pollutant	Concentration	Units	Justification
Benzene	0.23	µg/m ³	Maximum mapped background concentration from within 5 km of site-DEFRA 2001 dataset.
1,3-butadiene	0.08	µg/m ³	Maximum mapped background concentration from within 5 km of site-DEFRA 2001 dataset.
Ammonia	3.18	µg/m ³	Maximum mapped background concentration from within 5 km of site-DEFRA (CEH) 2014 dataset.
Hydrogen chloride	0.71	µg/m ³	Maximum monitored concentration across the UK 2012 to 2015
Hydrogen fluoride	2.35	µg/m ³	Maximum measured concentration from EPAQS report
Cadmium	0.57	ng/m ³	Maximum annual concentration averaged across all background sites across the UK 2015 to 2019 (excluding data from Sheffield Tinsley and Swansea Coedgwilym for nickel)
Thallium	-	ng/m ³	
Mercury	2.80	ng/m ³	
Antimony	-	ng/m ³	
Arsenic	1.10	ng/m ³	
Chromium	39.00	ng/m ³	
Cobalt	0.92	ng/m ³	
Copper	33.00	ng/m ³	
Lead	16.00	ng/m ³	
Manganese	36.00	ng/m ³	
Nickel	2.7	ng/m ³	
Vanadium	1.70	ng/m ³	
Dioxins and Furans	32.99	fgTEQ/m ³	
Dioxin-like PCBs	128.93	pg/m ³	Maximum monitored concentration across all UK sites 2014 to 2018
PaHs	0.98	ng/m ³	Maximum annual concentration averaged across all background sites across the UK 2015 to 2019

For the purpose of the assessment of the impact at ecological receptors the baseline concentrations set out in Section 7 have been used.

Annex

A Figures

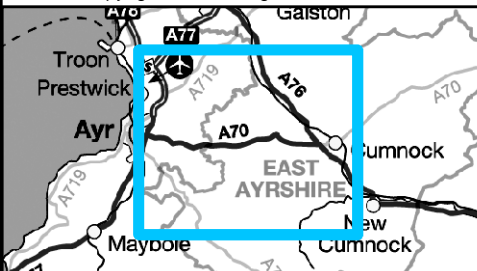


- Legend**
- Stack
 - Site boundary
 - 10 km buffer
 - Automatic monitoring sites
 - Non-automatic monitoring sites
 - UKEAP HM3 monitoring station
 - Mapped background squares (1km)

Client:	Barr Environmental Ltd
Site:	Killoch
Project:	3179
Title:	

Figure1 - Local Monitoring and background data

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