Air Quality Assessment

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Bishopbriggs

East Dunbartonshire Council

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SWECO

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1.0 Introduction

Sweco has been appointed by East Dunbartonshire Council to provide a detailed modelling assessment of Air Quality in Bishopbriggs. The assessment has been undertaken to determine the spatial extent of NO_2, PM_{10} and $PM_{2.5}$ pollutant concentrations in accordance with the Scottish Air Quality Objectives (AQO), providing the Council with a better understanding of pollutant concentrations within the wider area of Wester Cleddens in Bishopbriggs. The area has seen an increase in proposed developments in and around the Wester Cleddens area, largely residential, which has the potential to affect air quality concentrations.

The area of Bishopbriggs included within the assessment is presented in Figure 1-1. The assessment has considered the baseline year as 2019. This is the most recent year with available measurement, meteorological and traffic data. Due to Covid-19 a baseline year of 2020 or 2021 was not deemed appropriate due to national lockdown measures impacting on vehicle movement and monitored concentrations.

This report describes in detail a dispersion model study of road traffic emissions in the Bishopbriggs area, with the study area encompassing the Bishopbriggs Air Quality Management Area (AQMA) along the A803, Kirkintilloch Road and extending to the east of the Bishopbriggs, along South Crosshill Road towards Wester Cleddens Road roundabout.

Monitoring data collected between 2015 and 2019 has shown that concentrations of NO_2 have on average decreased over the years. There have been no exceedances of the NO_2 annual mean AQO over these 5 years of monitoring at all locations. The annual mean PM_{10} monitoring data from the Bishopbriggs automatic monitoring site also recorded concentrations below the AQO over the 5 years, ranging from 12-17$\mu g/m^3$. Most recently in 2019 the automatic monitoring site recorded 12 $\mu g/m^3$. For $PM_{2.5}$, only monitoring for 2019 is available recording 7 $\mu g/m^3$, below the AQO.

The main pollutants of concern within the Bishopbriggs area are NO_2, PM_{10} and $PM_{2.5}$ due to the volume of road traffic and subsequent congestion. The ongoing increase in the installation of biomass across East Dunbartonshire, alongside the domestic installation of wood burning stoves has the potential to result in a cumulative effect in emissions, particularly PM_{10} and $PM_{2.5}$. This growth in non road transport emissions could lead to an exceedance in the AQO.

The Bishopbriggs Air Quality Management Area (AQMA) has been in place since 2005, this detailed modelling study, focussing on the AQMA and its surrounding areas, will allow the Council to investigate whether there is potential for the AQMA boundary to be changed or potentially revoked, and whether future proposed developments are likely to cause an issue with the air quality in the area.

2.0 Legislation and Policy

2.1 Legislation

Air quality is an issue of potential significance at international, national and local levels. While there are undoubtedly important ramifications for global and national air quality from a wide range of developments, as recognised by numerous international conventions and European Directives, the primary focus of this assessment is to understand the current pollutant concentrations across the Bishopbriggs Area.

2.1.1 Environment Act 1995

Part IV of the Environment Act 1995 places a duty on the Secretary of State for the Environment to develop, implement and maintain an Air Quality Strategy with the aim of reducing atmospheric emissions and improving air quality. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland provides the framework for ensuring the air quality limit values are complied with based on a combination of international, national and local measures to reduce emissions and improve air quality. This includes the statutory duty, also under Part IV of the Environment Act 1995, where local authorities must assess air quality in their areas on an annual basis. This review and assessment process in known as Local Air Quality Management (LAQM).

The focus on local air quality is reflected in the air quality objectives (AQOs) set out in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland [1] and The Air Quality Standards (Scotland) Regulations 2010[2]. The strategy presents measures to control and improve the quality of air in the UK and reflects the increasing understanding of the potential health risks associated with poor air quality and the benefits that can be gained from its improvements.

Local Authorities are required to declare an Air Quality Management Area (AQMA) where it is likely that these objectives will not be achieved and to prepare an Action Plan to set out proposed measures to be taken to achieve the air quality objectives.

An AQMA within Bishopbriggs was declared in 2005 due to exceedances of the Scottish AQO for NO_2 and PM_{10}. The AQMA encompasses a 60m wide corridor along the A803 Kirkintilloch Road within Bishopbriggs between the council's border with Glasgow City and a point 30m north of Cadder roundabout. The Bishopbriggs Air Quality Action Plan (AQAP) was adopted in 2010, with an updated version published in 2014. The AQAP identifies actions and policies which the Council then implement to ensure air quality objectives are met. The AQAP has 41 action plan measures all aimed to reduce pollutant concentrations. Of the original 41 measures, 5 remain outstanding.

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[1] https://www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-1

[2] https://www.legislation.gov.uk/ssi/2010/204/pdfs/ssi_20100204_en.pdf

The relevant objectives for pollutants considered in this study are presented in Table 2-1.

TABLE 2-1:AIR QUALITY STANDARDS (AQS) FOR THE PROTECTION OF HUMAN HEALTH

Pollutant	Air Quality Standards ($\mu g/m^3$)	Measured as
Nitrogen Dioxide	40	Annual Mean
	200	One hour mean, not to be exceeded more than 18 times per year (equivalent to the 99.79th percentile of hourly means
Particulate Matter (PM_{10})	18	Annual Mean
	50	24 hour mean, not to be exceeded more than 7 times a year (equivalent to the 98.08th percentile of 24-hour means)
Particulate Matter ($PM_{2.5}$)	10	Annual Mean

2.2 Sensitive Locations

The locations where objectives apply are defined in the Air Quality Strategy (AQS) as locations outside buildings or other natural or man-made structures above or below ground where members of the public are regularly present and might reasonably be expected to be exposed over the relevant averaging period of the objectives. Typically, these include residential properties, hospitals and schools for the longer averaging periods (i.e. annual mean) pollutant objectives. Table 2-2 provides a summary of where the AQS objectives should and should not apply.

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TABLE 2-2: EXAMPLES OF WHERE THE AIR QUALITY OBJECTIVES SHOULD AND SHOULD NOT APPLY

Averaging Period	Pollutants	Objectives should apply at …	Objectives should not generally apply at …
Annual mean	NO_2, PM_{10}, $PM_{2.5}$	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
8-hour and 24-hour Means	PM_{10}, $PM_{2.5}$	All locations where the annual mean objective would apply, together with hotels and gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour Mean	NO_2	All locations where the annual mean, 24-hour mean and 8-hour mean apply plus: kerbside sites of busy shopping streets; parts of car parks, bus and railway stations, etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more; Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

3.0 Guidance

3.1 Local Air Quality Management Policy Guidance

This policy guidance[3] provides guidance to help local authorities with their local air quality management duties in line with the Environment Act 1995. The guidance outlines the background and legislative framework to which the local authorities must work to; the principles behind reviews and assessments of air quality and the recommended steps; how local authorities should handle the designation of AQMAs; the development of local air quality strategies and the general principles behind air quality and land use planning.

3.2 National Planning Framework (NPF) Scotland 2014

NPF3 brings together Scotland's plans and strategies in economic development, regeneration, energy, environment, climate change, transport and digital infrastructure to provide a coherent vision of how Scotland should evolve over the next 20 to 30 years. In turn, this vision will help to inform future policies and prioritise investment decisions.

NPF3 highlights that reducing the impact of transport in towns and cities will make a significant contribution to realising their potential as sustainable places to live. Reducing the impact of transport will require a reduction in congestion, air pollution and noise. Significant health benefits could be achieved by substantially increasing active travel within urban areas.

3.3 Cleaner Air for Scotland (CAFS) 2015

Cleaner Air for Scotland[4] is a cross-government strategy which details how the Scottish Government and any partner organisations propose to reduce air pollution and fulfil Scotland's legal requirements. It provides a national framework which allows the public to better understand how the Scottish Government and associated organisations will achieve these goals. The strategy outlines a range of policies and initiatives which include a National Modelling Framework; a National Low Emission Framework; the adoption of World Health Organisation guideline values for particulate matter in Scottish Legislation and proposals for raising more awareness on national air quality.

3.4 Cleaner Air for Scotland 2 (CAFS 2) 2021

Cleaner Air for Scotland 2[5] is an updated strategy to replace Cleaner Air for Scotland. It sets out the Scottish Government's air quality policy framework for the next five years and a series of actions to deliver further air quality improvements.

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[3] Part IV of the Environment Act 1995: Local Air Quality Management Policy Guidance PG(S) (16) March 2016

[4] Cleaner Air for Scotland – the Road to a Healthier Future. The Scottish Government. November 2015. Available at: http://www.scottishairquality.scot/lez/

[5] Cleaner Air for Scotland 2 – Towards a Better Place for Everyone. Scottish Government. July 2021. Available at: https://www.gov.scot/publications/cleaner-air-scotland-2-towards-better-place-everyone/

3.5 Clean Air Strategy 2019

The Clean Air Strategy[6] published in 2019 is a document which outlines actions set by the UK Government to tackle air pollution. The strategy applies across the UK, highlighting actions to be taken across Scotland, England, Wales and Northern Ireland. The strategy is a result of an extensive consultation process which has collated feedback on the actions the Government is proposing to help tackle air pollution. The actions in the Strategy are in line with EU requirements to reduce air pollution and provides detailed information on proposals and actions which are required from all parts of government and society. Its aim is to provide guidance on how the Government and Devolved Administrations intend to reduce their emissions.

4.0 Background Information

The assessment has reviewed available background concentrations from local monitoring data and the Scottish background maps. This information has been used within the modelling assessment.

4.1 Monitoring Data

During 2019, EDC measured NO_2 concentrations using diffusion tube monitoring at 18 locations in the immediate study area at Bishopbriggs. All 18 sites are at roadside monitoring locations.

A Detailed Assessment commissioned by the Council in 2016 was undertaken to investigate pollutant concentrations within the Bishopbriggs AQMA and determine whether the current AQMA required to be updated or revoked. The assessment highlighted pollution hotspots at Colston Road which resulted in additional NO_2 monitoring being added to the network in 2017. The additional diffusion tubes are located south of the A803 around Kirkintilloch Road.

In 2019, all diffusion tube sites measured annual mean concentrations less than 40 µg/m^3. The highest annual mean NO_2 concentration recorded in 2019 was 31.5 µg/m^3 at a roadside location (Bishopbriggs 13) which is well below the annual mean objective.

It is important to note there is a degree of uncertainty in diffusion tube monitoring data, largely due to the accuracy of results obtained which tend to be ±20% accurate. This should be considered when analysing and interpreting results. Full details of the QA/QC of the monitoring data for East Dunbartonshire Council can be found in their most recent Annual Progress Report[7].

East Dunbartonshire Council currently operates 4 automatic monitoring stations. There is one automatic site within the study area in Bishopbriggs. In 2019 the automatic site measured NO_2 and PM_{10} concentrations using chemiluminescent and Eberline sampling equipment (until 2019).

Annual mean PM_{10} concentrations over the 5 years (2015-2019) range from 12-17µg/m^3. There had been a steady increase in pollutant concentrations from 2015 to 2018, with concentrations increasing from 15 µg/m^3 to 17 µg/m^3. However, this concentration then fell to 12 µg/m^3 in 2019

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[6] Department for Environment Food & Rural Affairs: Clean Air Strategy 2019. Available at:
https://www.gov.uk/government/publications/clean-air-strategy-2019

[7] East Dunbartonshire Council, 2019, Annual Progress Report, available at:
http://www.scottishairquality.scot/assets/documents//East_Dunbartonshire_APR_Template_Scotland_2019_Final.pdf

which is well below the annual mean objective of 18 µg/m^3. Full range of results from 2015-2019 can be found in Table 4-2 below.

New particulate monitoring equipment in the form of FIDAS has been installed in the Bishopbriggs site in 2019 to monitor both PM_{10} and $PM_{2.5}$. The results show the $PM_{2.5}$ concentration to be 7 µg/m^3 in 2019 which is below the annual mean objective of 10 µg/m^3.

Details of the monitoring considered within this assessment are presented in Table 4-1 for NO_2 concentrations, Table 4-2 for PM_{10} concentrations and Table 4-3 for $PM_{2.5}$ concentrations measured during 2015 to 2019. Automatic monitoring locations are presented in Figure 4-1 and diffusion tube locations in Figure 4-2.

TABLE 4-1: NO_2 MONITORING RESULTS 2015 – 2019 (µg/m³)

Site ID	Site	X	Y	Location	In AQMA	2015**	2016**	2017**	2018**	2019**
Automatic Monitoring Locations										
EDB1	Bishopbriggs	260995	670130	Bishopbriggs	Yes	27.0	30.0	27.0	27.0	26.0
Diffusion Tube Monitoring										
EDB21	Bishopbriggs 13	260549	669312	Bishopbriggs	Yes	36.0	38.1	34.1	34.7	31.5
EDB22	Bishopbriggs 14	260995	670130	Bishopbriggs	Yes	30.9	31.8	25.5	24.1	22.0
EDB23	Bishopbriggs 14B	260995	670130	Bishopbriggs	Yes	30.0	29.0	24.6	23.3	21.5
EDB24	Bishopbriggs 14C	260995	670130	Bishopbriggs	Yes	28.9	26.7	25.6	22.8	21.8
EDB25	Bishopbriggs 16	260580	669533	Bishopbriggs	Yes	25.0	27.0	24.7	24.8	22.1
EDB26	Bishopbriggs 17	260552	669320	Bishopbriggs	Yes	27.1	31.0	29.0	27.6	24.9
EDB53	Bishopbriggs 21	261033	669650	Bishopbriggs	No	-	-	18.9	19.7	14.9
EDB54	Bishopbriggs 22	260571	669339	Bishopbriggs	Yes	-	-	33.2	32.7	29.0
EDB55	Bishopbriggs 23	260759	669999	Bishopbriggs	Yes	-	-	32.3	23.0	27.0
EDB56	Bishopbriggs 24	261903	671955	Bishopbriggs	Yes	-	-	21.2	22.8	24.9
EDB57	Bishopbriggs 25	260617	670338	Bishopbriggs	No	-	-	14.8	15.6	15.4
EDB31	Bishopbriggs 6	261016	670198	Bishopbriggs	Yes	-	-	-	-	17.2
EDB64	Bishopbriggs 26	262112	670517	Bishopbriggs	No	-	-	-	-	14.8
EDB65	Bishopbriggs 27	262305	670649	Bishopbriggs	No	-	-	-	-	14.0
EDB66	Bishopbriggs 28	262488	670630	Bishopbriggs	No	-	-	-	-	15.2
EDB67	Bishopbriggs 29	262741	670245	Bishopbriggs	No	-	-	-	-	22.5
EDB68	Bishopbriggs 30	262398	669436	Bishopbriggs	No	-	-	-	-	15.1
EDB69	Bishopbriggs 31	262953	670564	Bishopbriggs	No	28.1	34.4	28.8	24.9	24.1

*** All data rounded to 1 decimal place*

TABLE 4-2: PM_{10} AUTOMATIC MONITORING RESULTS 2015 – 2019 (µg/m³)

Site ID	Site	X	Y	Location	In AQMA	2015	2016	2017	2018	2019
Automatic Monitoring Locations- PM_{10}										
EDB1	Bishopbriggs	260995	670130	Bishopbriggs	Yes	15	15	16	17	12

TABLE 4-3: $PM_{2.5}$ AUTOMATIC MONITORING RESULTS 2015 – 2019 (µg/m³)

Site ID	Site	X	Y	Location	In AQMA	2015	2016	2017	2018	2019
Automatic Monitoring Locations- $PM_{2.5}$										
EDB1	Bishopbriggs	260995	670130	Bishopbriggs	Yes	-	-	-	-	7

5.0 Modelling Methodology

5.1 Dispersion Modelling

Pollutant emissions from road transport sources were modelled using the most up-to-date version of the advanced atmospheric dispersion modelling software ADMS-Roads Extra (5.0.0.1), developed by Cambridge Environmental Research Consultants (CERC).

The model uses a number of input parameters to simulate the dispersion of pollutant emissions, predicting ambient ground level pollutant concentrations. The input parameters include information on pollutant emissions from road transport and local meteorological conditions. Full details of the model set up used in this assessment are provided in the following sections.

5.2 Model Domain

The modelled road network presented in Figure 5-1 below, was centred in Bishopbriggs and encompassed all roads situated within and around the Bishopbriggs AQMA. The domain included the A803, Colston Road, Crowhill Road, South Crosshill Road, Hillside Drive, Wester Cleddens road and Wester Lumloch Road. The model domain is 3km x 3km, with a resolution of 15m.

Figure 5-1: Modelled road network

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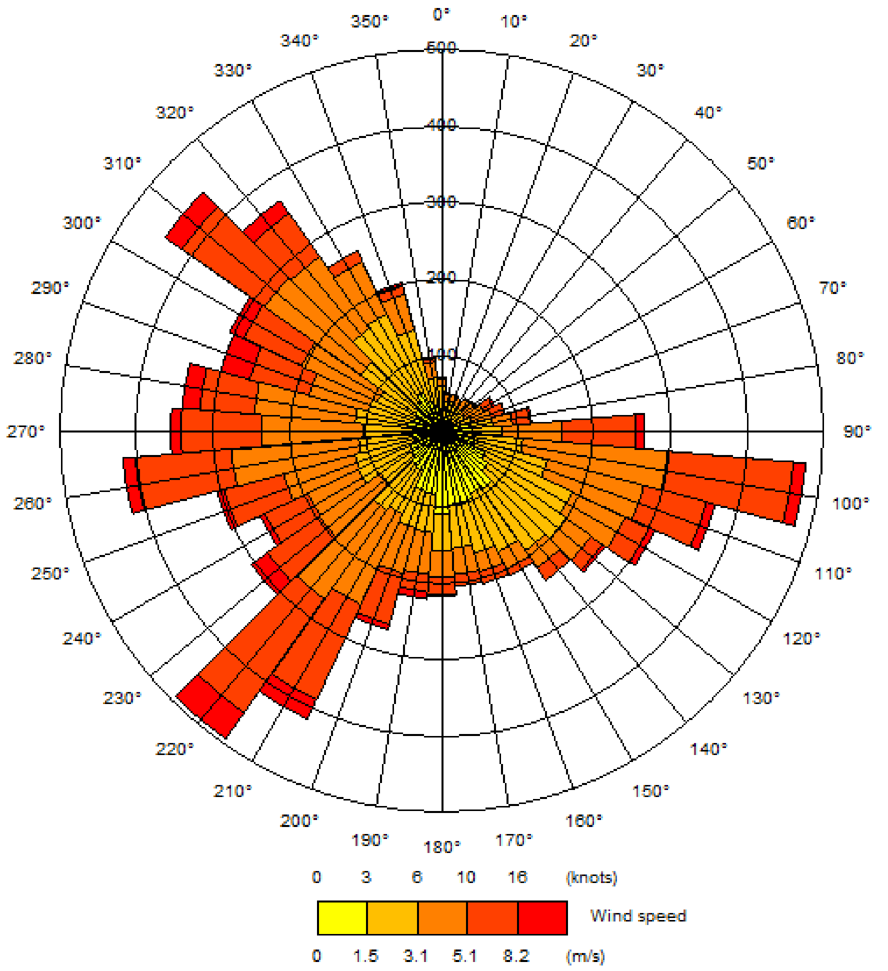
5.3 Mapping

The mapping data used within the assessment is OS Mastermap data provided by East Dunbartonshire (Licence no: 100020774).

5.4 Meteorological Data

ADMS-Roads uses hourly sequential meteorological data to calculate atmospheric dispersion. The meteorological data file contains a number of parameters including wind speed and direction, cloud cover and solar heat flux. The nearest site which records all required parameters is located at Bishopton, close to Glasgow Airport. Hourly sequential meteorological data for 2019 were used for the air quality modelling assessment. The wind rose for 2019 is presented in Figure 5-2.

Figure 5-2: Glasgow Bishopton Windrose 2019



5.5 Surface Roughness and Meteorological Parameters

A surface roughness of 1m was used to represent the dispersion site. The minimum Monin-Obukhov length (m) was set to 10m, which is representative of small towns.

At the meteorological site, a surface roughness of 0.02m was used to represent the Glasgow Bishopton metrological site. The minimum Monin-Obukhov length (m) was set to 10m.

5.6 Model Domain and Receptor Locations

The model has been used to predict annual mean concentrations of NO_2, PM_{10} and $PM_{2.5}$ at a selection of discrete receptors within the study area and over a regular Cartesian grid pattern. The modelled domain consisted of a 3km by 3km square grid covering the area (260200, 669000) to (263200, 672000), providing a 15m resolution. The receptor locations include residential and educational facilities. The receptors are located at the façade of buildings in the model domain where relevant exposure exists. The receptors have been modelled at 1.5 m to represent human exposure at ground floor level when present.

The modelled specified receptors locations are presented in Table 5-1 and Figure 5-3, Figure 5-4 and Figure 5-5.

TABLE 5-1: **RECEPTOR LOCATIONS**

Receptor	Type	X	Y	Height (m)
1495 Springburn Road	Residential	260547	669312	1.5
145 Kirkintilloch Road	Residential	261012	670187	4
24 Kirkintilloch Road	Residential	260582	669527	1.5
106 Colston Road	Residential	260576	669312	1.5
89 Kirkintilloch Road	Residential	260766	670009	1.5
87 Kirkintilloch Road	Residential	260760	670006	1.5
121 Kirkintilloch Road	Residential	260943	670121	1.5
141 Kirkintilloch Road	Residential	261010	670184	4
239 Kirkintilloch Road	Residential	261253	670890	1.5
1 Cadder Road	Residential	261894	671950	1.5
35 South Crosshill Road	Residential	261353	670516	1.5
Wester Cleddens Primary School	School	261553	670547	1.5
26 Hillside Drive	Residential	261502	670717	1.5
19 Kirriemuir Gardens	Residential	262147	670597	1.5
Palmer Court	Residential	262309	670643	1.5
St Helens Primary School	School	262464	670690	1.5
Bishopbriggs Academy	School	262635	670566	1.5
Woodhill Primary School	School	262418	670571	1.5

Lumloch Drive 1	Residential	262912	670520	1.5
Lumloch Drive 2	Residential	262955	670464	1.5

5.7 Road Traffic Emissions

In June 2019, on behalf of East Dunbartonshire Council, SWECO commissioned Automatic Traffic Counts (ATC) at sixl locations. The ATC counts were undertaken by Nationwide Data Collection (NDC). The traffic data gathered allowed Annual Average Daily Traffic (AADT) flows to be estimated with breakdown of vehicle type and speed to be used within the study, a summary of this is provided in Table 5.2.

As a result of the initial modelling undertaken for this study in 2020 pre the pandemic it was identified that additional surveys were required close to the automatic analyser. Due to the pandemic in 2020 and 2021 this package of work was on hold.

In February 2022, additional surveys were undertaken by TRACSIS, commissioned by Sweco on behalf of the Council. The survey was undertaken at two new additional locations plus one at the location of the DfT site. This allowed for direct comparison with 2019 and 2022 traffic count data to determine a relationship between the pre and post pandemic traffic data.

In order to update the modelling assessment and continue to use the 2019 base year, the traffic count data collected in 2022 required to be factored back to 2019 equivalent. Factoring the 2022 traffic count data, for the two new sites, was deemed the most appropriate approach due to allow the assessment to be based on 2019 pre Covid-19, due to uncertainties in traffic flows and measurement data in 2020-2022 due to Covid-19.

To adjust the 2022 traffic count data, an adjustment factor was calculated. The adjustment factor was calculated by comparing '2022 ATC 03' AADT with '2019 ATC 1' and '2019 DfT 10917' AADT. These count locations are all similarly located on the A803 north of Springfield Road. The two adjustment factors calculated were almost identical. As expected, the traffic data in 2022 was lower than that measured in 2019. The adjustment factor calculated of **1.33** was applied to the 2022 traffic count data to calculate a 2019 equivalent AADT for use within the assessment.

The ATC counts for both the 2019 and 2022 data also provided fleet information and speed data at the ATC locations. The ATC fleet classifications did not separate out Bus/Coaches from HGV, therefore the assessment used an LDV and HDV fleet split for these locations. A summary of all ATC locations is presented in Figure 5-6.

The traffic count information collected in 2019 and 2022, was supplemented with previous traffic count information collected in 2016 by Streetwise Services Ltd at the Colston Road / A803 junction. This data was used within the assessment in the Colston Road area as it is the most up-to-date data in this part of Bishopbriggs.

Traffic patterns in urban locations are complex and it is not possible to fully represent the complexities in atmospheric dispersion models. A degree of uncertainty is introduced in the modelling as it uses simple metrics (AADT, average speed and vehicle split composition) to describe the complex traffic patterns. Model verification deals with this uncertainty and is described in detail later in the report.

TABLE 5-2: TRAFFIC DATA USED WITHIN ASSESSMENT

Road	Traffic Count	AADT 2019	%LDV (Mcycle, cars, LGV)	%HDV (HGV & buses)	Data Source
Springburn Road	2016 ATC 2	16320	96.5%	7.8%	Streetwise Services Ltd/EDC
A803 south of Springfield Road	2022 ATC 1	15528	92.1%	7.9%	TRACSIS
A803 north of Springfield Road	2022 ATC 3	15782	93.8%	6.2%	TRACSIS
Colston Road	2016 ATC 2	10248	97.9%	2.1%	Streetwise Services Ltd/EDC
South Crosshill Road between Boclair Road and Cleddens Court	2019 ATC 2	4673	95.7%	4.2%	NDC
Wester Cleddens Road between Laggan Road and Ailsa Road	2019 ATC 6	7227	96.6%	3.4%	NDC
Wester Cleddens Road between Angus Avenue and Westerhill Road	2019 ATC 4	8650	94.2%	5.8%	NDC
Wester Lumloch Road between Westerhill & Auchinairn Roundabouts	2019 ATC 5	11848	94.7%	5.3%	NDC
Hillside Drive between Wester Cleddens Road & Park Road	2019 ATC 3	4234	96.7%	3.3%	NDC
Crowhill Road	2022 ATC 2	3353	92.1%	7.9%	TRACSIS

5.7.1 Vehicle Emission Factors

The Emissions Factors Toolkit (EFT V11.0 November 2021 release) was used in the modelling assessment to calculate pollutant emission factors for each modelled road link. This version of the EFT was the most recent release at the time of undertaking the assessment.

5.8 Treatment of modelled NO_x road contribution

It is necessary to convert the modelled road NO_x concentrations to NO_2 for comparison with the relevant objectives.

The Defra NO_x/NO_2 (v8.1) model was used to calculate NO_2 concentrations from the road NO_x concentrations predicted by ADMS-Roads. The model requires input of the background NO_x, the modelled road contribution and accounts for the proportion of NO_x released as primary NO_2. For East Dunbartonshire in 2019 with the "All Other urban UK Traffic" option in the model, the NO_x/NO_2 model estimates that 29.1% of NO_x is released as primary NO_2.

5.9 Validation of ADMS-Roads Extra

Validation of the model is the process by which the model outputs are tested against monitoring results at a range of locations and the model is judged to be suitable for use in specific applications; this is usually conducted by the model developer.

CERC have carried out extensive validation of ADMS applications by comparing modelled results with standard field, laboratory and numerical data sets, participating in EU workshops on short range dispersion models, comparing data between UK M4 and M25 motorway field monitoring data, carrying out inter-comparison studies alongside other modelling solutions such as DMRB and CALINE4, and carrying out comparison studies with monitoring data collected in cities throughout the UK using the extensive number of studies carried out on behalf of local authorities and Defra.

5.10 Building Effects and Street Layout

ADMS-Roads does not allow buildings to be included explicitly but allows various street parameters to be input to simulate the local flow around buildings and other obstacles in the vicinity of the road. The street parameters included in the model are road width, street canyon height and road elevation. The geometry of each road was determined through a combination of GIS mapping data and Google Earth. The geometry of each road was defined in terms of the kerb-to-kerb road width and, where appropriate, the height of any street canyons.

Street canyons can be included in the model for roads where there are high rise buildings on either side which act as barriers to the air flow and can channel wind along the road or cause localised air circulations that trap pollutants at street level. Canyon effects are significant for streets where the height of the buildings is at least equivalent or greater than the width of the street. No street canyons were identified within the study area, therefore this module was not utilised.

5.11 Background Concentrations

The 2018 based Scottish air quality background maps[8] were used to project 2019 background concentrations of NOx, NO_2 and PM_{10} in the study area. The background map for $PM_{2.5}$ was downloaded from the Defra background maps[9] as Scottish specific background maps are not yet available. This resource provides estimated annual mean background concentrations of key pollutants at a resolution of 1x1km for Scotland. Mapped background concentrations from the grid squares within the study area for 2019 are provided in Table 5-3.

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[8] Scottish Air Quality, 2018, Background Maps, accessed at: http://www.scottishairquality.scot/data/mapping?view=data

[9] Defra, 2017, Defra background maps, Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2017

TABLE 5-3 ANNUAL MEAN BACKGROUND CONCENTRATIONS (µg/m³)

	Total Road Source Modelling			Road Source Modelling (minus road contribution)		
Grid Square	NO_x	PM_{10}	$PM_{2.5}$	NO_x	PM_{10}	$PM_{2.5}$
260_669	20.8	11.1	6.4	19.2	10.8	6.3
261_670	18.1	10.8	6.3	16.8	10.6	6.3
261_671	15.5	10.3	6.1	14.4	10.1	6.1
260_670	16.6	10.3	6.2	15.1	10.1	6.1
262_670	17.0	10.5	6.2	15.6	10.3	6.1

Within the road traffic assessment, the 2019 NO_x, PM_{10} and $PM_{2.5}$ background concentrations were used. The road traffic assessment used the background concentration applicable to each receptor location due to variations throughout the modelling domain. The A- road contribution for each grid square has been removed from the background concentrations to avoid double counting of traffic emissions.

6.0 Dispersion Modelling Results

6.1 Model Verification

Model verification is the comparison of modelled results with available local monitoring data. This identifies how well the model is performing. LAQM.TG (16) recommends making the adjustment to the road contribution of the pollutant only. The model is refined as part of the verification process to reduce uncertainties within the modelling.

For each pollutant the model verification process is the same. The modelled Road contribution of each pollutant is compared to the measured Road component, to calculate a model verification factor. The results of the are discussed for each pollutant in the following sections.

6.1.1 NOx/NO_2 Model Verification

For the assessment, monitoring sites are located along the modelled road network. The modelled Road NOx results were verified against the following NO_2 modelling locations:

- Automatic monitoring site
- Bishopbriggs 6,
- Bishopbriggs 13
- Bishopbriggs 14
- Bishopbriggs 16
- Bishopbriggs 17
- Bishopbriggs 22
- Bishopbriggs 23
- Bishopbriggs 24
- Bishopbriggs 27
- Bishopbriggs 28.

Following any required refinements of the model, the modelled Road NOx contribution required an adjustment factor of **0.9706** to bring the predicted Road NOx concentrations in line with the measured Road NOx concentrations at the monitoring locations mentioned above. Due to the adjustment factor being very close to 1 and well within the 10% ideal model performance, no adjustment factor was applied to modelled road NOx concentrations. This also ensures a worst case approach.

The Defra NO_x to NO_2 calculator was then used to convert the road NOx concentrations to annual mean NO_2 concentrations, as outlined in Section 5.8.

Verifying modelling data with diffusion tube data will always be subject to uncertainty due to the limitations in diffusion tube monitoring data, even automatic data has some uncertainties. Model uncertainty can be estimated by calculating the root mean square error (RMSE). The RSME for NOx was 2.24 µg/m^3. The model results should be considered in this context.

A summary of the model adjustment is also provided in Table 6 1 and Table 6 2 below. Full details of the model verification process including the linear regression analysis are available in Appendix A - Model Verification**.**

TABLE 6-1: PRE-ADJUSTMENT MODELLED VS MEASURED NO_2 CONCENTRATIONS 2019

Measuring Location	Measured (µg/m^3)	Modelled (µg/m^3)
Bishopbriggs 13	31.5	32.2
Bishopbriggs 17	24.9	27.8
Bishopbriggs 14 Auto	26.0	23.9
Bishopbriggs 6	24.1	23.6
Bishopbriggs 16	22.1	23.0
Bishopbriggs 22	29.0	27.4
Bishopbriggs 24	24.9	20.8
Bishopbriggs 23	27.0	30.8
Bishopbriggs 27	14.8	16.6
Bishopbriggs 28	14.0	13.7

TABLE 6-2: POST-ADJUSTMENT MODELLED VS MEASURES NO_2 CONCENTRATIONS 2019

Measuring Location	Measured (µg/m^3)	Modelled (µg/m^3)
Bishopbriggs 13	31.5	31.6
Bishopbriggs 17	24.9	27.4
Bishoprbiggs 14 Auto	26.0	23.5
Bishopbriggs 6	24.1	23.2
Bishopbriggs 16	22.1	22.7
Bishopbriggs 22	29.0	27.0
Bishopbriggs 24	24.9	20.5
Bishopbriggs 23	27.0	30.3
Bishopbriggs 27	14.8	16.4
Bishopbriggs 28	14.0	13.6

6.1.2 PM_{10} and PM2.5Model Verification

There is only one PM monitor within the study area, LAQM TG(16) cautions against using only one location for model verification

The modelled road contribution for both PM_{10} and $PM_{2.5}$ was slightly overpredicting when compared to the measured concentrations. The model performance was just outside the LAQM TG(16) recommended +/- 25% limit for model performance. Therefore, an adjustment factor for PM_{10} and $PM_{2.5}$ of **0.762 and 0.684,** respectively, was required to bring the predicted road concentrations in line with measured concentrations at the automatic analyser.

Given the NOx adjustment factor is close to one which provides better spatial coverage across the whole model. The PM_{10} concentrations have been presented without applying the model adjustment factor, thus presenting a worst case assessment.

It is not possible to calculate the RMSE specific to PM due to only one verification location. Therefore, as worst case the RMSE calculated for NOx should be assumed and the model results should be considered in this context.

6.2 Modelling Results

Annual mean concentrations at the specified receptors are presented within this section, following the model verification process.

6.2.1 NO_2 Modelling Results

No annual mean NO_2 concentrations in excess of the 40 µg/m^3 air quality objective were predicted at any receptor locations modelled.

The highest annual mean NO_2 concentration was predicted to occur at Receptor 1 (30.2 µg/m^3) on Springburn Road. However, this is substantially below the air quality objective of 40 µg/m^3.

Full receptor results can be found in TABLE 6-3 below.

TABLE 6-3: MODELLED ANNUAL MEAN NO_2 CONCENTRATIONS AT SENSITIVE RECEPTORS 2019

Receptor	Address	NO_2 Annual Mean
Receptor 1	1495 Springburn Road	30.2
Receptor 2	145 Kirkintilloch Road	18.4
Receptor 3	24 Kirkintilloch Road	24.7
Receptor 4	106 Colston Road	29.8
Receptor 5	89 Kirkintilloch Road	25.0
Receptor 6	87 Kirkintilloch Road	24.8
Receptor 7	121 Kirkintilloch Road	18.7
Receptor 8	141 Kirkintilloch Road	18.5
Receptor 9	239 Kirkintilloch Road	19.6
Receptor 10	1 Cadder Road	18.0
Receptor 11	35 South Crosshill Road	15.1
Receptor 12	Wester Cleddens Primary School	14.0
Receptor 13	26 Hillside Drive	14.4
Receptor 14	19 Kirriemuir Gardens	14.4
Receptor 15	Palmer Court	15.9
Receptor 16	St Helens Primary School	13.6
Receptor 17	Bishopbriggs Academy	12.1
Receptor 18	Woodhill Primary School	11.6
Receptor 19	Lumloch Drive 1	15.8
Receptor 20	Lumloch Drive 2	15.2

6.2.2 PM_{10} Modelling Results

The predicted annual mean PM_{10} concentration did not exceed the AQO of 18 µg/m^3 at any of the modelled receptors in 2019. The maximum annual mean PM_{10} concentration was predicted at Receptor 1 (13.5 µg/m^3) on Springburn Road.

Full receptor results can be found in TABLE 6-4 below.

TABLE 6-4: MODELLED ANNUAL MEAN PM_{10} CONCENTRATIONS AT SENSITIVE RECEPTORS 2019

Receptor	Address	PM_{10} Annual Mean (no adjustment factor applied)
Receptor 1	1495 Springburn Road	13.5
Receptor 2	145 Kirkintilloch Road	11.7
Receptor 3	24 Kirkintilloch Road	12.8
Receptor 4	106 Colston Road	13.5
Receptor 5	89 Kirkintilloch Road	12.0
Receptor 6	87 Kirkintilloch Road	12.0
Receptor 7	121 Kirkintilloch Road	11.5
Receptor 8	141 Kirkintilloch Road	11.7
Receptor 9	239 Kirkintilloch Road	12.0
Receptor 10	1 Cadder Road	11.5
Receptor 11	35 South Crosshill Road	11.3
Receptor 12	Wester Cleddens Primary School	11.1
Receptor 13	26 Hillside Drive	11.1
Receptor 14	19 Kirriemuir Gardens	11.0
Receptor 15	Palmer Court	11.2
Receptor 16	St Helens Primary School	10.8
Receptor 17	Bishopbriggs Academy	10.6
Receptor 18	Woodhill Primary School	10.5
Receptor 19	Lumloch Drive 1	11.1
Receptor 20	Lumloch Drive 2	11.1

6.2.3 $PM_{2.5}$ Modelling

Scotland has an annual mean objective for $PM_{2.5}$ of 10 µg/m^3. With the PM_{10} verification applied, there are no exceedances of the annual mean concentration. The maximum $PM_{2.5}$ concentrations for 2019 are predicted at Receptor 1 (7.9 µg/m^3) on Springburn Road and Receptor 4 (7.9 µg/m^3).

The RMSE for the model is +/-2.4 µg/m^3 which when the $PM_{2.5}$ results are considered with this potential error the PM2.5 objective could be close to being exceeded, However, these are worst case predictions as no adjustment factors were applied.

Full receptor results can be found in TABLE 6-5 below.

TABLE 6-5: MODELLED ANNUAL MEAN $PM_{2.5}$ CONCENTRATIONS AT SENSITIVE RECEPTORS 2019

Receptor	Address	$PM_{2.5}$ Annual Mean (no adjustment factor applied)
Receptor 1	1495 Springburn Road	7.9
Receptor 2	145 Kirkintilloch Road	6.9
Receptor 3	24 Kirkintilloch Road	7.5
Receptor 4	106 Colston Road	7.9
Receptor 5	89 Kirkintilloch Road	7.2
Receptor 6	87 Kirkintilloch Road	7.2

Receptor	Address	$PM_{2.5}$ Annual Mean (no adjustment factor applied)
Receptor 7	121 Kirkintilloch Road	6.9
Receptor 8	141 Kirkintilloch Road	6.9
Receptor 9	239 Kirkintilloch Road	7.1
Receptor 10	1 Cadder Road	6.9
Receptor 11	35 South Crosshill Road	6.7
Receptor 12	Wester Cleddens Primary School	6.5
Receptor 13	26 Hillside Drive	6.6
Receptor 14	19 Kirriemuir Gardens	6.5
Receptor 15	Palmer Court	6.6
Receptor 16	St Helens Primary School	6.4
Receptor 17	Bishopbriggs Academy	6.3
Receptor 18	Woodhill Primary School	6.2
Receptor 19	Lumloch Drive 1	6.6
Receptor 20	Lumloch Drive 2	6.6

6.3 Contour plots

Contour plots for annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations showing the spatial variation of pollutant concentrations across the modelled study area are presented in Figures 6-1, 6-2 and 6-3.

The contour plot for the annual mean NO_2 concentrations (Figure 6-1) has shown there to be exceedances towards the south of Springburn Road intersecting Colston Road, near the Kenmure Avenue/Springfield Road junction and the roundabout north of Kirkintilloch Road. These show hotspots of exceedance concentrations between 40-49 µg/m^3 and are also within the Bishopbriggs AQMA. Exceedances are confined to on the road areas.

The contour plots for the annual mean PM_{10} concentrations (Figure 6-2) shows there are no exceedances across the study area. There are two small potential hotspots at the Springburn Road and Colston Road junction, and near the Kenmure Avenue/Springfield Road junction.

The contour plots for the annual mean $PM_{2.5}$ concentrations (Figure 6-3) show exceedances occurring on the A803 road carriageway. The exceedance is on the road carriageway and confined to the road area. There are potential hotspots at the Springburn Road and Colston Road junction, Kenmure Avenue/Springfield Road junction and the roundabout north of Kirkintilloch Road.

7.0 Conclusion

This assessment has discussed in detail the historic measurement data and the results from a dispersion model study of road traffic emissions along the A803 Kirkintilloch Road, East Dunbartonshire within the Bishopbriggs AQMA, with an extended study area towards the east on South Crosshill Road joining on Wester Cleddens Road. The study assessed the NO_2 and PM_{10} concentrations within the area to provide a clearer indication of the extent of pollutant concentrations, and whether the current Bishopbriggs AQMA requires to be amended.

The assessment was conducted using 2019 monitoring data obtained from East Dunbartonshire Council, along varying locations within Bishopbriggs. This also includes data from the automatic monitoring station within Bishopbriggs providing NO_2, PM_{10} and $PM_{2.5}$ concentration data.

As a result of the pandemic a combination of traffic data collected both in 2019 and 2022 were used. In line with LAQM TG(16) meteorological data from 2019 recorded at Glasgow Bishopton were used in ADMS-Roads to conduct the dispersion modelling assessment.

The assessment has produced the following conclusions:

- Measurement data is currently below the Scottish air quality objectives for all monitoring locations and pollutants
- There were no exceedances of the NO_2 annual mean objective of 40 µg/m^3 at any receptor locations modelled within the study area.
- There were no exceedances of the PM_{10} annual mean objective of 18 µg/m^3 at any receptor locations modelled within the study area.
- The extended study area of South Crosshill Road towards Wester Cleddens Road has shown NO_2 pollutant concentrations to be well below the AQO. There were no PM_{10} exceedances within this area.
- While there were no exceedances of the $PM_{2.5}$ annual mean objective of 10 µg/m^3 at any receptor locations modelled within the study area. Receptor 1 at 1495 Springburn Road could be at risk of exceeding the objective when the RMSE is taken into consideration.

While the study has concluded that there are currently no exceedances of any or the pollutants at any of the measured or modelled locations, it is recommended that East Dunbartonshire Council consider additional monitoring of NO_2, PM_{10} and $PM_{2.5}$ in the hotspot areas identified prior to making any decisions to revoke the AQM.

Prior to the determination of whether an AQMA should be revoked and in line with PG(s)(16) East Dunbartonshire Council should investigate whether there is any risk likely over the next 3 to 5 years of any potential emissions increases that may result in the need for an AQMA. While this study has looked at the current AQ no consideration has been given to potential emission increases.

Figures

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Appendix A – Model Verification

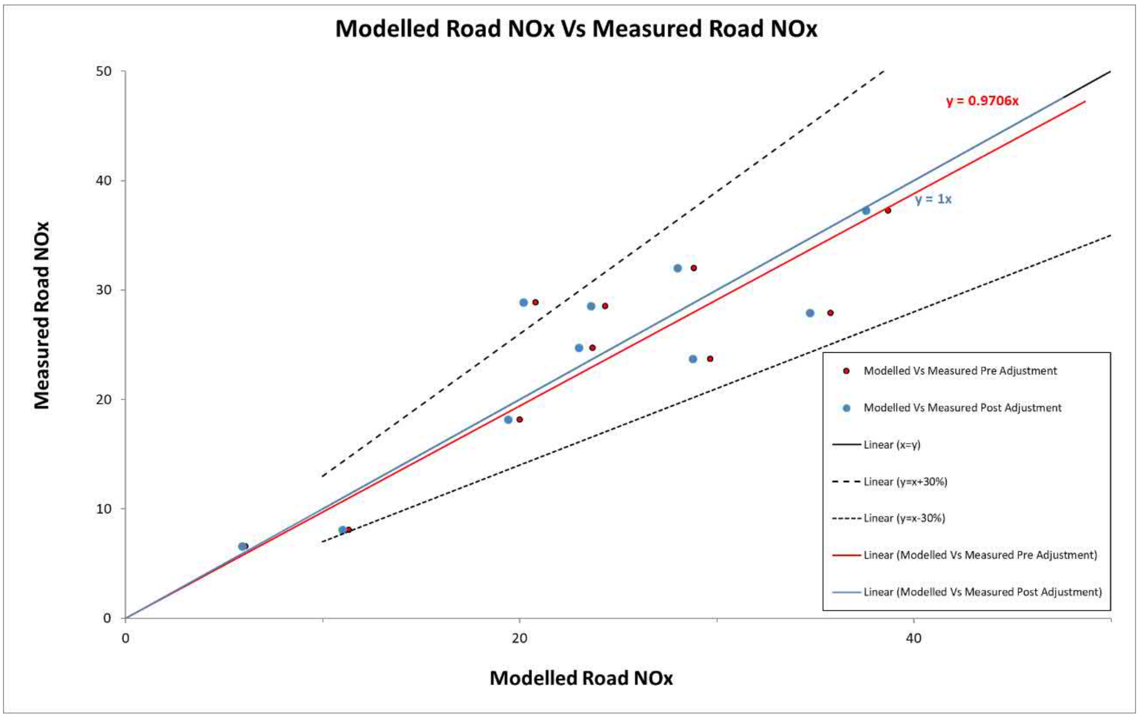
Verification is the process of comparing modelled results with the available local monitoring data. This identifies how accurate the modelled results are in comparison to monitored results and provides a clearer indication on how well the model is preforming. The process includes checking and refining model input data to better align modelled results with monitored results. Modelled results can be adjusted in accordance with LAQM TG(16) guidance.

As stated in chapter 6.0 - Results, the model was verified using annual mean NO_2 measurements from diffusion tube locations along the modelled road network. The modelling results were verified against modelling locations: Bishopbriggs 6, Bishopbriggs 13, Bishopbriggs 14 Auto, Bishopbriggs 16, Bishopbriggs 17, Bishopbriggs Bishopbriggs 22, Bishopbriggs 23, Bishopbriggs 24, Bishopbriggs 27 and Bishopbriggs 28.

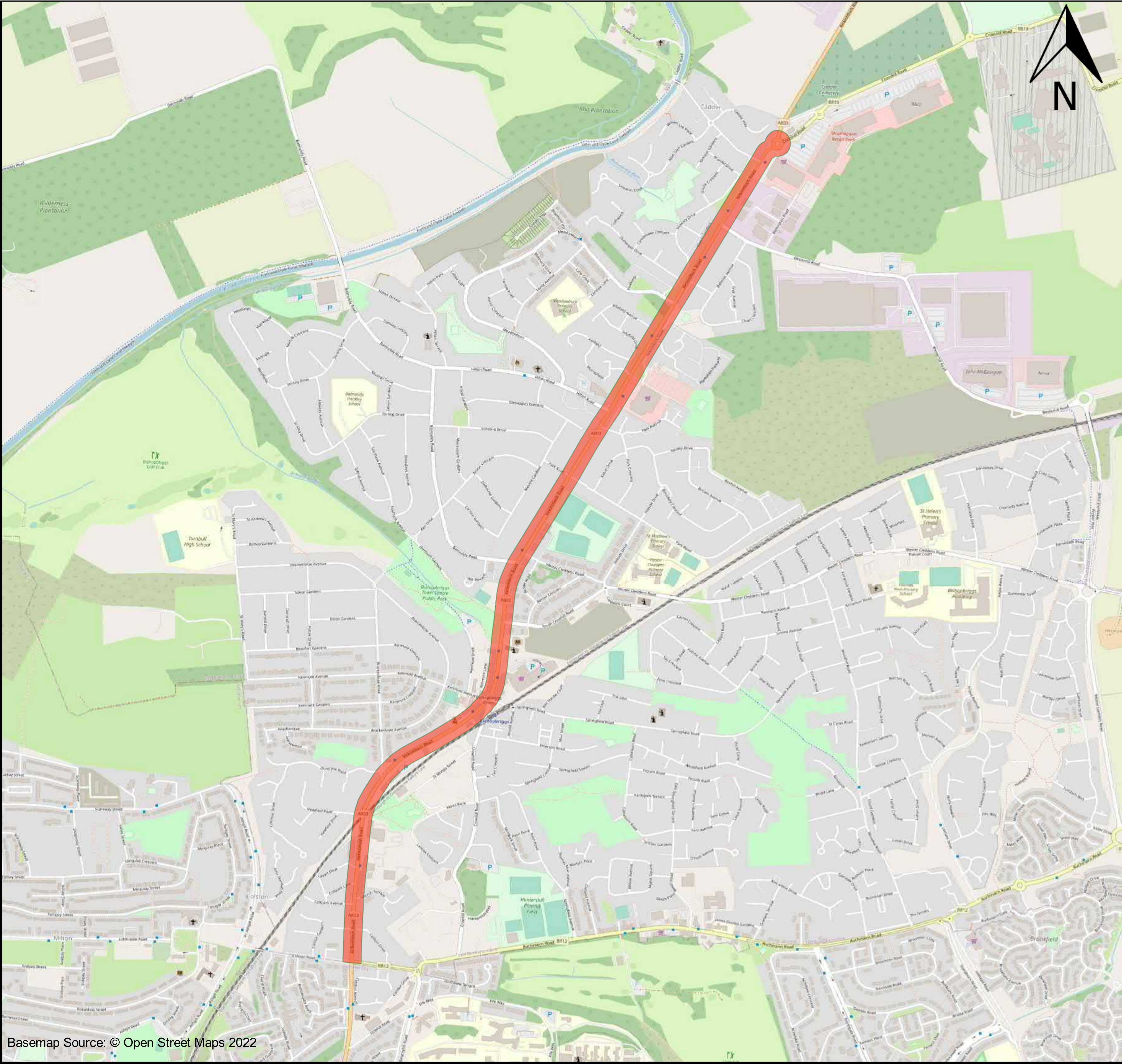
Following refinements of the model, the modelled road contribution did not require an adjustment factor (0.9706) to bring the predicted NO_2 concentrations in line with the measured concentrations at diffusion tube locations mentioned above.

Linear regression determines the line of best fit for the modelled NO_x against monitored NO_x. the gradient of the best line of fit is then used as the adjustment factor. A linear regression plot comparing modelled and monitored Road NO_x concentrations before and after adjustment is presented in Figure A.1.

Figure A. 1 - Linear regression plot of modelled vs monitored NOx 2019



The Root Mean Square Error (RMSE) is used to determine average error or uncertainty of the model. The units of RMSE are the same as the quantity being compared. If the RMSE value is higher than ±25% of the objective being assessed, then model inputs and verification should be reassessed for improvement. The RMSE for this study was 2.24 µg/m^3 after adjustment, which is in line with LAQM TG(16) guidelines (10% of the objective being assessed).



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BISHOPBRIGGS AQMA

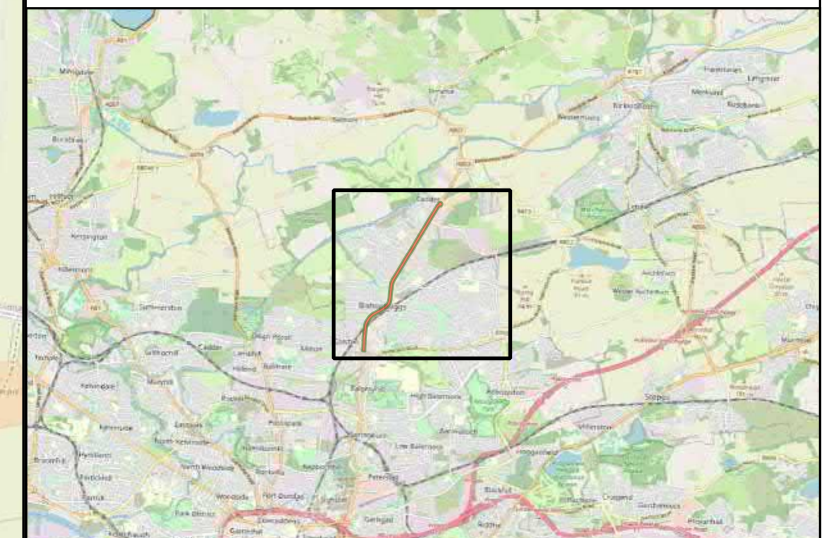

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FIGURE 1-1: BISHOPBRIGGS STUDY AREA AND AQMA

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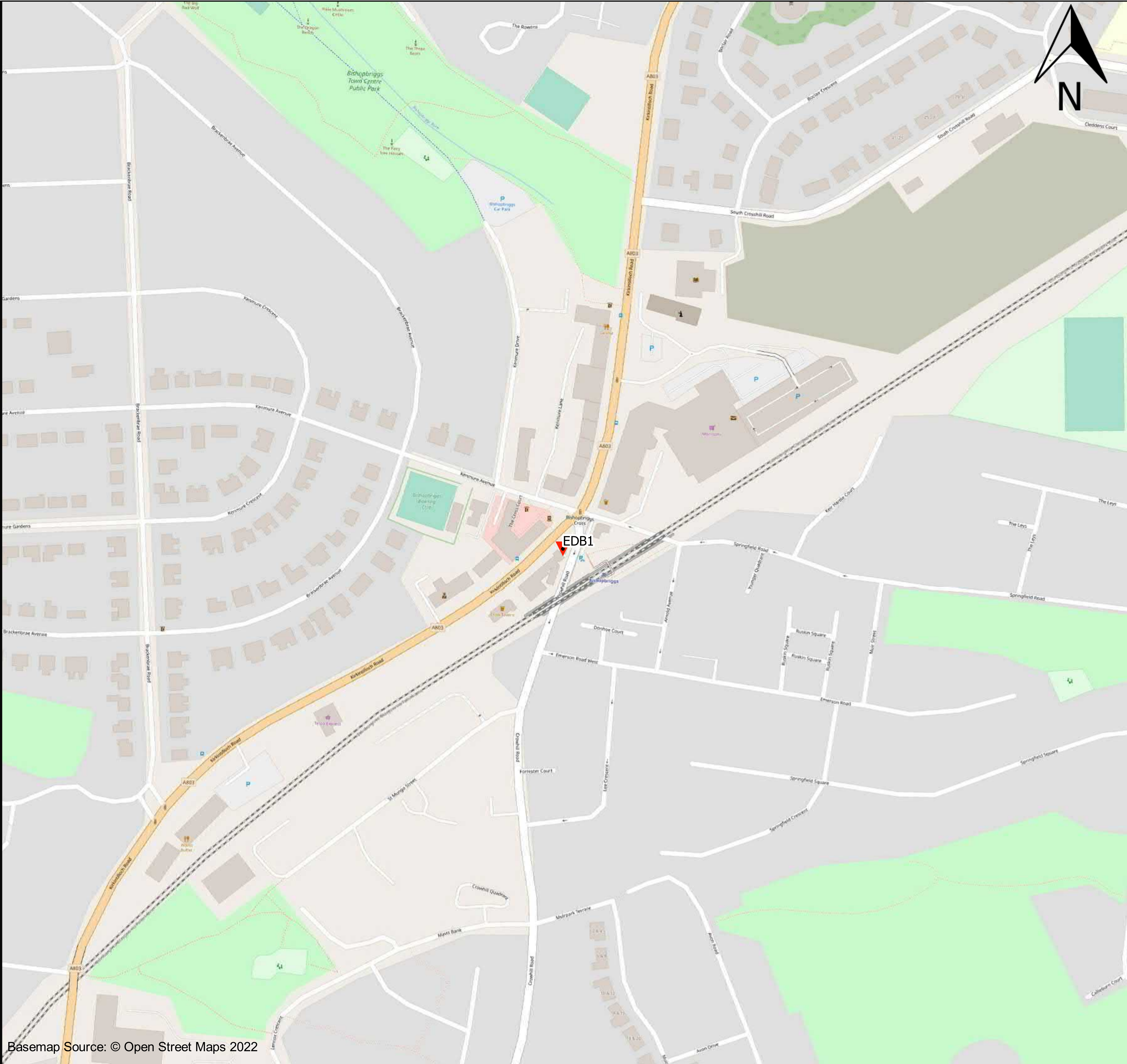
Drawing No.	65200977-SWE-ZZ-XX-DR-J-FIGURE-1-1	Sheet Size	A3



Legend

▼ AUTOMATIC MONITORING LOCATIONS

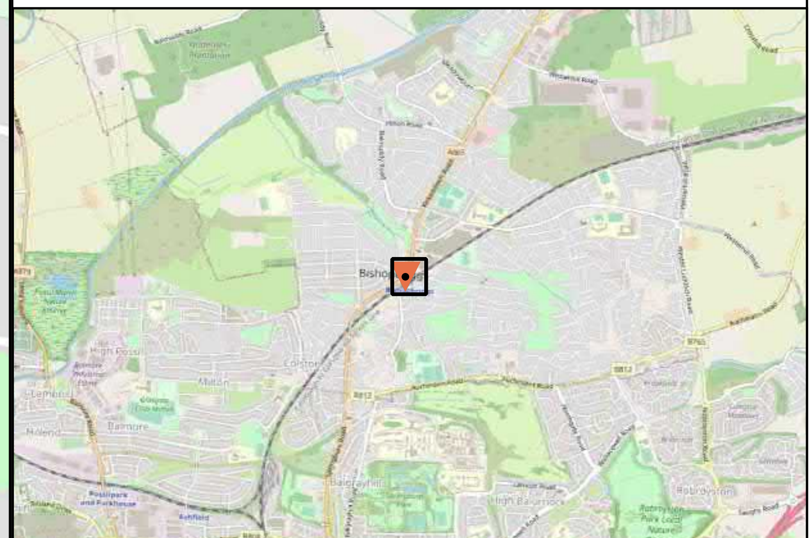


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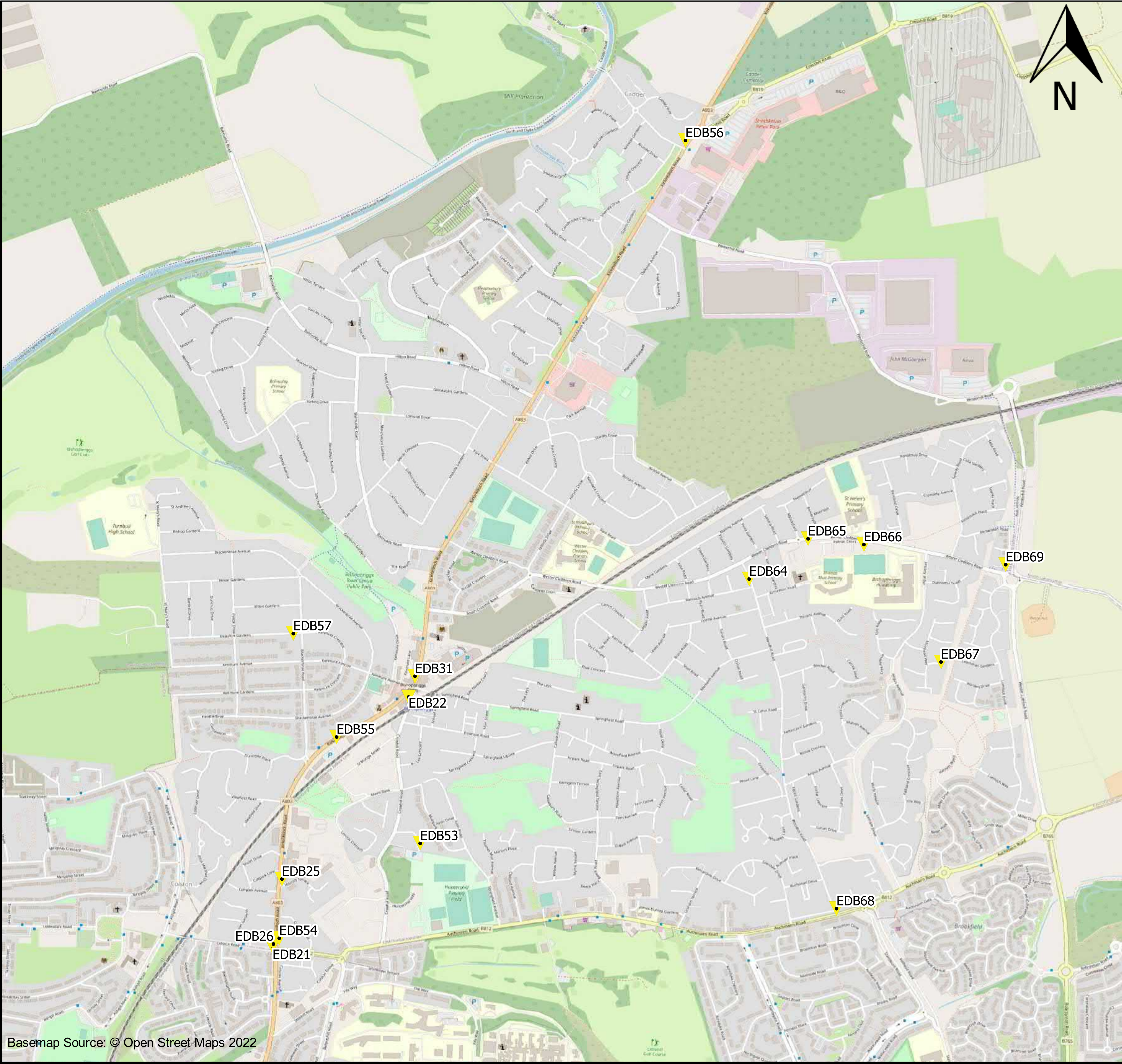
FIGURE 4-1: AUTOMATIC MONITORING LOCATIONS

Status Desc.	FINAL	Status	S2
Project No.	65200977	Scale	1:3,000
Drawing No.	65200977-SWE-ZZ-XX-DR-J-FIGURE-4-1	Sheet Size	A3



Legend

DIFFUSION TUBE MONITORING LOCATIONS

0 250 500 750 m

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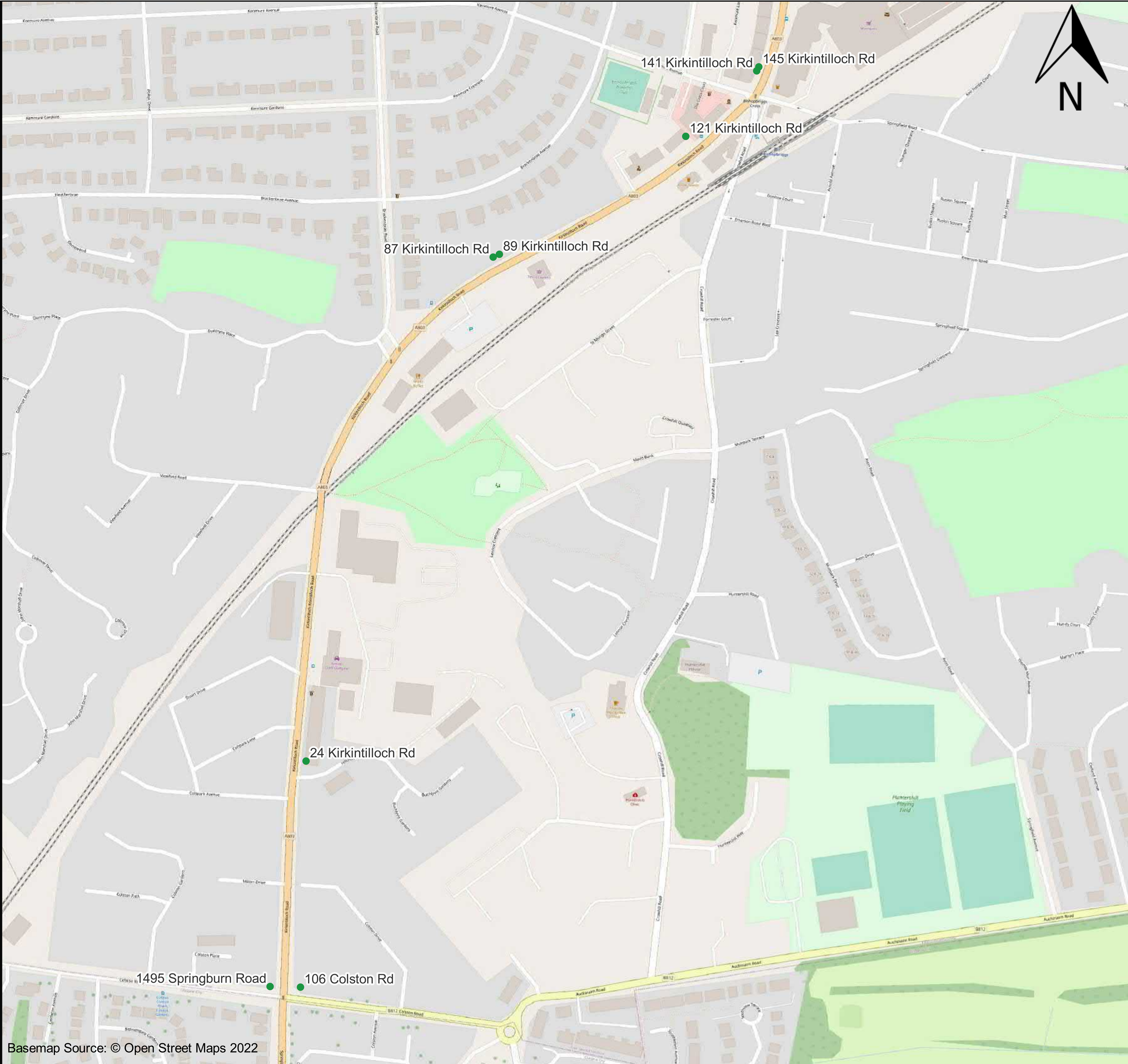
FIGURE 4-2: DIFFUSTION TUBE MONITORING LOCATIONS

Status Desc.	FINAL	Status	S2
Project No.	65200977	Scale	1:12,000
Drawing No.	65200977-SWE-ZZ-XX-DR-J-FIGURE-4-2	Sheet Size	A3



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- RECEPTOR LOCATIONS

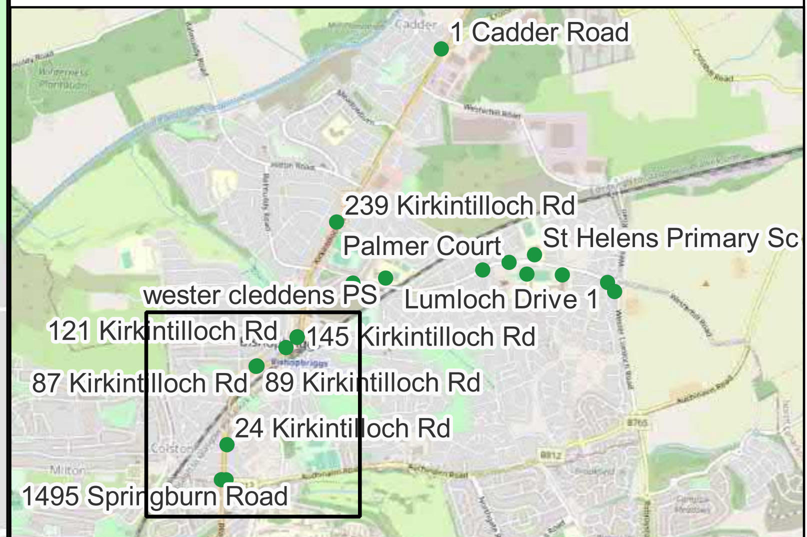

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FIGURE 5-3: RECEPTOR LOCATIONS

Status Desc.	FINAL	Status	S2
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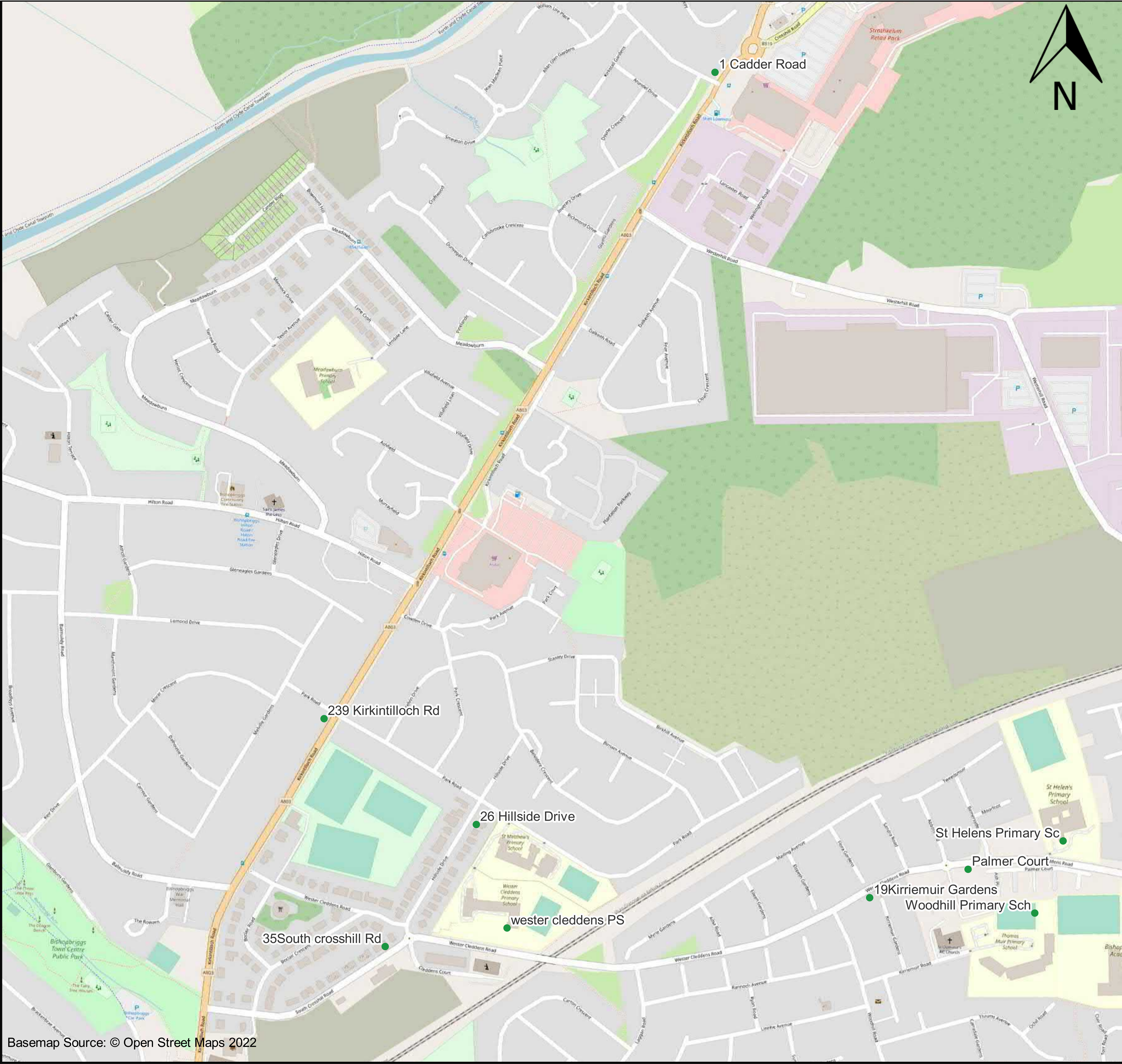
Drawing No.	65200977-SWE-ZZ-XX-DR-J-FIGURE-5-3	Sheet Size	A3



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- RECEPTOR LOCATIONS

0 100 200 300 m

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FIGURE 5-4: RECEPTOR LOCATIONS

Status Desc.	FINAL	Status	S2
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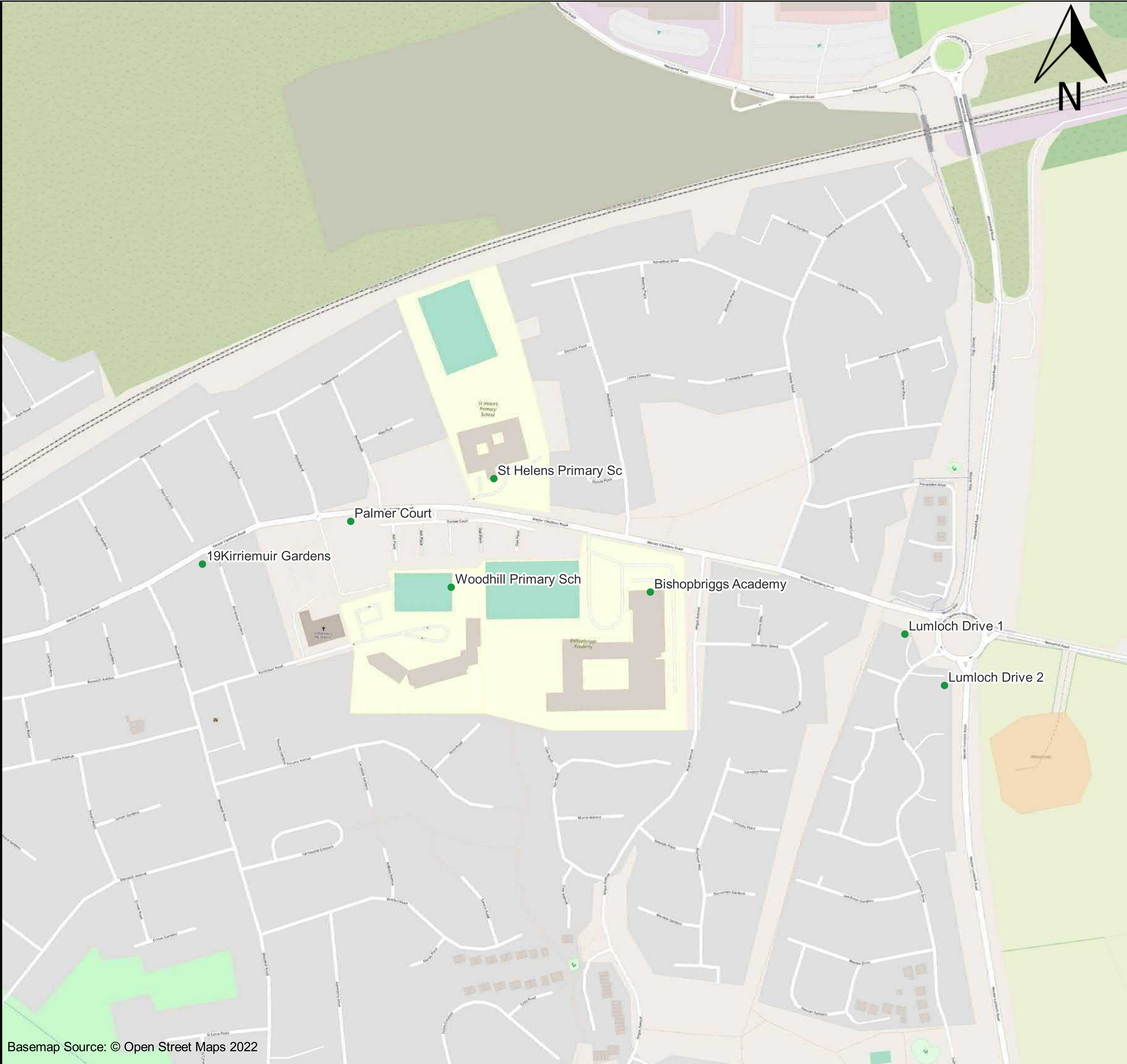
Drawing No.	65200977-SWE-ZZ-XX-DR-J-FIGURE-5-4	Sheet Size	A3



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- RECEPTOR LOCATIONS

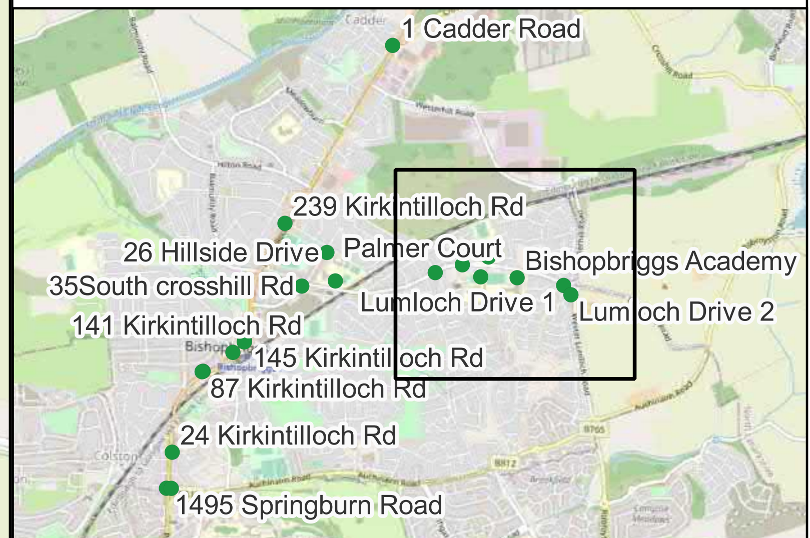

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FIGURE 5-5: RECEPTOR LOCATIONS

Status Desc.	FINAL	Status	S2
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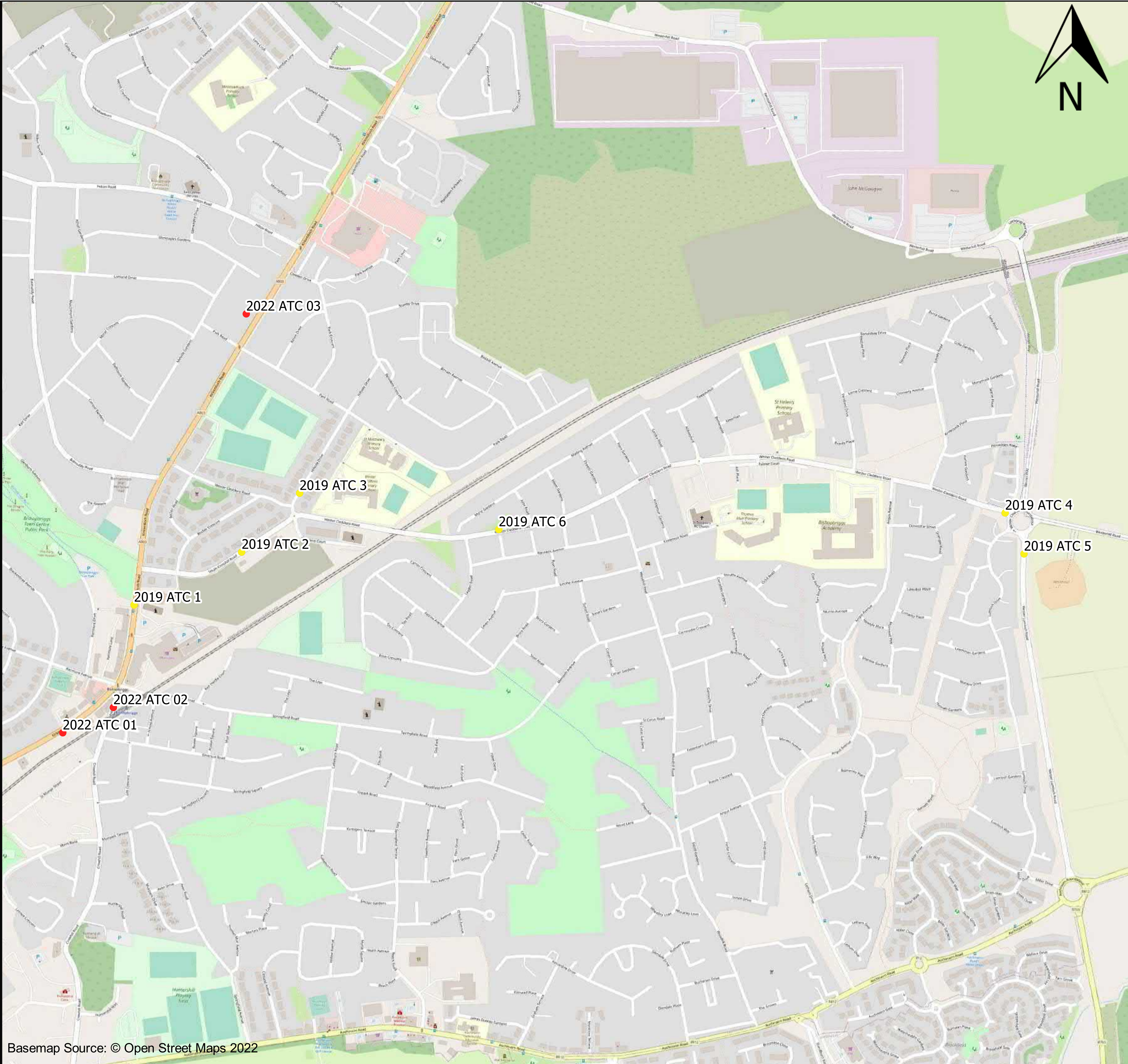
Drawing No.	65200977-SWE-ZZ-XX-DR-J-FIGURE-5-5	Sheet Size	A3



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- 2022 ATC COUNT LOCATIONS
- 2019 ATC COUNT LOCATIONS

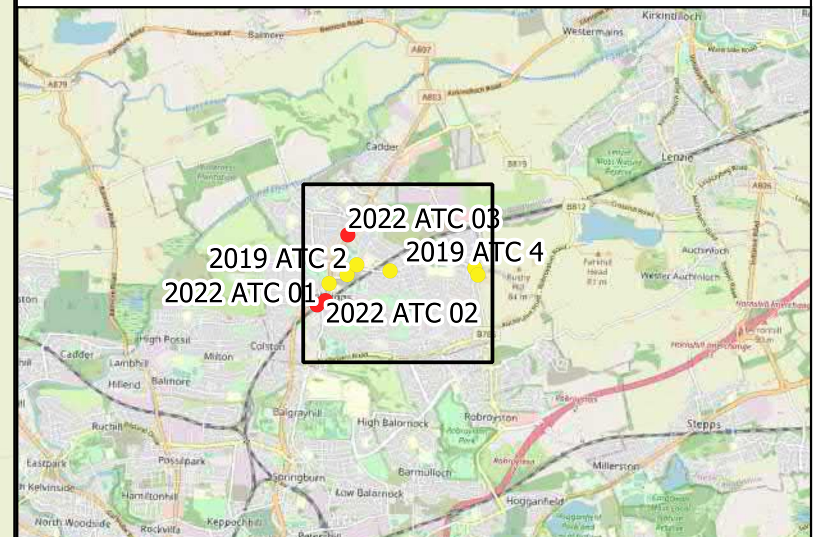

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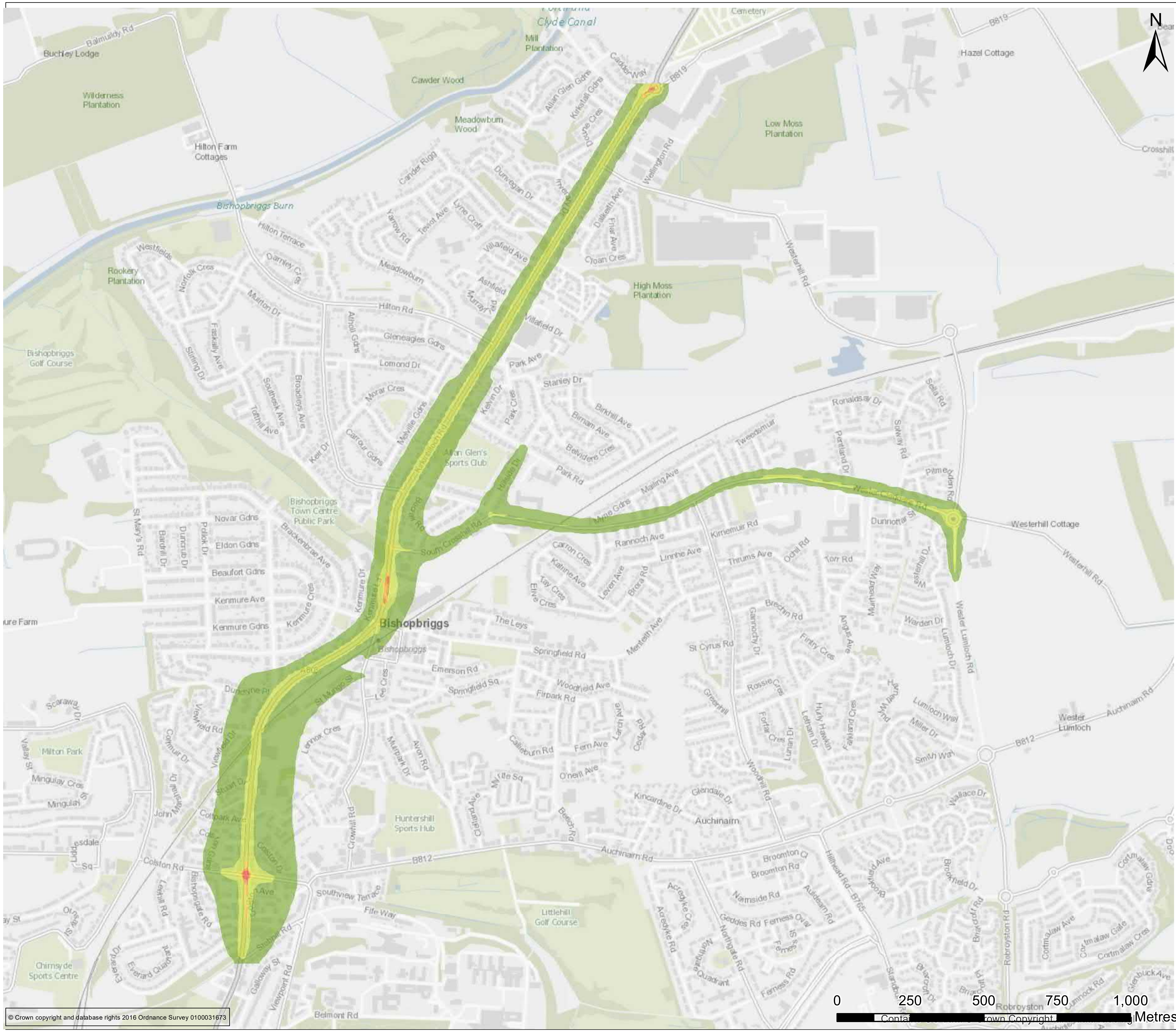
FIGURE 5-6: ATC LOCATIONS

Status Desc.	FINAL	Status	S2
Project No.	65200977	Scale	1:8,000
Drawing No.	65200977-SWE-ZZ-XX-DR-J-FIGURE-5-5	Sheet Size	A3



Legend

NO_2 Annual Mean µg/m^3

White	8 - 14
Dark green	14 - 20
Light green	20 - 30
Yellow	30 - 36
Orange	36 - 40
Red	40 - 49

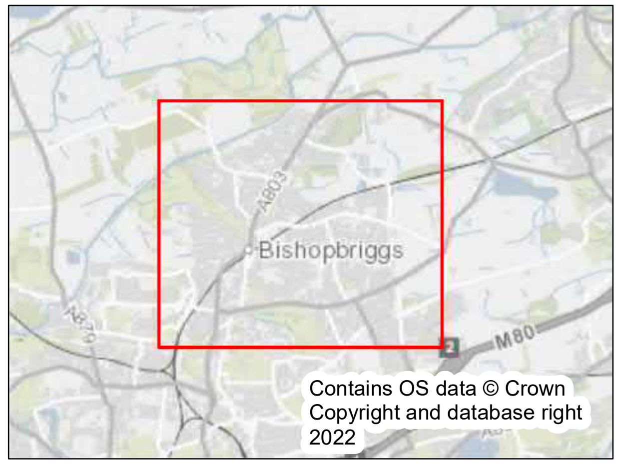


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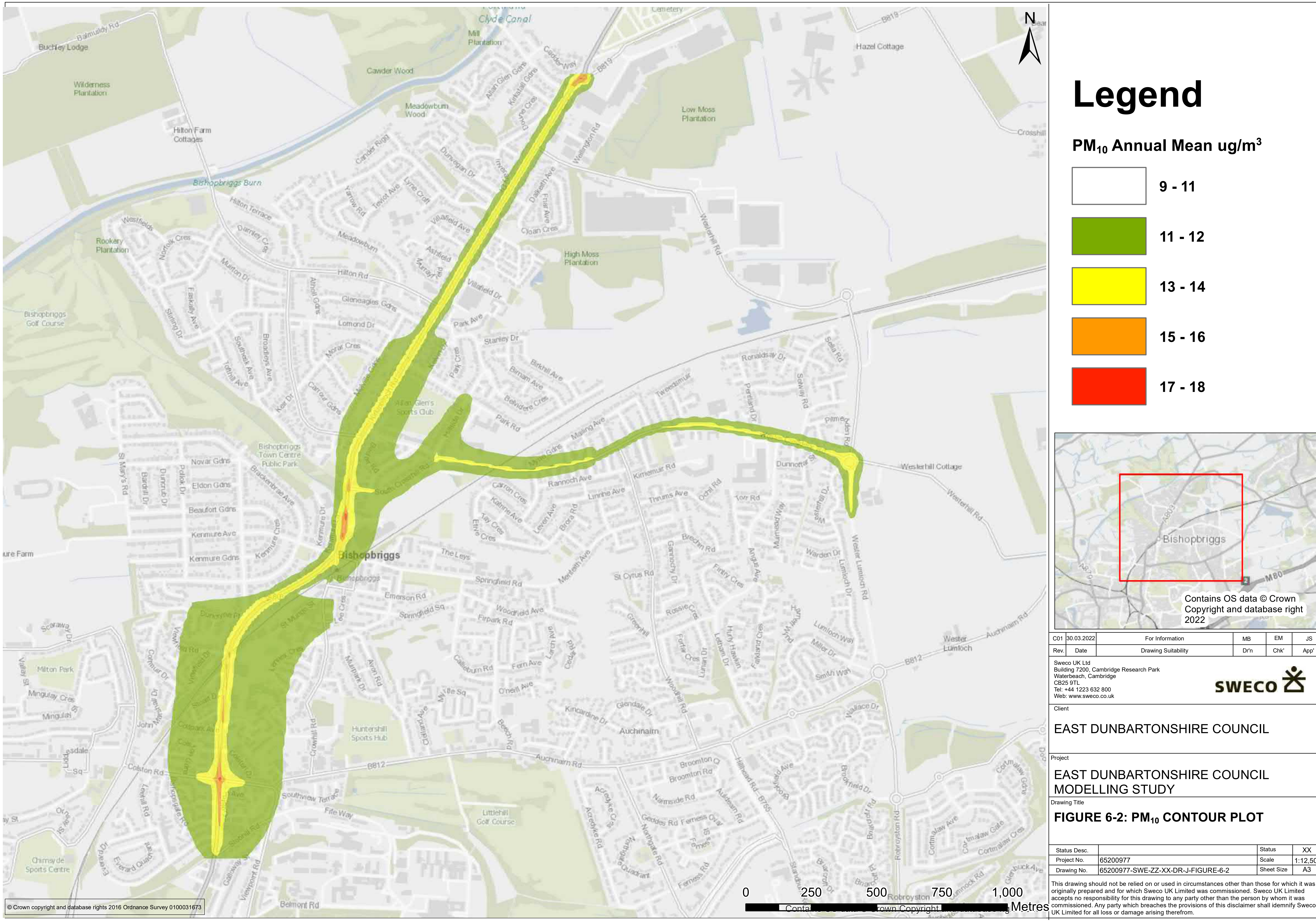
FIGURE 6-1: NO_2 CONTOUR PLOT

Status Desc.		Status	XX
Project No.	65200977	Scale	1:12,500
Drawing No.	65200977-SWE-ZZ-XX-DR-J-FIGURE-6-1	Sheet Size	A3



Legend

PM$_{10}$ Annual Mean ug/m^3

- 9 - 11
- 11 - 12
- 13 - 14
- 15 - 16
- 17 - 18

Rev.	Date	Drawing Suitability	Dr'n	Chk'	App'
C01	30.03.2022	For Information	MB	EM	JS

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EAST DUNBARTONSHIRE COUNCIL

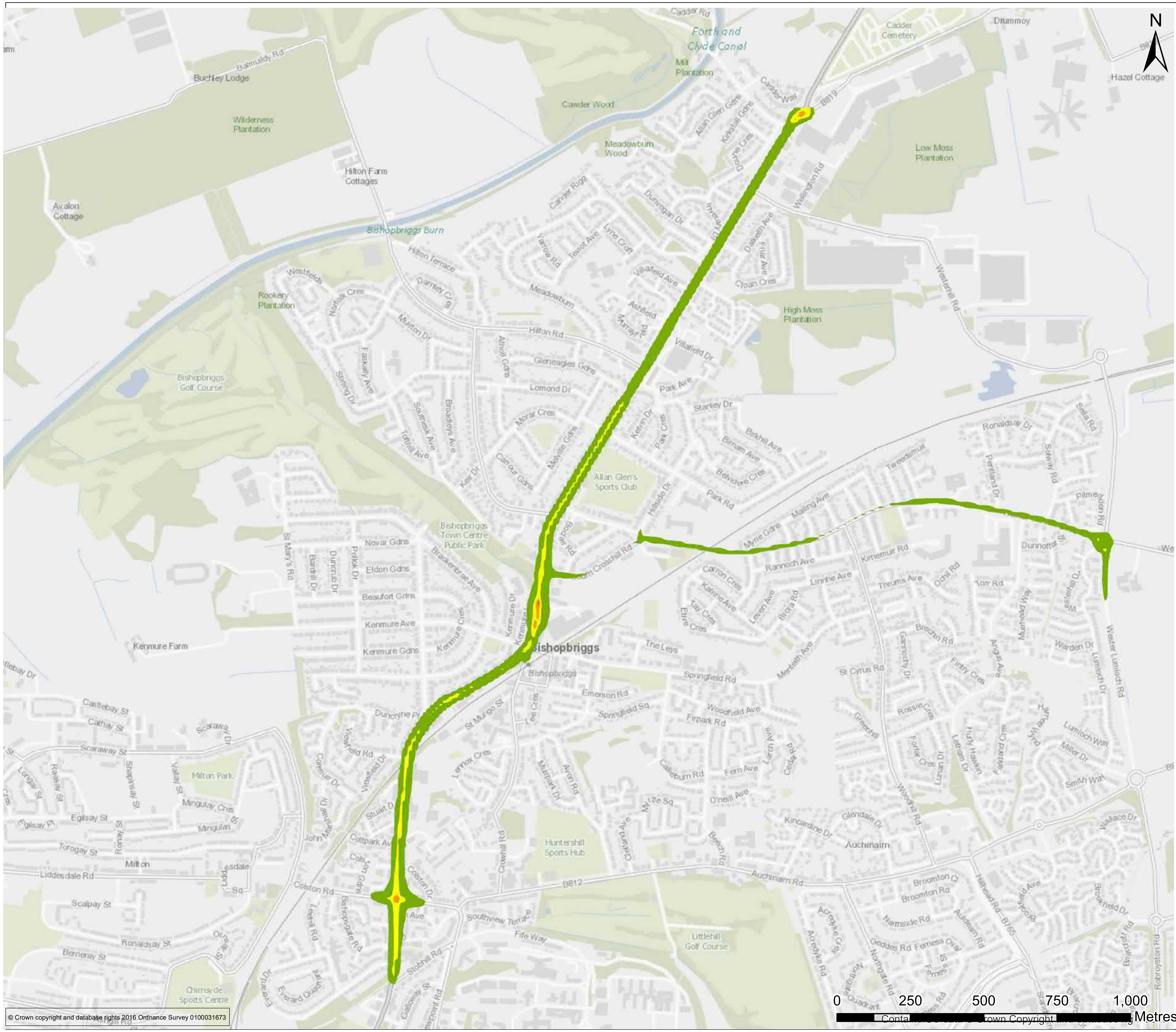
Project

EAST DUNBARTONSHIRE COUNCIL MODELLING STUDY

Drawing Title

FIGURE 6-2: PM$_{10}$ CONTOUR PLOT

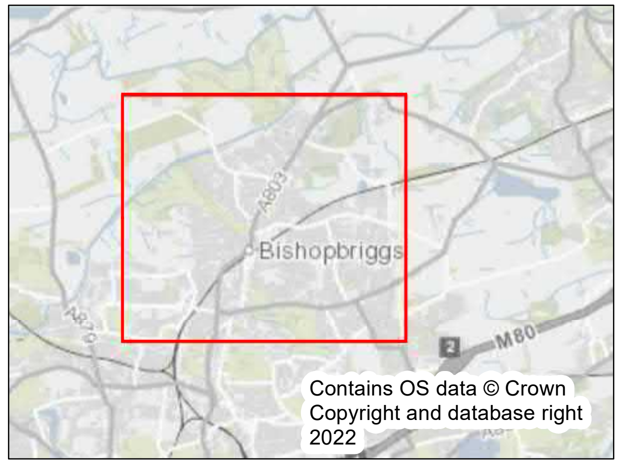
Status Desc.		Status	XX
Project No.	65200977	Scale	1:12,500
Drawing No.	65200977-SWE-ZZ-XX-DR-J-FIGURE-6-2	Sheet Size	A3



Legend

$PM_{2.5}$ Annual Mean ug/m^3

- 6 - 7
- 7 - 8
- 8 - 9
- 9 - 10
- 10 - 11



C01	30.03.2022	For Information	MB	EM	JS
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FIGURE 6-3: $PM_{2.5}$ CONTOUR PLOT

Status Desc.		Status	XX
Project No.	65200977	Scale	1:12,500
Drawing No.	65200977-SWE-ZZ-XX-DR-J-FIGURE-6-2	Sheet Size	A3