Portsmouth
CITY COUNCIL

Detailed Assessment Report

Local Air Quality Management 2015 - Environmental Health

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1 Executive Summary

Local authorities have a statutory obligation to review and assess local air quality from time to time to determine whether it is likely to meet National Air quality Objectives (NAQO) set out in the Air Quality (England) Regulations 2000 (as amended). Where these objectives are not expected to be met, the local authority must declare Air Quality Management Area (LAQMA) and draw up an Air Quality Action Plan (AQAP) to assist the local auhtority in moving towards compliance with the NAQOs.

Portsmouth City Council (PCC) produced this Detailed Assessment (DA) report to satisfy the LA's obligations under Part IV of the Environmental Act 1995. This report is aiming to:

- ✓ Carry out a DA of nitrogen dioxide (NO_2).
- ✓ Review the extent of predicted exceedance of NO_2 annual NAQO in the remaining AQMAs (AQMA 6, 7, 9, 11, and 13).

The information used in this report was sourced from both the road traffic micro-simulation modelling and the Air Quality Impact Assessment (AQIA) sections of the "Optimisation of Road Traffic Management Control System(s)" (ORTMCS[1]) report.

As NO_2 remains the main pollutant of concern locally, annual mean NO_2 concentrations have been predicted using the regional dispersion model AAQuIRE at sensitive receptor locations within five individual route corridors. This has been completed for the Base Year Scenario (BYS) and for the Do Minimum Scenarios (DMSs) for the assessment years (2013 and 2015). The potential impacts associated with each of the DMS have then assessed.

This DA report covers the three following tasks:

- ✓ Development of a BYS air quality dispersion model using the pre-collected road traffic data from the extensive traffic surveys. The BYS model is developed to predict the annual mean NO_2 concentrations for 2013 and used for model verification purposes.
- ✓ Development of a DMS air quality dispersion models for all corridors with the exception of Corridor 4 using the road traffic micro-simulation predictions to predict the annual mean NO_2 concentrations for assessment years, 2013 and 2015.
- ✓ Prediction of NO_2 concentrations at sensitive receptor locations and to produce contour plots of predicted NO_2 concentrations.

The 2015 DA concluded that:

- ✓ There are no predicted exceedances of the annual mean NO_2 NAQO at any modelled receptor location in any of the five route corridors in the BYS, DMSs(2013), and DMSs (2015).

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[1] ORTMCSs project is a desk top study, was set up by PCC to explore the possibility (ies) to improve road traffic management controls for the purpose of achieving possible local air quality improvement. This is a pioneering project in scale that took a form of a set of feasibility studies. These focused on testing ways to regulate and improve road traffic flow management to achieve an improvement in local air quality without creating new air pollution hotspots.

- ✓ The maximum predicted annual mean NO_2 concentration in the DMSs(2013) is 39.1 µg/m^3 at Receptor 15.
- ✓ The maximum predicted annual mean NO_2 concentrations in the DMSs(2013) by route corridor are:
  - Corridor 1: 39.1 µg/m^3 at Receptor 15.
  - Corridor 2: 37.0 µg/m^3 at Receptor 84.
  - Corridor 3: 35.0 µg/m^3 at Receptor 72.
  - Corridor 4: 34.4 µg/m^3 at Receptor 71 (BYS result as there is no DMS for Corridor 4).
  - Corridor 5: 34.2 µg/m^3 at Receptor 55.
- ✓ The maximum predicted annual mean NO_2 concentration in the DMSs(2015) is 37.8 µg/m^3 at Receptor 15.
- ✓ The maximum predicted annual mean NO_2 concentrations in the DMSs(2015) by route corridor are:
  - Corridor 1: 37.8 µg/m^3 at Receptor 15.
  - Corridor 2: 35.7 µg/m^3 at Receptor 84.
  - Corridor 3: 33.0 µg/m^3 at Receptor 72.
  - Corridor 4: 33.2 µg/m^3 at Receptor 71 (Projected base year result).
  - Corridor 5: 34.2 µg/m^3 at Receptor 55.

The DA results indicate that the annual mean NO_2 NAQO will not be exceeded at any modelled sensitive receptor location in 2013 or 2015 should additional traffic management measures not be implemented. However, the predicted annual mean NO_2 concentrations, particularly for the DMSs(2013), are close to the annual mean objective at several modelled receptor locations.

Due to inherent uncertainties within the dispersion modelling process, where predicted concentrations are within 10% of annual mean NO_2 NAQO, it is possible that exceedance of the annual mean NO_2 NAQO may occur.

At receptors 15 (39.1 µg/m^3), 16 (37.1 µg/m^3), 67 (38.5 µg/m^3), 84 (37.0 µg/m^3), 85 (37.4 µg/m^3) and 87 (37.2 µg/m^3) annual mean NO_2 concentrations are predicted to be within 10% of the annual mean objective.

Any revocation of an AQMA should consider both the predictions made throughout the corridors via the contour maps and local monitoring.

2 Introduction

2.1 Local Air Quality Management (LAQM)

LAs have a statutory obligation to review and assess air quality from time to time to determine whether it is likely to meet NAQO set out in the Air Quality (England) Regulations 2000 (as amended).

Where these objectives are not expected to be met, the authority must declare AQMAs and draw up an AQAP to assist the authority in moving towards compliance with the objectives.

2.2 National Air Quality Strategy

The National Air Quality Strategy (NAQS) identifies eight ambient air pollutants that have the potential to cause harm to human health. These pollutants are principally associated with local air quality (LAQ) factors, with the exception of ozone, which is instead considered to be a regional problem. The Air Quality Regulations 2007 set standards for the seven pollutants that are associated with LAQ. These NAQOs aim to reduce the health impacts of the pollutants to safe levels.

2.3 Aims of PCC's DA Report

PCC produced the DA report to satisfy the LA’s obligations under Part IV of the Environmental Act 1995. This report is aiming to:

- ✓ Carry out a DA of NO_2.
- ✓ Review the extent of NO_2 predicted exceedance of nitrogen dioxide annual NAQO in the remaining AQMAs (AQMA 6, 7, 9, 11, and 13).

2.4 Scope of PCC's DA Report

This report addresses all DEFRA’s requirements under LAQM regime. It aims to revisit the Further Assessment's (FA) NO_2 detailed modelling carried out in 2010 covering the remaining five AQMAs and to allow PCC to confirm the extent of exceedance of NAQO.

This was considered in response to the extensive change in road traffic flows resulting from:

- ✓ New restructuring of road layout at many road links and junctions.
- ✓ Change in road traffic management control systems at many of the major junctions.

As a result of the above, the following factors were revisited and reconsidered for the first time since the last detailed modelling was carried:

- ✓ Annual average daily traffic (AADT).
- ✓ Heavy goods vehicles (HGV) proportions.
- ✓ Average speed.

3 Legislation and Policy

3.1 European Air Quality Directives

The Air Quality Framework Directive (96/62/EC)[2] on ambient air quality assessment and management defines the policy framework for 12 air pollutants known to have a harmful effect on human health and the environment. Ambient concentration limit values for the specific pollutants are set through a series of daughter directives.

Following the daughter directives, Council Directive 2008/50/EC[3] on ambient air quality and cleaner air for Europe came into force in 2008, and was transposed into national legislation in 2010[4]. It consolidated existing air quality legislation and made provisions for member states to postpone limit value attainment deadlines and allow an exemption from the obligation to meet limit values for certain pollutants, subject to strict conditions and assessment by the European Commission (EC).

3.2 National Air Quality Legislation

The provisions of Part IV of the Environment Act 1995 establish a national framework for air quality management, which requires all local authorities to conduct local air quality reviews. Section 82(1) of the Act requires these reviews to include an assessment of the current air quality in the area and the predicted air quality in future years. Should the reviews indicate that the objectives prescribed in the NAQS[5] and the Air Quality Standards Regulations 2010 will not be met, the local authority is required to designate an AQMA. Action must then be taken at a local level to ensure that air quality in the area improves.

The NAQS identifies nine ambient air pollutants that have the potential to cause harm to human health. These pollutants are associated with local air quality problems, with the exception of ozone, which is instead considered to be a regional problem. Similarly, the Air Quality Regulations 2010 set objectives, but for just seven of the pollutants that are associated with local air quality. These objectives aim to reduce the health effects of the pollutants to negligible levels.

The air quality objectives and limit values currently applicable to the UK can be split into two groups. Each has a different legal status and is therefore handled differently within the framework of UK air quality policy. These are:

- ✓ NAQO set down in regulations for the purposes of local air quality management; and
- ✓ European Union (EU) limit values transcribed into UK legislation for which compliance is mandatory.

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[2] Air Quality Framework Directive (96/62/EC) on ambient air quality assessment and management
[3] Council Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe
[4] The Air Quality Standards Regulations 2010 Statutory Instrument 2010 No. 64
[5] Defra (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

3.3 Pollutants of Concern: Nitrogen Dioxide

The government and the devolved administrations adopted two NAQOs for NO_2 which were to be achieved by the end of 2005. In 2010, mandatory EU air quality limit values on pollutant concentrations were to apply in the UK, however the UK Government applied for derogation. For some parts of the UK the application has been refused, and for major cities a decision has yet to be reached. The EU Limit Values for NO_2 in relation to human health are the same as the national objectives:

- ✓ An annual mean concentration of 40 µg/m^3 (micrograms per metre cubed); and
- ✓ An hourly mean concentration of 200 µg/m^3, to be exceeded no more than 18 times per year.

In practice, meeting the annual mean objective has been and is expected to be considerably more demanding than achieving the 1-hour objective. The annual mean objective of 40 µg/m^3 is currently widely exceeded at roadside sites throughout the UK, with exceedances also reported at urban background locations in major conurbations. Exceedances are associated almost exclusively with road emissions.

There is considerable year-to-year variation in the number of exceedances of the hourly objective, driven by meteorological conditions which give rise to winter episodes of poor dispersion and summer oxidant episodes. Analysis of the relationship between 1-hour and annual mean NO_2 concentrations at roadside and kerbside monitoring sites indicate that exceedances of the 1-hour objective are unlikely where the annual mean concentrations are less than 60 µg/m^3.

NO_2 and nitric oxide (NO) are both oxides of nitrogen, and are collectively referred to as NO_X. All combustion processes produce NO_X emissions, largely in the form of NO, which is then converted to NO_2, mainly as a result of its reaction with ozone in the atmosphere. Therefore, the ratio of NO_2 to NO is dependent on the concentration of ozone and the distance from the emission source.

3.4 PCC's AQAP

As part of the 2004 DA, PCC modelled NO_2 concentrations across. The results indicated that the annual mean NO_2 NAQO would be exceeded at 13 hotspot areas across the city. In accordance with the NAQS and Air Quality Regulations described above, PCC declared 13 AQMAs.

In 2007, PCC developed the first draft of their AQAP and although not formally adopted, many of the proposed actions were implemented as part of the Local Transport Plan (LTP). In 2009, PCC undertook a FA, which indicated that air quality in Portsmouth had improved sufficiently to enable the revocation of 8 of the 13 AQMAs.

In 2010, PCC reviewed the 2007 draft AQAP to target the remaining ‘hotspot’ areas. The revised AQAP set out measures in pursuit of achieving the national objectives to deliver cleaner ambient air. Although aiming to deliver city wide improvements in air quality, the primary purpose of the AQAP was to explore measures which would combat the areas of poor air quality within Portsmouth’s remaining five AQMAs. As part of the 2009 FA, a source apportionment study was undertaken. This concluded that:

- In 2007, the predominant source of NO_x emissions was determined to be HGVs, closely followed by car emissions; and
- In 2010, the influence of cars and background concentrations was greater than those of 2007 but HGVs remained the highest polluter comparatively when considering the number of each type of vehicle.

The results of the source apportionment study enabled PCC to identify the sources that cause the highest level of pollution and those upon which the AQAP should focus and prioritise.

The following were considered to be priorities of the AQAP:

Priority 1:

- **HGVs:**
  In 2010, HGVs were predicted to contribute between 23.2% and 24.5% of the NO_X within AQMAs 6 and 11. Therefore any percentage decrease in HGVs passing through these areas will have a significant beneficial impact upon local air quality. Another factor to address is the implications of HGVs’ reduced speed, as the very lowest speeds are disproportionately more polluting. Congestion impairing HGV movement is therefore highly significant and needs to be reduced. Furthermore, HGVs contribute directly to the problem of congestion when making deliveries. This is particularly relevant on the London Road / Kingston Road / Fratton Road corridor (AQMA 6).
- Measures:
  - Applying a weight restriction to prevent HGV’s entering London Road, south of Stubbington Road, to ensure that Stamshaw Avenue is not used as an alternative route by HGVs;
  - Improving traffic light signals to speed traffic movement at the junction of Kingston Crescent and London Road. These would be more responsive to vehicle demand and be able to immediately react to changing vehicle flows, reducing queuing and congestion and leading to an improvement in air quality;
  - Removing the on-street parking bays to the north of the junction with Kingston Crescent to improve the movement of traffic; and
  - Improving signage to car parks. Currently Stubbington Avenue car park is only operating at around 40%–50% capacity. A review of pricing

policies, improve signage, lighting and security should be undertaken in order to increase take up of this underused facility.

Priority 2:

- **Car traffic:**
  In 2010, cars were predicted to contribute between 24.3% and 32.0% of NO_x emissions within AQMAs 6 and 11. Reducing congestion across the road network is essential if air quality is to improve.
- Measures:
  - Introduction of new traffic management systems at key locations to reduce congestion and pollution, such as the use of MOVA (Microprocessor Optimised Vehicle Actuation);
  - Junction improvements on the St Michael's gyratory as during the afternoon peak hour, large queues form on Hampshire Terrace due to the large quantities of vehicles exiting Portsmouth and the pedestrian crossing signals. Traffic signal control should be introduced to improve traffic flow on Hampshire Terrace; and
  - Introduction of a Park-and-Ride scheme and a review of parking charges.

Priority 3:

- **Buses**
  In 2010, buses were predicted to contribute between 4.9% and 14.4% of the NO_x emissions within AQMA 6 and 11. The continued introduction of bus priority measures and introduction of improved bus exhaust technology therefore plays an important part in ensuring public transport can offer a realistic and sustainable alternative to the private car.
- Measures:
  - Targeted schemes to improve bus services, to increase usage and reduce emission levels in co-ordination with bus operators and partner authorities.

Priority 4:

- **Domestic, commercial and background sources**
  As background concentrations are influenced by pollution generated from outside Portsmouth's boundaries, emissions are difficult to specify or control. The AQAP states that wherever possible, PCC needs to encourage a reduction of unnecessary discharges from residential and industrial premises and encourage the use of more efficient heating systems.

Priority 5:

- **Shipping sources**
  The Further Assessment confirmed that the emissions from shipping did not exceed 10% of the total NO_X contribution in AQMA 11. This contribution is relatively small given the economic importance of shipping to Portsmouth.

Priority 6:

- **Industrial sources**
  In 2007, industrial sources were found to contribute between 0.2% and 0.4% to the NO_X levels in AQMA 6 and 11.

Priority 7:

- **Continuous improvement**
  Although the current legal limits on ambient air quality are now met across the majority of Portsmouth, the remaining NO_2 'hotspots' within the 5 AQMAs mean that exposure in these areas is still highly significant. However, even where the objectives have been achieved, effort is needed to maintain air quality given pressures from Portsmouth's increasing population and demands on transport and land use.

3.5 Assessment and Methodology

The DA comprises the following three tasks:

- ✓ Development of a BYS air quality dispersion model using the pre-collected road traffic data from the extensive traffic surveys. The BYS model is developed to predict the annual mean NO_2 concentrations for 2013 and used for model verification purposes.
- ✓ Development of a DMS air quality dispersion models for all corridors with the exception of Corridor 4 using the road traffic Micro-simulation predictions to predict the annual mean NO_2 concentrations for assessment years, 2013 and 2015.
- ✓ Prediction of NO_2 concentrations at sensitive receptor locations and to produce contour plots of predicted NO_2 concentrations.

4 Domain Study

4.1 Introduction

PCC identified a domain study to address a total of 24 junctions across the city where significant changes in traffic flow were anticipated due to the change in traffic management (in Appendix E, Figure 8). The selected 24 junctions include areas where detrimental effects may be experienced due to these changes.

The majority of these junctions focus on the main north - south corridors that connect the M27 / A27 to Portsea Island and are illustrated in in Appendix E, Figure 8 and include the remaining and some of the revoked AQMAs.

These junctions were identified and grouped in a set of five areas (corridors) and were not confined immediately to the road network within the five remaining AQMAs (AQMA 6, AQMA 7, AQMA 9, AQMA 11, and AQMA 13).

The choice of these 24 junctions across the city was based on two main reasons:

- ✓ Most of these junctions are located within existing or revoked AQMAs.
- ✓ At the majority of these 24 junctions significant changes in traffic flow are anticipated due to the road traffic management control changes since last extensive road traffic survey. These include areas where detrimental effects may be experienced due to the changes in road traffic flows.

These were set up for the purpose of both vehicle micro-simulation modelling and air dispersion modelling:

4.1.1 Corridor 1

This corridor is located partly within the area of Portsmouth city centre, situated south of the M275. This study area includes three major roundabouts, one gyratory and four major signalised junctions. It includes the motorway M275, which is the principal route for traffic entering and leaving Portsmouth. It further continues as the A3 into Portsmouth and together they form the main routes through Portsmouth city centre area. The A3 forms a key link road between the M275, A288 and A2030 (Appendix E, Figure 8).

The area of assessment is shown bounded by the blue line and includes all junctions from the Rudmore Roundabout in the north through to St Michael's Gyratory in the south and Lake Road/A2030 roundabout to the east. In the middle of the network is the Mile End Road roundabout and the Marketway roundabout which has recently been converted from a roundabout to a signalised junction.

4.1.2 Corridor 2

This corridor is located within the area of Portsmouth city centre and Fratton. The study area includes two give way controlled roundabouts, and five signalised junctions (Appendix E, Figure 8).

4.1.3 Corridor 3

This corridor extends from Highland Avenue to M27 across the city. The study area includes one give-way controlled roundabout, one approach of a give-way controlled roundabout, two give-way controlled priority junctions, and four signalised junctions (Appendix E, Figure 8) bounded by the blue line.

4.1.4 Corridor 4

This corridor is located within the area of Cosham, situated to the north of the M27 of the city (Appendix E, Figure 8). The study area includes two give way controlled roundabouts along the A397 and A3, all approaches and exits, and three signalised junctions.

4.1.5 Corridor 5

This corridor is located within the area of Southsea, situated to the south of the A2030 (Appendix E, Figure 8).The study area includes three signalised junctions, two priority junctions and several pedestrian crossings. The study area is shown bounded by the blue line.

Three of the corridors were set as traffic corridor models (Corridors 1 to 3) and two as junction corridor models (Corridors 4 and 5). The junctions included in each of the five corridors (models) are described in (Appendix E, Figure 8).

5 Required Road Traffic Data For Air Quality Modelling

5.1 Introduction

Road traffic data required for air quality dispersion modelling was sourced from:

- ✓ Base year road traffic data generated by extensive traffic surveys.
- ✓ Road traffic signal from PCC's road traffic management unit.
- ✓ Projected traffic data generated from road traffic micro-simulation modelling.

5.1.1 Traffic Surveys

A data collection programme was undertaken by Traffic Survey Partners (TSP) on behalf of Arup throughout October 2013 but the main day of traffic surveys were undertaken on Tuesday 1st October 2013. The data collection is described below by category.

5.1.1.1 Turning Counts

Manual classified counts (MCC) (car, taxi, light goods vehicles (LGV), other goods vehicles (OGV1 and OGV2), motorbike, bus and coach classifications) were conducted between 07:00 in the morning to 19:00 in the evening. The survey video files have also been received.

5.1.1.2 Automated Traffic Counts (ATC)

The ATC loops were placed and covered a period of 4 weeks from Monday 30th September to Sunday 27th October 2013 in order to avoid half term holidays.

5.1.1.3 Travel Time

Journey time surveys were conducted using the moving observer method on Tuesday 1st October2013, between 07:00 to 10:00, 12:00 to 14:00 and 16:00 to 19:00.

5.1.1.4 Queue Lengths

Manual queue length surveys were collected for all approaches at each junction on Tuesday 1st October 2013 between 07:00 to 10:00, 12:00 to 14:00 and 16:00 to 19:00. The queue lengths were collated per lane with spot observations undertaken every 5 minutes. All observations were undertaken at the appropriate give way lines.

5.1.1.5 Pedestrians Surveys

The surveys were undertaken on Tuesday 1st October 2013 and counted the number of pedestrians crossing in each direction at signalised crossing at or adjacent to the surveyed junctions.

For the remainder of the crossings within the network where the data is unavailable, assumptions have been made per 15 minute interval.

5.1.1.6 Bus Services

The network contains several bus stops so it was necessary to isolate the bus services running through the network from the traffic count data and code these separately to the main traffic counts in order to model the correct traffic conditions.

The main bus operator in Portsmouth is First Hampshire and Dorset with a few services operated by Stagecoach Coastline.

All timetables for the services which operate in the network during the weekday AM, Inter and PM peak periods were collated from the Travel Line internet site (http://traveline.info/). The routes of the individual services through the network were given the corresponding service numbers as their route number and given separate inbound and outbound routes.

In order to calculate when the bus service would appear in the network, the nearest stop on the edge of the network was selected for the start time of the service, or where this information was missing, the nearest stop outside of the network was adopted and the time taken by the bus between this stop and when it appeared in the network was calculated and added to the start time.

Once the bus times were calculated for each 15 minute interval, the buses were then entered into VISSIM separately using public transport inputs.

The dwell times for all bus stops within the network have been set to the default value of 20 seconds with a 2 second standard deviation. All buses have been coded to stop at every stop along their route, to provide a robust assessment.

5.1.2 Traffic Signal Data

The traffic signal specifications for all signalised junctions within the study area were provided by PCC' road traffic management unit. Where specifications were not available, observed timings for each junction were provided.

5.1.3 Road Traffic Modelling

Atkins was commissioned by PCC to develop five existing conditions micro-simulation models of various Do Minimum road traffic control improvement schemes along key routes within Portsmouth boundary within each of the five pre-identified study areas as described in Chapter 4 using VISSIM which is part of the PTV Vision Transport modelling suite, a microscopic traffic flow simulation model based on car following and lane change logic.

A full data collection programme was commissioned and carried out by Arup in order to provide road traffic data for both:

- ✓ To build existing condition model, BYS model.
- ✓ To calibrate and validate the road traffic micro-simulation model.

This traffic surveys included manual classified turning movement surveys at the key junctions throughout the study area and Automatic Number Plate Recognition (ANPR) cameras for journey time analysis.

VISSIM can analyse vehicular traffic including bus / tram, pedestrian and bicycle operations under constraints such as lane configuration, traffic composition, traffic signals, and bus/tram stops. VISSIM does not follow the conventional link / node modelling system, but utilises a link / connector system that enables complex geometry to be modelled. The link / connector system also permits different traffic controls (signal, give way or stop) to be utilised anywhere in the model. VISSIM is also capable of modelling vehicle actuation traffic control utilising the Vehicle Actuated Programming (VAP) module as well as MOVA using the PCMOVA module from TRL. Therefore, it is an appropriate tool for the evaluation of the combination of complex geometry and traffic controls (give way and traffic signal) operations that will be assessed within the study area.

All traffic signal controllers have been coded in Visual Vehicle Actuated Programming (VisVAP) using the signal specifications in order to replicate the average SCOOT green times, Cableless Linked Fixed time plans (CLF) or Vehicle Actuated (VA) control.

The models have been constructed to represent the morning peak period from 07:00 to 10:00, an Inter peak from 12:00 to 14:00 and an evening peak period from 16:00 to 19:00 each with a 30 minute seed period, prior to each peak to populate the network before analysis is undertaken.

A site visit was undertaken during the AM, IP and PM peaks to observe traffic conditions along the network at each corridor.

The final collected and predicted data were projected to 24 hours to generate Annual Average Daily Traffic (AADT) the road traffic data format required for air quality dispersion modelling.

5.1.4 Model Development

The VISSIM model is comprised of five basic components:

- ✓ Highway network (links and connectors).

- ✓ Traffic control systems (signal, stop and give-way control).
- ✓ Traffic inputs.
- ✓ Vehicle type and compositions.
- ✓ Vehicle routes.

VISSIM version v5.40-09 has been used to construct and run the model.

5.1.4.1 Balanced Turning Movements

Within VISSIM the traffic flows need to be balanced so the same amount of traffic enters and exits each junction within the network. The MCC data was utilised to produce a network of unbalanced turning movement flows in 15 minute intervals.

The SATURN flows were then used to create turning proportions which were used to balance the remaining junctions back to the surveyed roundabouts in 15 minute intervals.

A seed period of 30 minutes was utilised to populate each peak, however, where traffic data for the 30 minute interval of 06:30-07:00 was not available therefore, the 07:00-07:15 flows were utilised and appropriate correction is applied based upon observations from the survey video footage.

5.1.4.2 Highway Network

The base road network for the existing conditions VISSIM models was constructed for both peaks based upon an Ordinance Survey CAD background.

In order to facilitate realistic queuing and vehicle behaviour the main link type utilised on the dual carriageway sections was Urban Free Lane Selection (Motorised) and on the signal lane sections Urban Left-Side Rule (Motorised) utilised, both Wiedemann 74.

5.1.4.3 Traffic Control System

Priority rules were placed at all give-way locations, with separate rules for lights and heavy vehicles to account for differing gap acceptance values at roundabouts.

5.1.4.4 Vehicles Types and Classes

VISSIM uses individual vehicle models that are grouped into vehicle types which are then grouped into vehicle classes. Vehicle classes for Car, Taxi, LGV, HGV, Bus and Motorcycle were used within the model. The car class was further split into small and large cars; HGV was further split into OGV1 and OGV2. All other vehicle classes contained a single vehicle type.

5.1.4.5 Vehicle Inputs and Composition

The balanced traffic flow networks for the AM and PM peak periods were used to determine the total vehicle inputs at all entries into the network in 15 minute intervals.

The survey data was used to calculate the vehicle type compositions at the entry points to the network in 15 minute intervals.

The light vehicles in VISSIM were split into vehicle types of small cars and large cars in the assumed proportions of 75% and 25% respectively.

5.1.4.6 Vehicle Routes

The balanced traffic flow networks for the AM and PM peaks were used to determine the total vehicle routes throughout the network in 15 minute intervals.

5.1.4.7 Traffic Signal Data

The traffic signal specifications provided by PCC were interrogated in order to code in the most applicable signal control method at each junction. All junctions were coded in VAP using the VisVAP module of VISSIM regardless of the specific control method. Using VAP allows Vehicle Actuation (VA) to be replicated in the model using detector loops in VISSIM, provide demand dependant phases and stages to be introduced as well as the ability to apply different time plans mid-way through a simulation. In the case of the Portsmouth model, VisVAP has been used to change the programme times to match the master clock settings within the specifications.

5.1.4.8 Model Output

Measures of effectiveness have been coded and output from VISSIM including the following:

- ✓ General network performance statistics.
- ✓ Junction analysis (including demand and supply volumes, average and maximum queue lengths).
- ✓ Journey Times; and
- ✓ Vehicle record.

5.1.5 Model Calibration and Validation

In order to confirm that the model is fit for the purpose of the evaluation of proposed improvement measures and to provide credibility to results it is necessary to calibrate and validate the model.

The calibration process involves changing the network set up and behavioural characteristics to achieve a match between observed and modelled data.

Model validation assesses the accuracy of the model by comparing traffic data from the model with independent traffic data not used in the model building process. Validation is directly linked to the calibration process as adjustments in calibration are needed to improve the models ability to replicate field measured traffic conditions.

The calibration and validation of each corridor existing conditions model and assessment of proposed schemes developed used VISSIM, which is part of the PTV Vision Transport modelling suite. VISSIM is a microscopic traffic flow simulation model based on car following and lane change logic. VISSIM can analyse vehicular traffic including bus / tram, pedestrian and bicycle operations under constraints such as lane configuration, traffic composition, traffic signals, and bus/tram stops. VISSIM does not follow the conventional link /node modelling system, but utilises a link / connector system that enables complex geometry to be modelled. The link / connector system also permits different traffic controls (signal, give way or stop) to be utilised anywhere in the model. VISSIM is also capable of modelling vehicle actuation traffic control utilising the VAP module as well as MOVA using the PCMOVA module from TRL. Therefore, it is an appropriate tool for the evaluation of the combination of complex geometry and traffic controls (give way and traffic signal) operations that will be assessed within the study area.

The models runs have been constructed to represent the morning peak period from 07:00 to 10:00, an Inter peak period from 12:00 to 14:00 and an evening peak period from 16:00 to 19:00 with a 30 minute seed period prior to each peak to populate the network before analysis is undertaken.

5.1.5.1 Corridor 1

As VISSIM is a stochastic model, the results differ slightly depending on the random seed assigned to each simulation run. Therefore, in order to obtain statistically significant results, the models were simulated 16 times with different random seeds.

All peaks have been validated very well in terms of flow throughput, with the AM peak achieving 99% GEH and the PM and Inter achieving 100% GEH.

The network operates within capacity with an overall LOS of D in the AM peak, C in the PM peak and B in the Inter peak.

In the AM peak, the Holbrook Road / Lake Road roundabout operates over capacity and the Church Street Roundabout operates at capacity during the last two hours.

In the PM peak the Holbrook Road roundabout operates at capacity in the first two hours. The Inter peak shows no capacity issues, although several individual turning movements are operating at capacity.

The AM peak modelled travel times have been validated with 74% of modelled travel times within the lower and upper ranges, however, the cumulative travel times validate to 95%. Travel times for the PM peak validate with 93% of modelled times within the upper and lower ranges, and 100% for cumulative times. In the Inter peak, 89% of modelled travel times validate to the observed times, along with 79% of cumulative times. This is due to the fact that during the survey day, traffic management was in place along Commercial Road and at the Church Street Roundabout, which closed lanes and thus reducing capacity around this junction.

The queue lengths throughout all peaks were not validated particularly well to the observed queues, with much lower modelled average queues and much higher maximum queues.

However, comparisons between the videos and VISSIM showed similar queues and therefore, the queue lengths were deemed to be validated to acceptable levels and more importantly, the travel times in the model match well to the observed journey times.

The VISSIM models was deemed to have been calibrated and validated to within acceptable levels and was therefore, fit for purpose and was used as an evaluation tool for potential improvement schemes within the study area to improve air quality.

5.1.5.2 Corridor 2

All peaks have been validated very well in terms of flow throughput, with AM peak achieving 99.8% GEH, PM peak achieving 99.2% GEH and the Inter peak achieving 99.6% GEH.

The queue lengths throughout all peaks were validated particularly well to the observed queues, with lower modelled average queues and higher maximum queues. However, as the majority of the junctions with observed queue lengths are signalised, queue length validation was not considered to an appropriate measure (as the recording methodology is very different between observed and modelled), therefore, greater emphasis was based on the journey time validation.

The AM peak modelled travel times were validated well, with the cumulative travel time validated to 100% of modelled travel times. The cumulative travel times for the PM peak and Inter peak validate to 73% and 95% respectively.

The VISSIM models was deemed to have been calibrated and validated to within acceptable levels and are therefore, fit for purpose and can be used as an evaluation tool for potential improvement schemes within the study area to improve air quality.

5.1.5.3 Corridor 3

All peaks were validated very well in terms of flow throughput, with each peak meeting the GEH threshold in 100% of the cases for the PM and Inter-Peak periods, and 99.6% of the cases for the PM periods.

The AM, Inter-Peak and PM peak results for junction performance indicate that several junctions operate at unacceptable LOS during at least one of the peak hours. The Stubbington Avenue / Burrfields Road junction is the most critical junction which operates at LOS E or F during 7 of the 8 hours analysed. The A288 / Goldsmith Avenue operates at an unacceptable LOS for 4 of the 8 hours, while the junctions of A288 (Copnor Road) / Rodney Avenue, and A288 (Copnor Road) / Old London Road operate at an unacceptable LOS for 3 of the 8 hours analysed.

The modelled travel times for the PM, Inter-Peak and PM peak periods were validated adequately with 100% of modelled travel times meeting the 95% Confidence Level thresholds. In addition, all the models were also validated to meet the DMRB criteria of ±15% (or 1-minute if higher) for more than 85% of the cases. The cumulative end-to-end travel times meet the ±15% criteria in 100% of the cases for all peak hour directions except the southbound direction during the 13:00 to 14:00 Inter-Peak hour.

The average modelled queue lengths throughout all peaks are reasonably close to the observed queues, with less than 10% of cases where the difference between modelled and observed queues exceeds 10 vehicles. In addition, a visual validation of queues showed similar queuing patterns. Therefore, the queue lengths are considered to be satisfactory especially since both the travel times and volumes in the model match very well to the observed travel times and volumes, respectively.

The VISSIM models was deemed to have been calibrated and validated to within acceptable levels and were therefore, fit for purpose and can be used as an evaluation tool for potential improvement schemes within the study area to improve air quality.

5.1.5.4 Corridor 4

All peaks have been validated very well in terms of flow throughput, with each peak achieving 100% GEH.

The AM and PM peak results for junction performance indicate that the network operates within capacity with an overall LOS of C. However, the middle peak hour for both peaks the network is operating with an overall LOS of D, with the Hospital junction operating close to capacity with an overall LOS of D. Several individual movements are operating at or over capacity in the last two hours of the AM peak and throughout the entire PM peak. The Inter peak junction performance indicates no capacity issues with the network operating with an overall LOS of B.

The AM peak modelled travel times have been validated well, with 96% of modelled travel times within the lower and upper ranges, however, the cumulative travel times validate to 100%. Travel times for the PM and Inter peaks validate extremely well with 100% of modelled times within the upper and lower ranges, along with 100% cumulative times validating.

The queue lengths throughout all peaks have not been validated particularly well to the observed queues, with much lower modelled average queues and much higher maximum queues. As a result, visual validation of queues was undertaken for each peak and screenshots provided showing comparisons of the survey video footage compared with the VISSIM model at the same time. The comparisons showed similar queues and therefore, the queue lengths have been deemed to be validated to acceptable levels and more importantly, the travel times in the model match very well to the observed journey times.

The existing conditions VISSIM models were deemed to have been calibrated and validated to within acceptable levels and are therefore, fit for purpose and can be used as an evaluation tool for potential improvement schemes within the study area to improve air quality.

5.1.5.5 Corridor 5

All peaks have been validated very well in terms of flow throughput, with each peak achieving 100% GEH.

The AM Peak results indicate that the network operates within capacity with an overall LOS of C, although during the middle peak hour the Victoria Road / Elm Grove junction operates close to capacity with a LOS of D and several individual movements at the junction operate at capacity with a LOS of E.

During the PM Peak the network operates within capacity with an overall LOS of C for the PM peak. Throughout the entire PM peak the Victoria Road / Outram Road junction operates close to capacity with a LOS of D for all peak hours and with some individual movements operating at or over capacity.

The Inter peak junction performance indicates no capacity issues with the network operating with an overall LOS of B.

The AM peak modelled travel times validate extremely well, with 100% of modelled travel times within the lower and upper ranges. Travel times for the PM and Inter peaks also validate well with 95.8% (PM Peak) and 93.8% (Inter Peak) of modelled times within the upper and lower ranges, along with and 91.7% (PM Peak) and 100% (Inter Peak) cumulative times validating.

The queue lengths throughout all peaks have not been used to validate the model as the manner and frequency with which they are recorded on site are not considered to be robust or comparable to the output of queue length data from VISSIM.

The travel times in the model match very well to the observed journey times.

The VISSIM models are now deemed to have been calibrated and validated to within acceptable levels and are therefore, fit for purpose and can be used as an evaluation tool for potential improvement schemes within the study area to improve air quality.

6 Detailed Dispersion Modelling

6.1 AAQuIRE

The AAQuIRE dispersion modelling software, developed by AECOM, was used to predict the annual mean NO_2 concentrations for each scenario. AAQuIRE uses the CALINE4 model for the dispersion of road-traffic emissions. The model is fully validated and has been extensively used worldwide. Further details are provided in Appendix C.

The modelling study uses the most recent version of the Emission Factor Toolkit (EFT) published by Defra[6]. The EFT takes into consideration the following information derived from the National Atmospheric Emission Inventory:

- Fleet composition data for motorways, urban and rural roads.
- Fleet composition based on European emission standard from pre-Euro 1 to Euro 6.
- Scaling factors reflecting improvements in the quality of fuel and some degree of retrofitting; and
- Technology conversions in the national fleet.

The EFT specifically incorporates updated NO_X emissions factors and the latest vehicle fleet information based on measurements and projections, and was the most recent version available at the time the assessment was undertaken.

6.2 Conversion of NO_X to NO_2

The proportion of NO_2 in NO_X varies greatly with location and time according to a number of factors including the amount of oxidant available and the distance from the emission source. Due to projected future-year reductions in NO_X concentrations it is expected that NO_2 concentrations will not be limited as much by ozone. This would result in an increase in the NO_2/NO_X ratio. In addition, a trend has been noted in recent years whereby roadside NO_2 concentrations have been increasing at certain roadside monitoring sites, despite emissions of NO_X falling. The 'direct NO_2' phenomenon has had an increasingly marked effect in many urban locations throughout the UK and must be considered when undertaking modelling studies.

In this study modelled NO_X values were converted to NO_2 using the 'NO_X to NO_2' calculator Version 4.1[7], released in June 2014. The "All other UK Urban Traffic" vehicle fleet mix, the appropriate year (2013 or 2015) and local authority (Portsmouth City Council) were specified for the conversion of modelled NO_X concentrations to NO_2 concentrations.

[6] Defra (2014). Emission Factors Toolkit Version 6.0.2. http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft

[7] Defra (2014). NO_X to NO_2 Calculator. Version 4.1. http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

6.3 Traffic Data

Traffic data for each assessment year (2013, 2015) in the form of annual average daily traffic (AADT) flows, HGV percentages and vehicle speeds were required as inputs to the dispersion model and were sourced as described in Chapter 5.

6.4 Base Year

As part of the first package of the ORTMCS, ARUP were commissioned to undertake traffic surveys at 24 junctions. Traffic surveys were undertaken between the 30th September 2013 and 27th October 2013 using Automatic Traffic Counters (ATCs), which provided the number of vehicles, speed and category of the vehicles for each hour of the day. These data were converted to AADT flows using PCC's four ATCs located across Portsmouth. For each of the four ATCs, an average ratio was determined between the October survey data and the average for the year. The ratio was applied to the project-specific survey data to derive the corresponding AADT flows.

It should be noted that due to road works being undertaken at the time of the traffic surveys, Site 1 was resurveyed between 11th January and 13th February 2014. The same methodology was used to derive the AADT flows as discussed above.

The ATC installed by ARUP also provided 24 hour vehicle speed data, which was applied to the model to reflect the diurnal variation in vehicle speeds. It was assumed that the traffic speeds recorded during the ARUP survey periods were representative of the whole year.

6.5 Do Minimum Scenario (DMS)

As part of the second package of the ORTMCS project, Atkins was commissioned to model traffic flows for the DMS using predictions generated by micro-simulation.

The DMS includes all changes implemented or planned on site since BYS model was developed as described in Appendix E Table 12.

From the traffic modelling Atkins provided AADT data and HGV proportions, and speed data for the AM peak (7:00 to 10:00), PM peak (16:00 to 19:00) and inter-peak periods. These data were used in the air quality impact assessment to predict NO_2 concentrations and air quality impacts associated with the proposed scenarios.

The traffic data used in the detailed dispersion modelling are summarised in Appendix D, Table 12. It should be noted that the speed data presented in Table 12 represent daily average speed For modelling purposes the diurnal speed variation function was used to simulate changes in vehicle speeds throughout the day.

6.6 Receptors

Air quality receptors susceptible to changes in air quality typically include residential properties, schools, care homes, hospitals and designated ecological sites.

A total of 89 sensitive receptors were selected across the study areas covered by the five route corridors. Annual mean NO_2 concentrations at these receptor locations were predicted for each of the traffic management scenarios to assess the potential air quality impacts associated with those scenarios:

- ✓ Corridor 1: 19 receptors.
- ✓ Corridor 2: 10 receptors.
- ✓ Corridor 3: 35 receptors.
- ✓ Corridor 4: 9 receptors.
- ✓ Corridor 5: 16 receptors.

The receptors were chosen to represent worst-case locations where the largest air quality impacts associated with each scenario might be anticipated, based on the projected changes in traffic flow and proximity to the road. The locations of all the modelled receptors are illustrated in Appendix E, Figure 8.

In addition to the discrete receptor locations, NO_2 concentrations were predicted over Cartesian grids of 10 metre resolution, covering each of the model study areas. The Cartesian grids were used to create contour plots of NO_2 concentrations to indicate the potential wider impacts of each traffic management scenario on local air quality. Concentrations were predicted at a height of 1.5 m to represent typical human exposure.

6.7 Meteorological Data

The meteorological dataset used in the assessment was derived from Thorney Island meteorological station for 2013. This meteorological station is located approximately 12 km away from Portsmouth and considered to be most representative of the meteorological conditions in Portsmouth.

The wind rose for this site and further details of the preparation of meteorological data for use in dispersion modelling are provided in Figure 12 in Appendix F.

6.8 Model Verification

For any air quality assessment it is necessary to consider and account for errors in the modelling process. Systematic errors in modelling results can arise from many factors, such as uncertainties in vehicle flows, speeds and the composition of the vehicle fleet. Such errors can be addressed and corrected for by making comparisons with monitoring data. The modelling results presented in this report were verified by comparing model predictions against monitored pollutant concentrations in the study areas and adjusting model predictions where necessary.

The accuracy of the future year modelling results is relative to the accuracy of the base year results, therefore greater confidence can be placed in the future year concentrations if good agreement is found for the base year.

PCC undertakes NO_2 monitoring using passive diffusion tubes and continuous monitors across the city. Twenty one of these sites were located within the study area and suitable for model verification purposes. Comparison of the modelled and monitored 2013 concentrations using the methodology defined in LAQM.TG(09) determined that an adjustment factor of 1.43 should be applied to the model outputs. Further details of the verification procedure are provided in Appendix G; the monitoring site locations are indicated in Figure 12 in Appendix H.

6.9 Baseline

6.9.1 Local Air Quality Management

In 2005, PCC designated 13 AQMAs across the city, in response to the findings of the 2004 Detailed Assessment. In 2010, PCC revoked 8 of these AQMAs, retaining AQMAs 6, 7, 9 and 12, and re-designating AQMA 11.

Descriptions of the five remaining AQMAs are given below, and all are designated for exceedances of the annual mean NO_2 objective:

- ✓ AQMA 6: Extending north from along Fratton Road from Fratton Bridge into Kingston Road, continuing into London Road until the roundabout junction with Stubbington Road and Gladys Avenue.
- ✓ AQMA 7: Focusing on Hampshire Terrace and St Michaels Road Gyratory.
- ✓ AQMA 9: Focusing on the southernmost section of Eastern Road from Sword Sands Road south into Velder Avenue and it’s junction with Milton Road.
- ✓ AQMA 11: The redesigned AQMA extends from Rudmore Roundabout south to Church Street Roundabout.
- ✓ AQMA 12: Encompassing the greater part of Queen Street from The Hard to St James’s Road. This area is retained as there is a lack of enough historical monitoring data to justify the revocation at this stage.

6.9.2 Pollutant Monitoring

PCC monitors NO_2 using both continuous monitors and passive diffusion tubes.

6.9.2.1 Continuous Monitoring

PCC operates three continuous monitors across the city; London Road, Burrfield and Mile End Road, all of which are located in roadside locations and within the declared

AQMAs. A map showing the locations of the monitoring stations is provided in Figure 12 in Appendix H.

The results of recent years' continuous monitoring are presented in Appendix E, Table 3. Generally, annual mean NO_2 concentrations have decreased between 2010/11 and 2013 or remained stable. In 2013, all monitoring sites recorded annual mean NO_2 concentrations below the objective.

6.9.2.2 Diffusion Tube Monitoring

PCC undertakes monitoring of NO_2 concentrations using passive diffusion tubes at 22 locations across Portsmouth. The locations of these sites are illustrated in Figure 12 in Appendix H and recent years' results are shown in Appendix E Table 4. Generally, concentrations have decreased or remained stable between 2010 and 2013. In 2010, nine sites exceeded the national objective compared to three in 2013. The three sites to exceed the annual mean NO_2 objective in 2013 are located on Fratton Road (AQMA 6), London Road (AQMA 6) and Lord Montgomery Way (AQMA 7).

6.9.3 Background Concentrations

A large number of sources of air pollutants exist which individually may not be significant, but collectively, over a large area, need to be considered. The concentrations calculated by the model due to vehicle emissions can then be added to these background concentrations to give the total concentration.

6.9.3.1 Monitored Background Concentrations

As part of the diffusion tube network operated by PCC, three monitoring sites are situated in background locations (2, 8 and 10). In addition, a background monitoring site operated by Defra as part of the Automatic Urban Rural Network (AURN) is located at Gatcombe Park, Portsmouth. These sites were considered for their use to provide background NO_2 concentrations for use in the air quality assessment.

The use of Gatcombe Park AURN site was excluded due to the slightly low data capture at this site in 2013 (84%). Similarly, the use of Hawthorn Crescent diffusion tube site was ruled out as the site is located in close proximity to a busy section of the A27 and may therefore be influenced by road traffic emissions, and as such cannot be considered a background site (Appendix E, Table 6).

6.9.3.2 Modelled Background Concentrations

Modelled estimations of background air quality concentrations are provided by Defra[8] for each 1 km grid square in the UK for each year between 2010 and 2030. Road sources were discounted from the total background pollutant concentrations to avoid double-counting, to give 'adjusted' values. Average background NO_X and NO_2 concentrations for the grid squares that cover the whole of Portsmouth are presented in Appendix E, Table 6 for 2013 and 2015.

6.9.3.3 Summary

While it is preferential to use actual monitored rather than modelled background concentrations in modelling, it was concluded that the results of monitoring at local background sites were unsuitable for use in the modelling due. It was considered more appropriate to use the Defra modelled air pollution background concentrations due to the scales of the modelled areas and the small number of background monitoring locations from which to determine suitable monitored background concentrations. .

It should be noted that for sensitive receptor modelling the background concentrations used are taken from the 1 km square within which the modelled receptor is located. For the Cartesian grid modelling (for the production of contour plots) the background concentrations used represent an average of all the grid squares covering the model domain.

Further details of the background concentrations used in the DA are included in Appendix I.

[8] Defra (2014). Air Pollution Background Concentration Maps. http://uk-air.defra.gov.uk/data/laqm-background-home

6.10 Results

6.10.1 Introduction

Annual mean NO_2 concentrations have been predicted for the following scenarios:

- ✓ 2013 Base Year (BYS).
- ✓ 2013 Do-Minimum (DMS).
- ✓ 2015 Do-Minimum (DMS).
- ✓ 2015 Do nothing (Corridor 4 only).

The assessment results are presented and discussed by route corridor. All predicted NO_2 concentrations have been carried out using background concentrations and emission factors for both 2013 and 2015. The use of 2013 background concentrations and emission factors serves as a sensitivity test, providing a worst-case assessment that effectively assumes no improvement in vehicle emissions or reductions in background pollution between the base year and implementation year.

The air quality impacts of each future scenario is assessed by comparisons with either the BYS 2013 or DMS(2013), except for Corridor 4 where there is no DMS. In this case impacts are quantified by comparison to the BYS.

6.11 Corridor 1

Corridor 1 encompasses Junctions 1 to 6 (Appendix E, Figure 8).

6.11.1.1 Predicted Concentrations for 2013

- ✓ The predicted annual mean NO_2 concentrations for the 19 sensitive receptors located in Corridor 1 in 2013 are presented in Appendix E Table 7.
- ✓ Model outputs for the 2013 BYS is clearly illustrated in contour maps for junctions in Appendix E, from Figure 8 to Figure 8.
- ✓ Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2013 at all modelled receptors in all modelled scenarios. Hence, all receptors in Corridor 1 are also predicted to achieve the annual mean NO_2 objective in the BYSc1, and DMSc1(2013).
- ✓ The predicted changes in concentrations for many of the modelled receptors between the BYSc1 and the DMSc1 reflect the effects of traffic management interventions implemented to date.

- ✓ At receptors 12, 13 and 66, NO_2 concentrations are predicted to decrease between the BYSc1 and DMSc1 by up to 0.9 μg/m^3; at all other receptors, increases in NO_2 concentrations of up to 1.2 μg/m^3 are predicted between the BYSc1 and DMSc1.
- ✓ The maximum predicted annual mean NO_2 concentrations in all modelled scenarios is 39.1 μg/m^3 and occur at Receptor 15. The highest annual mean NO_2 concentration occurring in BYSc1 is 38.4 μg/m^3 at Receptor 15.
- ✓ Between the BYSc1 and the DMSc1(2013), annual mean NO_2 concentrations are predicted to increase by up to 1.2 μg/m^3 at Receptor 18; smaller increases in concentration between the BYSc1 and DMSc1(2013) are predicted at fifteen other modelled locations. At the remaining receptors concentrations are predicted to be unchanged or decrease slightly

6.11.1.2 Predicted Concentrations in 2015

- ✓ The predicted annual mean NO_2 concentrations for the 19 sensitive receptors located in Corridor 1 in 2015 are presented in Appendix E Table 7.
- ✓ Model outputs for the 2015 DMS is clearly illustrated in contour maps for junctions in Appendix E, from Figure 8 to Figure 8
- ✓ Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2015 at all modelled receptor locations. Hence, all receptors in Corridor 1 are also predicted to achieve the annual mean NO_2 objective in DMSc1(2015).
- ✓ The highest annual mean NO_2 concentration is 37.8 μg/m^3 occurring at Receptor 15.
- ✓ Decrease in annual mean NO_2 concentrations in the DMSc1 are predicted at all Receptors as anticipated.

6.12 Corridor 2

Corridor 2 encompasses Junctions 7 to 13 (Appendix E, Figure 8), and is oriented north-south running through central Portsmouth.

6.12.1 Predicted Concentrations in 2013

- ✓ The predicted annual mean NO_2 concentrations for the ten sensitive receptors located in Corridor 2 in 2013 are presented in Appendix E Table 7.
- ✓ Model outputs for the 2013 BYS is clearly illustrated in contour maps for junctions in Appendix E, from Figure 8 to Figure 8.
- ✓ Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2013 at all modelled receptors in all modelled scenarios. Hence, all receptors

in Corridor 2 are also predicted to achieve the annual mean NO_2 objective in the BYSc2, and DMSc2(2013).

- ✓ The predicted changes in concentrations for many of the modelled receptors between the BYSc2 and the DMSc2 reflect the effects of traffic management interventions implemented to date.
- ✓ The maximum predicted annual mean NO_2 concentrations in all modelled scenarios is 37.0 $\mu g/m^3$ and occur at Receptor 84. The highest annual mean NO_2 concentration occurring in BYSc2 is 36.7 $\mu g/m^3$ and also occurring at Receptor 84.
- ✓ Between the BYSc2 and the DMSc2(2013), annual mean NO_2 concentrations are predicted to increase by up to 2.4 $\mu g/m^3$ at Receptor 83; smaller increases in concentration between the BYSc2 and DMSc2(2013) are predicted at five other modelled locations. At the remaining receptors concentrations are predicted to be unchanged or decrease slightly.

6.12.2 Predicted Concentrations in 2015

- ✓ The predicted annual mean NO_2 concentrations for the 10 sensitive receptors located in Corridor 2 in 2013 are presented in Appendix E Table 7.
- ✓ Model outputs for the 2015 DMS is clearly illustrated in contour maps for junctions in Appendix E, from Figure 8 to Figure 8
- ✓ Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2015 at all modelled receptor locations. Hence, all receptors in Corridor 2 are also predicted to achieve the annual mean NO_2 objective in DMSc2(2015).
- ✓ The highest annual mean NO_2 concentration is 35.7 $\mu g/m^3$ occurring at Receptor 84.
- ✓ Decrease in annual mean NO_2 concentrations in the DMSc2 are predicted at all Receptors as anticipated.

6.13 Corridor 3

Corridor 3 encompasses Junctions 14 to 19, and runs north-south in the east of Portsmouth(Appendix E, Figure 8).

6.13.1 Predicted Concentrations in 2013

- ✓ The predicted annual mean NO_2 concentrations for the modelled sensitive receptors located in Corridor 3 in 2013 are presented in Appendix E

- ✓ Table 10.
- ✓ Model outputs for the 2013 BYS is clearly illustrated in contour maps for junctions in Appendix E, from Figure 8 to Figure 8.
- ✓ Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2013 at all modelled receptors in all modelled scenarios. Hence, all receptors in Corridor 3 are also predicted to achieve the annual mean NO_2 objective in the BYSc3, and DMSc3(2013).
- ✓ The predicted changes in concentrations for many of the modelled receptors between the BYSc3 and the DMSc3 reflect the effects of traffic management interventions implemented to date.
- ✓ The maximum predicted annual mean NO_2 concentrations in all modelled scenarios is 35.5 µg/m^3 and occur at Receptor 72. The highest annual mean NO_2 concentration occurring in BYSc3 is also 35.5 µg/m^3 and occurring at Receptor 72.
- ✓ Between the BYSc3 and the DMSc3(2013), annual mean NO_2 concentrations are predicted to increase by up to 1.2 µg/m^3 at Receptor 74 and 76. It appears that these increases are due to projected increases in traffic flows along this section resulting from traffic management measures already introduced. Smaller increases in concentration between the BYSc2 and DMSc2(2013) are predicted at eight other modelled locations. At the remaining receptors concentrations are predicted to be unchanged or decrease slightly.

6.13.2 Predicted Concentrations in 2015

- ✓ The predicted annual mean NO_2 concentrations for the 35 sensitive receptors located in Corridor 3 in 2015 are presented in Appendix E, Table 10.
- ✓ Model outputs for the 2015 DMS is clearly illustrated in contour maps for junctions in Appendix E, from Figure 8 to Figure 8
- ✓ Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2015 at all modelled receptor locations. Hence, all receptors in Corridor 3 are also predicted to achieve the annual mean NO_2 objective in DMSc3(2015).
- ✓ The highest annual mean NO_2 concentration is 33 µg/m^3 occurring at Receptor 72.
- ✓ Decrease in annual mean NO_2 concentrations in the DMSc3 are predicted at all receptors as anticipated.

6.14 Corridor 4

Corridor 4 encompasses Junctions 20 and 21, located to the north of Portsmouth (Appendix E, Figure 8).

6.14.1 Predicted Concentrations in 2013

- ✓ The predicted annual mean NO_2 concentrations for the nine sensitive receptors located in Corridor 4 in 2013 are presented in Appendix E Table 10.
- ✓ Model outputs for the 2013 BYS is clearly illustrated in contour maps for junctions in Appendix E, Figure 8.
- ✓ Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2013 at all modelled receptors in all modelled scenarios. Hence, all receptors in Corridor 4 are also predicted to achieve the annual mean NO_2 objective in the BYSc4.
- ✓ In Corridor 4 no DMSc4(2013) was considered. The maximum predicted annual mean NO_2 concentrations is 34.4 $\mu g/m^3$ at Receptor 71 in the BYSc4, and the maximum predicted concentrations in all other modelled scenarios are also predicted to occur at Receptor 71.

6.14.2 Predicted Concentrations in 2015

- ✓ The predicted annual mean NO_2 concentrations for the nine sensitive receptors located in Corridor 4 in 2015 are presented in Appendix E Table 10
- ✓ Model outputs for the 2015 DMS is clearly illustrated in contour map for junctions in Appendix E, Figure 8.
- ✓ Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2015 at all modelled receptor locations. Hence, all receptors in Corridor 3 are also predicted to achieve the annual mean NO_2 objective in DMSc3(2015).
- ✓ The predicted changes in concentrations for all modelled receptors between the BYSc4 and the DMSc4 do not reflect any the effects of traffic management interventions implemented to date as none was considered.
- ✓ The highest annual mean NO_2 concentration is 33.2 $\mu g/m^3$ occurring at Receptor 71. This is located adjacent to Northern Road, near the roundabout with Wayte Street.
- ✓ Decrease in annual mean NO_2 concentrations in the DMSc4 are predicted at all Receptors as anticipated.
- ✓ Between the BYSc4 and the DMSc4(2015), annual mean NO_2 concentrations are predicted to decrease at all receptor locations. These decreases are anticipated and are due to projected improvement in emissions in automotive industry.

6.15 Corridor 5

Corridor 5 encompasses Junctions 22 to 24, located to the south of Portsmouth (Appendix E, Figure 8).

6.15.1 Predicted Concentrations in 2013

- ✓ The predicted annual mean NO_2 concentrations for the 16 sensitive receptors located in Corridor 5 in 2013 are presented in Appendix E Table 11.
- ✓ Model outputs for the 2013 BYS is clearly illustrated in contour maps for junctions in Appendix E, Figure 8 and Figure 8.
- ✓ Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2013 at all modelled receptors in all modelled scenarios. Hence, all receptors in Corridor 5 are also predicted to achieve the annual mean NO_2 objective in the BYSc5, and DMSc5(2013).
- ✓ The predicted changes in concentrations for many of the modelled receptors between the BYSc5 and the DMSc5 reflect the effects of traffic management interventions implemented to date.
- ✓ The maximum predicted annual mean NO_2 concentrations in all modelled scenarios is 34.2 µg/m^3 and occur at Receptor 55. The highest annual mean NO_2 concentration occurring in DMSc5(2013) is also 34.2 µg/m^3 and occurring at Receptor 55.
- ✓ Between the BYSc5 and the DMSc5(2013), annual mean NO_2 concentrations are predicted to increase by up to 1.9 µg/m^3 at Receptor 55. It appears that these increases are due to projected increases in traffic flows along this section resulting from traffic management measures already introduced. Small to smaller increases in concentration between the BYSc5 and DMSc5(2013) are predicted at thirteen other modelled locations. At the remaining receptors concentrations are predicted to be unchanged or decrease slightly.

6.15.2 Predicted Concentrations in 2015

- ✓ The predicted annual mean NO_2 concentrations predicted for the 16 sensitive receptors located in Corridor 5 in 2015 are presented in Appendix E Table 11.
- ✓ Model outputs for the 2015 DMS is clearly illustrated in contour maps for junctions in Appendix E, Figure 8 and Figure 8
- ✓ Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2015 at all modelled receptor locations. Hence, all receptors in Corridor 5 are also predicted to achieve the annual mean NO_2 objective in DMSc5(2015).
- ✓ The highest annual mean NO_2 concentration is 34.2 µg/m^3 occurring at Receptor 55.

- ✓ Decrease in annual mean NO_2 concentrations in the DMSc5 are predicted at all Receptors as anticipated.

7 Conclusions

Annual mean NO_2 concentrations have been predicted for each of the sensitive receptor locations within each of the five individual route corridors for the BYS, DMSs(2013), and DMSs(2015) using the AAQuIRE regional dispersion model and the potential impacts associated with each of the Do-Minimum scenarios were assessed.

The results are summarised as follows:

- ✓ There are no predicted exceedences of the annual mean NO_2 objective at any modelled receptor location in any of the five route corridors in the BYS, DMSs(2013) and DMSs(2015). .
- ✓ The maximum predicted annual mean NO_2 concentration in the DMSs(2013) is 39.1 $\mu g/m^3$ at Receptor 15.
- ✓ The maximum predicted annual mean NO_2 concentrations in the DMSs(2013) by route corridor are:
    - Corridor 1: 39.1 $\mu g/m^3$ at Receptor 15.
    - Corridor 2: 37.0 $\mu g/m^3$ at Receptor 84.
    - Corridor 3: 35.0 $\mu g/m^3$ at Receptor 72.
    - Corridor 4: 34.4 $\mu g/m^3$ at Receptor 71 (BYS result as there is no DMS for Corridor 4).
    - Corridor 5: 34.2 $\mu g/m^3$ at Receptor 55.
- ✓ The maximum predicted annual mean NO_2 concentration in the DMSs(2015) is 37.8 $\mu g/m^3$ at Receptor 15.
- ✓ The maximum predicted annual mean NO_2 concentrations in the DMSs(2015) by route corridor are:
    - Corridor 1: 37.8 $\mu g/m^3$ at Receptor 15.
    - Corridor 2: 35.7 $\mu g/m^3$ at Receptor 84.
    - Corridor 3: 33.0 $\mu g/m^3$ at Receptor 72.
    - Corridor 4: 33.2 $\mu g/m^3$ at Receptor 71 (Projected base year result).
    - Corridor 5: 34.2 $\mu g/m^3$ at Receptor 55.

The results of the DA indicate that the annual mean NO_2 objective will not be exceeded at any modelled sensitive receptor location in 2013 or 2015 should additional traffic management measures not be implemented. However, the predicted annual mean NO_2 concentrations, particularly for the DMSs(2013), are close to the annual mean objective at several modelled receptor locations.

Due to inherent uncertainties within the dispersion modelling process, where predicted concentrations are within 10% of the annual mean objective it is possible that exceedence of the objective may occur. At Receptors 15 (39.1 μg/m^3), 16 (37.1 μg/m^3), 67 (38.5 μg/m^3), 84 (37.0 μg/m^3), 85 (37.4 μg/m^3) and 87 (37.2 μg/m^3) annual mean NO_2 concentrations are predicted to be within 10% of the annual mean objective.

Any possible future revocation of an Air Quality Management Area should consider both the predictions made throughout the corridors via the contour maps and local monitoring.

8 Appendices

Appendix A: Tables

Table 1: Junctions included in each of the Corridor Models

Corridor	Junctions
1	- Junction 1: M27 Flyover and roundabout with the A3, A2017 (Kingston Crescent) and Wharf Road. - Junction 2: Mile End Road and Prospect Road. - Junction 3: Roundabout with Commercial Road, Hope Street, Church Street and Mile End Road. - Junction 4: Roundabout with Lake Road, Commercial Road and Marketway. - Junction 5: Cambridge Road, Hampshire Terrace, A2030 and Anglesea Road. - Junction 6: Alfred Road, Queen Street and Anglesea Road.
2	- Junction 7: Winston Churchill Avenue, Victoria Road North and Holbrook Road. - Junction 8: Victoria Road North, Fratton Road, Fawcett Road. - Junction 9: Fratton Road and Arundel Street. - Junction 10: Fratton Road and St Mary's Road. - Junction 11: Fratton Road and Lake Road. - Junction 12; Kingston Road and New Road. - Junction 13: London Road and Chichester Road.
3	- Junction 14: London Road, Old London Road, Copnor Road. - Junction 15: Copnor Road and Stubbington Avenue. - Junction 16: Baffins Road, St Mary's Road, Langston Road and Milton Road. - Junction 17: Milton Road, Velder Avenue, Rodney Road and Alverstone Road. - Junction 18: Milton Road, Goldsmith Road and Eastney Road. - Junction 19: Northern Parade and London Road.
4	- Junction 20: Southampton Road, Northern Road and Spur Road. - Junction 21: Northern Road, Medina Road and Wayte Street.
5	- Junction 22: Elm Grove, Grove Road south and Grove Road north. - Junction 23: Elm Grove, Victoria Road North, Albert Road and Outram Road. - Junction 24: Albert Road, Waverley Road and Lawrence Road.

Table 2: Implemented Road Traffic Management Improvement Measures to Date

Corridor	AQMAs	Identified and Implemented Traffic Improvement
Corridor 1	- 5 and 11	- Signalised improvements at the Rudmore Roundabout; - Mile End Road/ Church Street Roundabout/Marketway Roundabout improvements, including the extension of the bus lane southbound to Marketway; and - St Michael's Gyratory improvements, including the signalisation of the Anglesea Road approach with pedestrian facilities and Cambridge Road triple crossing to run in isolation.

Corridor 2	- 6	- Modifications made to the following junctions:
		  - Kingston Road/New Road;
		  - Fratton Road/Arundel Street: Fratton Road including moving the northbound stop line; and
		  - Kingston Road/Kingston Crescent: updated with revised staging to allow staggered pedestrian crossing over Kingston Crescent and allowing south-bound right turn filter phase.

Corridor 3	- 3 and 9	- Modifications were made to the following junctions:
		  - London Road/Northern Parade junction: signalisation (includes prohibiting southbound U-turn movement);
		  - A288/Goldsmith Avenue junction: installation of MOVA and geometric improvements includes reconfiguring the northbound approach to provide one through lane and one left turn lane, along with provision of signalised pedestrian crossings.
		  - A288 / Velder Avenue junction: installation of MOVA.
		  - A288 / St. Mary's Hospital Entrance junction: installation of MOVA.
		  - A288 / Stubbington Avenue / Burrfields Road junction: optimisation of signal timings and the stage sequence. Revised stage sequence introducing a break in the flow of traffic into the southbound receiving lane of Copnor Road to prevent the queueing traffic back into the junction.

Corridor	AQMAs	Identified and Implemented Traffic Improvement
Corridor 4	- 13	- None
Corridor 5	- 5	- Removal of stage 3 from the Victoria Road / Outram Road / Elm Grove junction (Phase B becomes gap seeking) - The additional carriageway has been assigned to a cycle lane

Table 3: Continuous Monitoring of NO_2, 2010 – 2013

Location		Type	Within AQMA?	Annual Mean NO_2 (µg/m^3)			
				2010	2011	2012	2013
R1	London Road	Roadside	Yes	**52.1**	**46.0**	**43.9**	39.7
R4	Burrfield Road	Roadside	Yes	38.4	31.5	36.1	33.5
R5	Mile End Road	Roadside	Yes	-	35.0	36.9	35.9

NB exceedances of the objective are emboldened.

Table 4: NO_2 Diffusion Tube Monitoring, 2010 – 2013

Location		Type	Within AQMA?	Annual Mean NO_2 (µg/m^3)			
				2010	2011	2012	2013
1	Lord Montgomery Way	Roadside	Yes	**49.3**	39.5	**42.5**	**41.3**
3	High Street	Roadside	Yes	32.9	26.2	26.6	22.1
4	Queen Street	Roadside	Yes	37.8	32.9	36.3	30.4
5	119 Whale Island Way	Roadside	Yes	33.9	28.9	28.6	27.5
6	88 Stanley Road	Roadside	Yes	35.9	34.8	35.6	38.6
7	138 Lower Derby	Roadside	Yes	29.4	27.2	29.8	30.0
9	6 Northern Road	Roadside	Yes	**41.0**	36.1	35.1	32.0
11	Anchorage Road	Roadside	Yes	29.4	32.7	31.8	29.5
14	4 Merlyn Drive	Roadside	Yes	26.8	21.7	22.7	21.6
15	29 Milton Road	Roadside	Yes	34.6	28.5	28.8	28.2
16	Parade Court, London Road	Roadside	Yes	35.2	35.0	36.4	34.1
18	4 Milton Road	Roadside	Yes	32.0	27.8	29.5	27.8
19	7 Velder Avenue	Roadside	Yes	**43.2**	**44.7**	34.5	30.7
20	136 Eastney Rd	Roadside	Yes	34.2	28.7	26.1	27.4
21	116 Albert Road	Roadside	Yes	**43.4**	38.6	35.8	34.0
22	2 Victoria Road North	Roadside	Yes	34.6	29.0	31.6	28.7
23	106 Victoria Road North	Roadside	Yes	**43.4**	35.8	**41.1**	32.2
24	221 Fratton Road	Roadside	Yes	**44.8**	38.3	39.1	**42.5**
25	117 Kingston Road	Roadside	Yes	**45.2**	**41.4**	**44.6**	38.7
26	The Tap London Road	Roadside	Yes	**56.6**	**48.8**	**50.5**	**51.7**
30	Market Tavern (Mile End Rd)	Roadside	Yes	**43.7**	**43.2**	38.0	37.7
32	Larch Court, Church Rd	Roadside	Yes	36.5	33.6	36.0	31.1

NB exceedances of the objective are emboldened.

Table 5: Background Monitoring Sites

Location		Monitoring Type	Within AQMA?	Annual Mean NO_2 (µg/m^3)			
				2010	2011	2012	2013
C4	Gatcombe Park AURN	CM	No	21.9	19.0	21.2	20.3
2	12 Chadderton Gardens	DT	No	23.3	17.4	17.5	16.5
8	492 Hawthorn Crescent	DT	No	30.0	28.6	28.8	27.2
10	20 Stroudley Avenue	DT	No	21.5	18.5	17.9	17.7

Table 6: Forecast Annual Mean Background Pollutant Concentrations (µg/m^3)

Pollutant	2013		2015	
	Total	Adjusted	Total	Adjusted
NO_x	36.9	31.0	33.0	29.0
NO_2	25.4	21.9	23.1	20.6

Table 7: Corridor 1, Annual Mean NO_2 Concentrations

Receptor ID	BYSc1-2013	DMSc1-2013	DMSc1-2015	DMc1-2013/BYSc1-2013 Impact	DMc1-2015/DMSc1-2013 Impact
12	35.3	34.4	33.6	-0.9	-0.8
13	34.9	34.5	33.6	-0.4	-0.9
15	38.4	39.1	37.8	0.7	-1.3
16	36.2	37.1	35.9	0.9	-1.2
17	32.6	32.9	31.8	0.3	-1.1
18	29.2	30.4	29.1	1.2	-1.3
19	27.5	28.4	27.5	0.9	-0.9
62	32.0	32.7	31.6	0.7	-1.1
63	33.1	33.1	32.0	0.0	-1.1
64	33.6	33.9	32.7	0.3	-1.2
65	31.3	32.1	31.0	0.8	-1.1
66	35.3	34.5	33.7	-0.8	-0.8
67	38.0	38.5	36.2	0.5	-2.3
68	31.1	31.3	30.4	0.2	-0.9
69	32.4	32.5	31.6	0.1	-0.9
70	29.2	29.4	28.6	0.2	-0.8
85	36.8	37.4	36.1	0.6	-1.3
86	33.7	34.0	32.7	0.3	-1.3
87	36.4	37.2	35.9	0.8	-1.3

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 µg/m^3 and less than +0.1 µg/m^3 are reported as 0.0.

Table 8: Corridor 2, Annual Mean NO_2 Concentrations

Receptor ID	BYSc2	DMSc2-2013	DS1Sc2-2015	DMc2-2013/BYSc2 Impact	DMc2-2015/DMSc2-2013 Impact
6	30.4	32.0	31.1	1.6	-0.9
7	27.6	28.8	28.0	1.2	-0.8
8	33.9	34.2	33.1	0.3	-1.1
9	32.4	32.3	31.5	-0.1	-0.8
10	31.4	30.8	30.0	-0.6	-0.8

11	27.9	27.9	27.2	0	-0.7
82	33.1	33.3	32.3	0.2	-1
83	30.7	33.1	32.2	2.4	-0.9
84	36.7	37.0	35.7	0.3	-1.3
89	30.9	30.9	29.9	0	-1

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 $\mu g/m^3$ and less than +0.1 $\mu g/m^3$ are reported as 0.0.

Table 9: Corridor 3, Annual Mean NO_2 Concentrations

Receptor ID	BYSc3	DMSc3-2013	DMSc3-2015	DMc3-2013/BYSc3 Impact	DMc1-2015/DMSc3-2013 Impact
1	29.1	29.0	28.2	-0.1	-0.8
2	31.8	31.5	30.4	-0.3	-1.1
3	31.9	31.2	29.9	-0.7	-1.3
4	29.8	29.4	28.5	-0.4	-0.9
5	30.1	29.9	28.9	-0.2	-1
20	28.1	27.8	27.2	-0.3	-0.6
21	28.4	27.8	27.0	-0.6	-0.8
22	26.8	26.5	25.7	-0.3	-0.8
23	30.7	29.6	28.6	-1.1	-1
32	30.7	29.7	28.8	-1	-0.9
33	27.8	27.8	26.9	0	-0.9
34	28.3	28.5	27.6	0.2	-0.9
35	28.3	28.4	27.7	0.1	-0.7
36	30.3	30.4	29.7	0.1	-0.7
37	28.4	29.0	28.2	0.6	-0.8
38	26.9	27.4	26.6	0.5	-0.8
39	28.1	28.2	27.2	0.1	-1
40	23.8	23.6	22.9	-0.2	-0.7
41	26.5	26.8	26.0	0.3	-0.8
42	31.6	30.6	29.6	-1	-1
43	30.3	29.3	28.4	-1	-0.9
44	25.1	24.0	23.4	-1.1	-0.6
45	25.8	25.2	24.3	-0.6	-0.9
46	23.2	22.4	21.8	-0.8	-0.6
47	25.7	25.0	24.3	-0.7	-0.7
60	25.8	25.3	24.7	-0.5	-0.6
61	30.5	29.4	28.5	-1.1	-0.9
72	35.5	35.0	33.0	-0.5	-2
73	35.3	34.9	32.9	-0.4	-2
74	25.8	27.0	25.9	1.2	-1.1
75	31.3	30.8	29.6	-0.5	-1.2
76	25.5	26.6	25.5	1.1	-1.1
77	30.0	29.0	28.1	-1	-0.9
78	25.9	25.1	24.3	-0.8	-0.8
88	32.3	32.5	31.3	0.2	-1.2

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 μg/m^3 and less than +0.1 μg/m^3 are reported as 0.0.

Table 10: Corridor 4, Annual Mean NO_2 Concentrations

Receptor ID			
	BYSc4-2013	DMSc4-2015	DMc4-2015/BYSc4-2013 Impact
24	34.2	33.0	-1.2
25	31.8	30.6	-1.2
26	29.2	28.4	-0.8
27	32.0	30.8	-1.2
28	27.0	26.3	-0.7
29	28.3	27.6	-0.7
30	25.2	24.7	-0.5
31	26.2	25.4	-0.8
71	34.4	33.2	-1.2

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 μg/m^3 and less than +0.1 μg/m^3 are reported as 0.0. * There is no DM scenario for Corridor 4; impacts are calculated by comparison to the base year scenario. Results for DMS are based on base year traffic data modelled with 2015 emission rates and background concentrations.

Table 11: Corridor 5, Annual Mean NO_2 Concentrations

Receptor ID					
	BYSc5-2013	DMSc5-2013	DMSc5-2015	DMc5-2013/BYSc5-2013 Impact	DMc5-2015/DMSc5-2013 Impact
14	28.0	28.2	28.1	0.2	-0.1
48	22.6	23.2	23.1	0.6	-0.1
49	25.3	26.1	26.1	0.8	0
50	23.0	23.7	23.7	0.7	0
51	26.5	28.0	27.9	1.5	-0.1
52	24.1	24.4	24.3	0.3	-0.1
53	22.6	23.5	23.5	0.9	0
54	26.0	26.6	26.6	0.6	0
55	32.3	34.2	34.2	1.9	0
56	30.3	30.9	30.9	0.6	0
57	27.2	27.6	27.6	0.4	0
58	27.0	27.7	27.6	0.7	-0.1
59	28.4	28.7	28.5	0.3	-0.2
79	28.3	29.8	29.8	1.5	0
80	29.9	30.7	30.6	0.8	-0.1
81	31.0	30.9	31.0	-0.1	0.1

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 μg/m^3 and less than +0.1 μg/m^3 are reported as 0.0.

Appendix B: Air Quality Management Areas and Corridors

Figure 1: Junction Locations Across the City

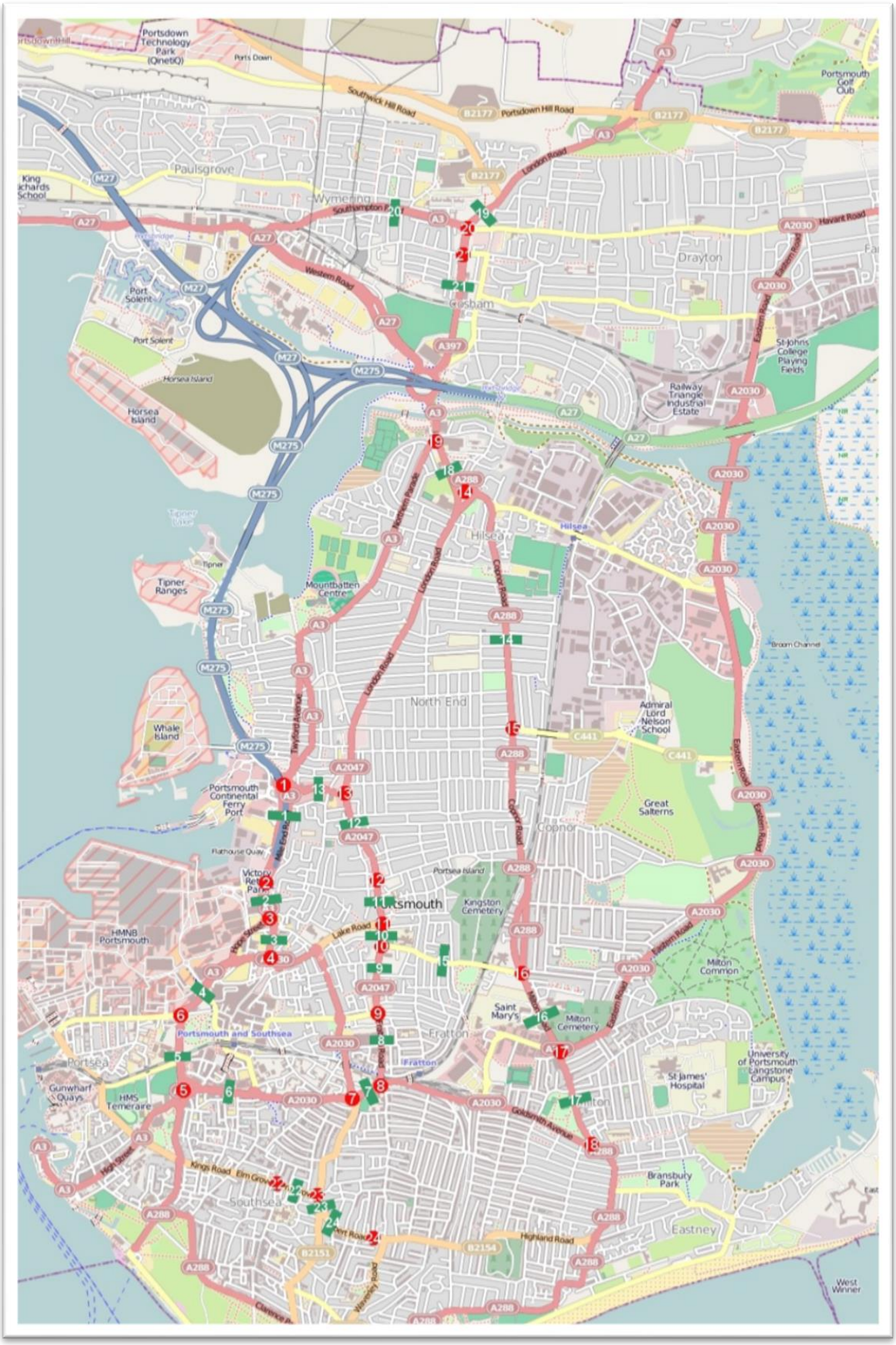


Figure 2: Air Quality Management Areas and Corridors Locations

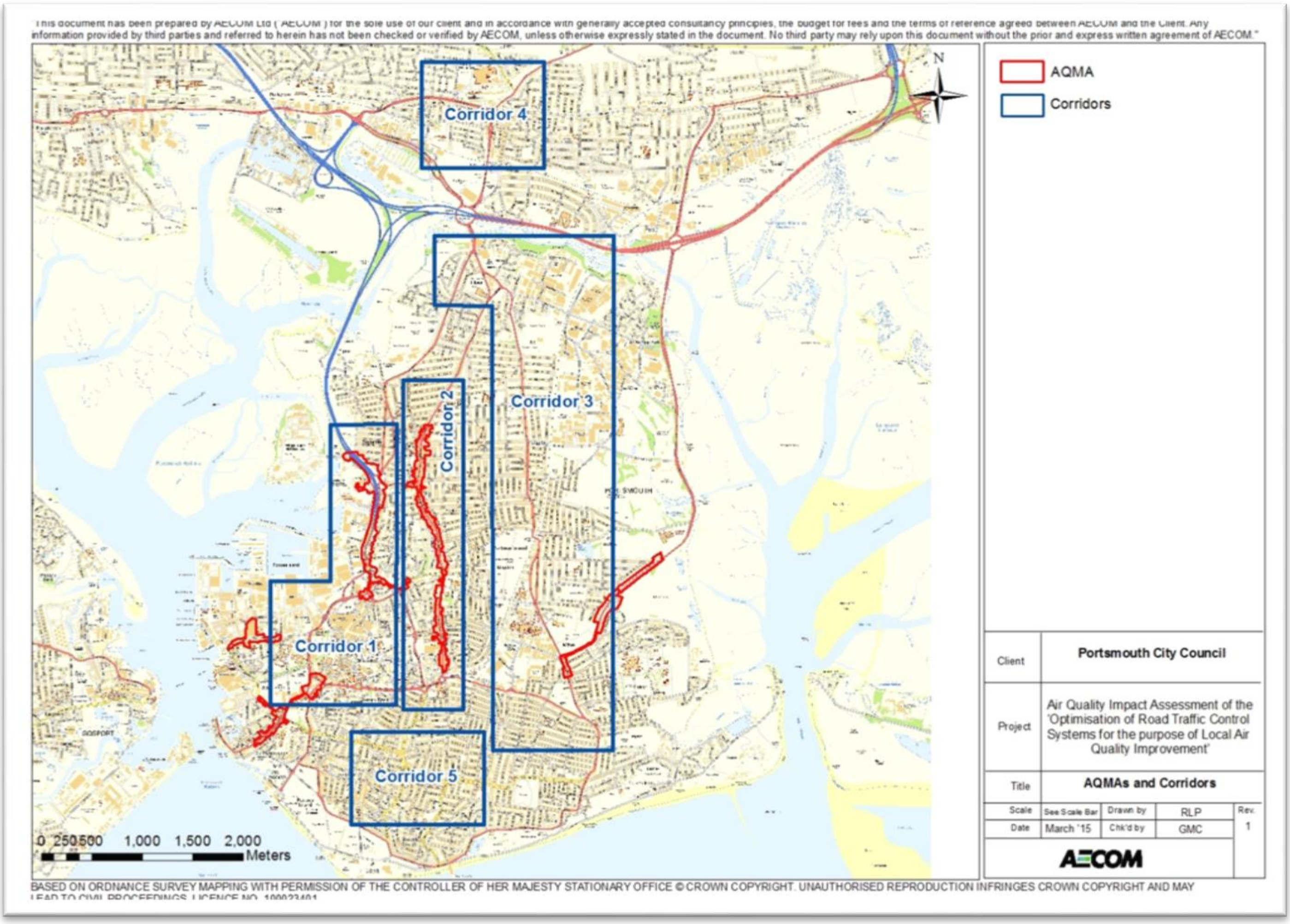


Figure 3: Extent of the Study Area of Corridor 1 (bounded in blue line)

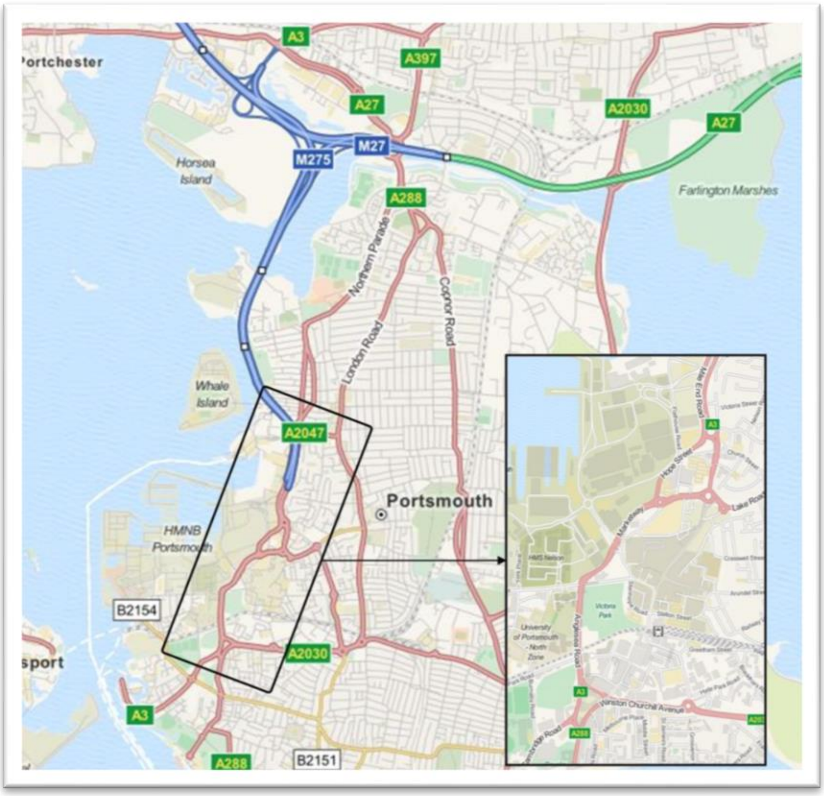


Figure 4: Extent of the Study Area of Corridor 2 (bounded in blue line)

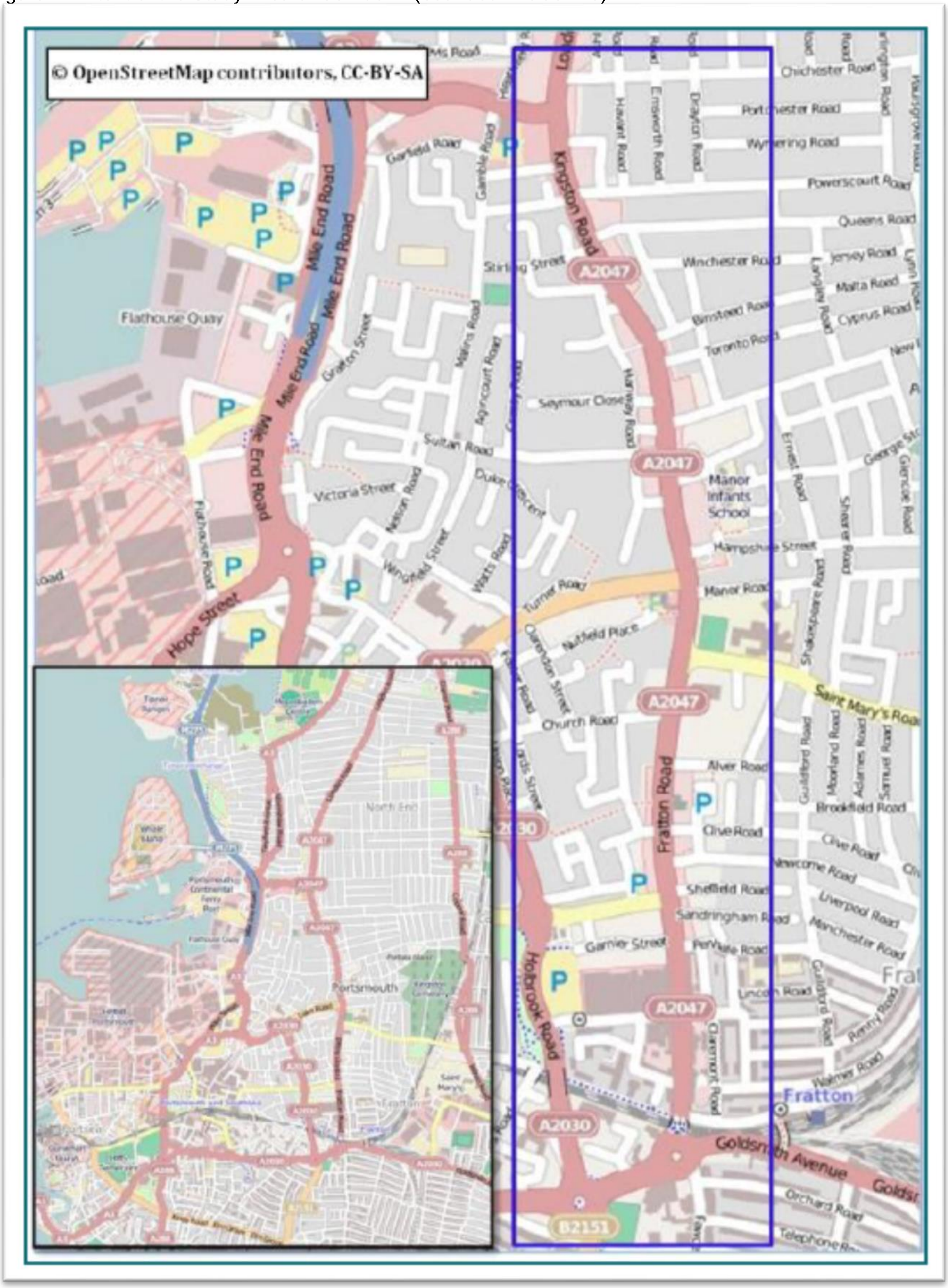


Figure 5: Extent of the Study Area of Corridor 3 (bounded in blue line)

Figure 6: Extent of the Study Area of Corridor 4 (bounded in blue line)

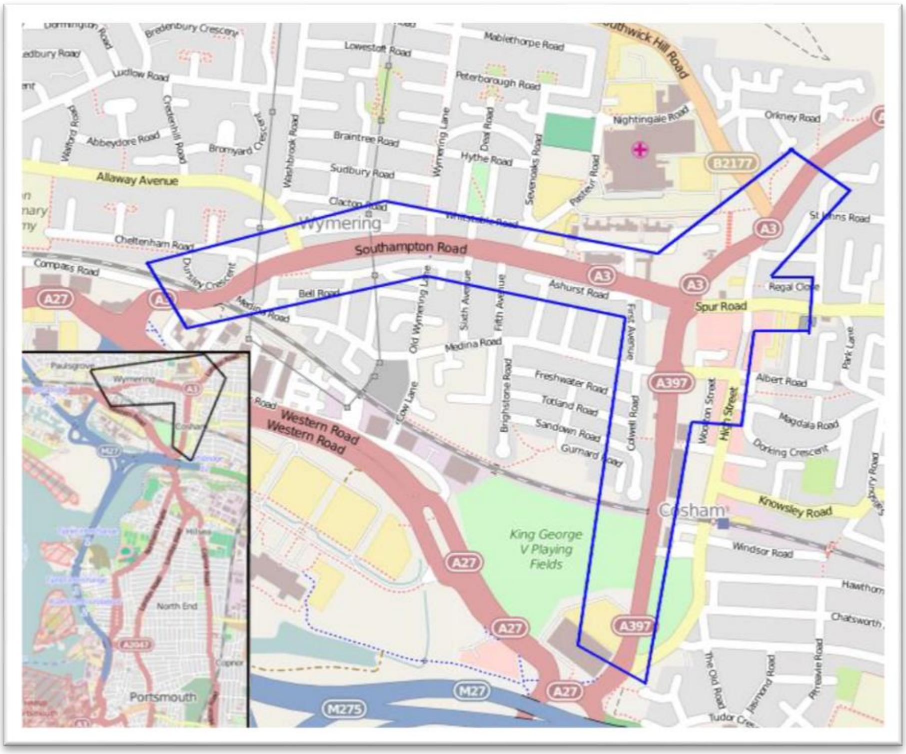
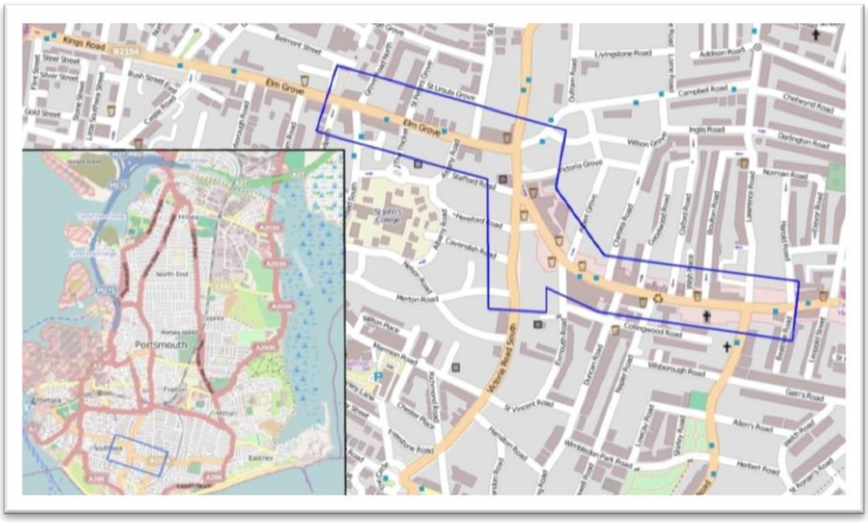


Figure 7: Extent of the study area of Corridor 5 (bounded in blue line



Appendix C: AAQuIRE

The AAQuIRE 6.2 software is a system that predicts Ambient Air Quality in Regional Environments and comprises a regional air quality model and statistical package. The latest version of the Emission Factors Toolkit, released in November 2014, has been incorporated into the AAQuIRE software.

AAQuIRE was developed by AECOM to meet three requirements in predictive air quality studies. The first requirement was an immediate need for a system that produced results that could be interpreted easily by non-air quality specialists to allow for proper informed inclusion of air quality issues in wider fora, the main example being to allow consideration of air quality issues in planning processes. This was achieved by allowing results to be generated over a sufficiently large study area, and at an appropriate resolution, for the issue being considered. The results are also presented in a relevant format, which is normally a statistic directly comparable with an air quality criterion or set of measured data being considered. For example, the AQS PM_{10} 24-hour objective level of 50 µg/m^3 is expressed as a 90th percentile of hourly means. AAQuIRE can also produce results directly comparable with all ambient air quality standards.

The second requirement was for a system to be based, initially, on existing and well-accepted and validated dispersion models. This has two advantages. The primary one is that it avoids the need to prove a new model against the accepted models and therefore enhances acceptability. The second advantage is that when appropriate new models are developed they can be included in AAQuIRE and be compared directly with the existing models, and sets of measured data, using the most appropriate statistics.

The final primary requirement for AAQuIRE was a consideration of quality assurance and control. An important aspect of modelling is proper record keeping ensuring repeatability of results. This is achieved within AAQuIRE by a set of log files, which record all aspects of a study and allow model runs to be easily repeated. The ways in which AAQuIRE and the models currently available within it operate are discussed below.

The first step in operating AAQuIRE is to prepare the input data. The following data are needed for the year and pollutant to be modelled:

- meteorological data expressed as occurrence frequencies for specified combinations of wind speed, direction, stability and boundary layer height;
- road system layout and associated traffic data within and immediately surrounding the study area;
- industrial stack locations and parameters; and
- a grid of model prediction locations (receptors).

The modelling is always carried out to give annual average results from which appropriate shorter period concentrations can be derived.

The second stage is the generation of the model input files required for the study. All the data collated in the first stage can be easily input into AAQuIRE, using the worksheets, drop down boxes and click boxes in the Data Manager section of the software. Data from spreadsheets can be easily pasted into worksheets, so that any complicated procedures required for data manipulation can be achieved before entry into AAQuIRE. Several diurnal and seasonal profiles can be defined for each separate source. The relevant meteorological data can also be specified at this stage.

The third stage is executing the models. The study area will usually be divided up into manageable grids and run separately using the Run Manager in AAQuIRE. The results from the separate files can be combined at a later stage. Pollutant concentrations are determined for each receptor point and each meteorological category and are subsequently combined.

The fourth stage is the statistical processing of the raw dispersion results to produce results in the relevant averaging period. Traffic sources and industrial sources can be combined at this stage provided the same receptor grid has been used for both. Background concentrations should also be incorporated at this stage.

The final stage is presentation of results. The result files from the statistical interpretation are formatted to be used directly by the Surfer package produced by Golden Software Inc. However, the model outputs are more commonly imported into a GIS (e.g. ArcView and Map Info) for display and further data processing.

Appendix D: Traffic Data

Table 12: Road Traffic Data across the Domain Study (Five Corridors)

Link Description	AADT				HGV %				Speed (kph)			
	BY	DM	DS1	DS2	BY	DM	DS1	DS2	BY	DM	DS1	DS2
J1-NSLIPNB	10,917	11,258	11,259	11,260	5.9	7.2	7.2	7.2	40	75	75	75
J1-NSLIPSB	9,759	10,063	10,064	10,064	6.3	3.4	3.4	3.4	39	54	54	54
J1-ETAvNB	8,902	8,738	8,734	8,746	2.3	4.7	4.7	4.7	25	45	45	45
J1-ESRdSB	9,086	9,769	9,769	9,768	1.9	3.8	3.8	3.8	23	36	36	36
J1-EEB	7,884	7,868	7,867	7,863	2.0	4.1	4.0	4.0	25	52	52	52
J1-EWB	8,243	8,715	8,716	8,715	1.5	2.4	2.4	2.4	23	33	33	33
J1-EKC	15,688	16,957	16,957	16,952	2.0	3.4	3.3	3.3	24	42	42	42
J1-EB&T	214	46	46	46	12.8	64.9	64.9	64.9	23	37	37	37
J1-SSLIPSB	8,027	8,424	8,424	8,424	3.3	7.4	7.4	7.4	39	59	59	59
J1-Flyover	53,177	51,538	51,560	51,576	2.6	3.2	3.2	3.2	78	78	78	78
J1-SSLIPNB	8,625	7,880	7,886	7,891	4.5	5.9	6.0	6.0	40	58	58	58
J1-WCFP	8,013	7,910	7,922	7,907	14.8	12.8	12.8	12.8	24	42	42	42
J2-NNB	62,936	61,600	61,624	61,640	4.5	6.5	6.5	6.6	40	75	75	75
J2-SNB	64,094	62,795	62,819	62,836	4.2	10.4	10.4	10.4	39	54	54	54
J2-SSB	8,669	8,875	8,877	8,876	5.2	10.9	10.9	10.9	29	49	49	49
J2-W	36,386	33,850	33,890	33,887	3.1	4.1	4.1	4.1	27	62	62	62
J2-NWB	33,390	31,666	31,706	31,719	2.7	3.6	3.6	3.6	27	51	51	51
J3-NSB	30,876	30,918	30,917	30,924	2.5	4.0	4.0	4.0	26	50	51	49
J3-S	8,786	9,160	9,161	9,167	4.7	5.6	5.6	5.6	26	49	49	49
J3-E	33,764	33,900	33,900	33,904	2.7	3.9	4.0	3.9	26	55	56	57
J3-W	33,024	33,109	33,108	33,115	2.5	4.0	4.0	4.0	26	50	51	49
J3-NNB	30,579	30,587	30,627	30,610	2.8	4.2	4.2	4.2	25	34	35	34
J4-N	12,436	10,532	10,519	10,519	0.7	2.8	2.8	2.8	25	31	31	31
J4-S	16,766	15,967	15,965	15,972	3.1	3.8	3.9	3.8	25	39	39	39
J4-EEB	25,846	24,495	24,526	24,536	2.7	3.6	3.6	3.6	27	51	51	51
J4-EWB	32,455	32,532	32,545	32,543	2.7	4.1	4.1	4.1	25	47	47	47
J4-WEB	31,852	30,587	30,627	30,610	2.7	4.2	4.2	4.2	25	34	35	34
J4-WWB	485	541	546	540	73.9	58.5	58.7	58.7	25	29	29	29
J4-EEB2	6,379	6,056	6,056	6,057	9.6	10.8	10.8	10.8	24	33	34	34
J4-RBT	6,244	6,413	6,455	6,436	5.4	5.2	5.2	5.2	26	29	29	30
J5-NNB	4,580	4,330	4,333	4,335	7.8	11.3	11.4	11.4	22	35	34	34
J5-NSB	22,653	22,354	22,361	22,358	3.9	5.2	5.2	5.2	26	35	36	36
J5-KRRD	12,623	12,469	12,511	12,493	7.5	8.0	7.9	7.9	25	31	31	32
J5-EEB	19,695	19,091	19,107	19,101	4.8	6.9	6.9	6.9	24	35	35	35
J5-EWB	13,038	12,117	11,873	12,119	2.3	2.5	2.1	2.5	23	39	39	39
J5-ESN	10,814	10,520	10,312	10,522	2.0	3.3	2.9	3.3	27	39	39	39
J5-ST P RD	15,213	14,400	14,120	14,403	3.8	4.2	3.7	4.1	27	39	39	38
J5-SNW	4,455	4,091	4,011	4,093	7.3	6.3	5.6	6.4	28	44	44	44
J5-S	5,894	6,019	5,814	6,019	6.7	7.1	6.0	7.1	23	38	38	38
J5-WS	16,651	14,523	14,207	14,518	3.9	4.9	4.3	4.8	25	36	36	36
J5-W	1,833	1,068	1,049	1,068	0.5	0.6	0.5	0.6	25	30	30	30
J5-WN	18,470	16,405	15,939	16,406	3.6	4.6	3.8	4.5	25	36	36	36
J6-SNB	13,454	13,995	13,650	13,992	2.3	3.1	2.6	3.1	25	38	37	37
J6-SSB	17,177	14,062	13,787	14,072	3.7	4.2	3.7	4.2	25	28	28	28
J6-E	11,264	11,157	10,861	11,161	6.9	6.0	5.0	6.0	25	41	41	41
J6-W	19,204	15,886	15,629	15,887	3.8	3.6	3.2	3.6	25	42	42	42
J6-NNB	16,588	15,480	15,480	15,477	2.3	2.9	2.9	2.9	23	22	22	22
J6-NSB	13,351	13,572	13,564	13,574	2.0	3.4	3.4	3.4	27	39	39	39
J7-N	1,434	1,643	1,641	1,641	78.5	66.7	66.7	66.7	25	32	32	32
J7-S	11,197	11,861	11,865	11,875	12.5	12.8	12.8	12.8	27	31	31	31
J7-EEB	21,133	20,034	20,034	20,041	2.4	3.2	3.2	3.2	25	37	37	37

Link Description	AADT				HGV %				Speed (kph)			
	BY	DM	DS1	DS2	BY	DM	DS1	DS2	BY	DM	DS1	DS2
J7-WEB	17,747	17,983	17,988	18,018	2.2	3.4	3.4	3.4	26	37	37	37
J7-WWB	24,329	27,911	28,032	28,052	0.8	1.0	0.9	1.0	25	41	41	41
J7-NSLIP	19,522	19,058	19,142	19,125	1.7	1.6	1.6	1.6	25	43	43	43
J8-N	11,313	13,662	13,761	13,754	2.1	1.5	1.5	1.5	24	39	39	39
J8-E	7,265	7,325	7,353	7,343	4.3	3.2	3.1	3.1	28	44	44	43
J8-WEB	8,327	8,387	8,441	8,440	4.0	2.7	2.6	2.7	23	48	48	48
J8-WWB	1,495	1,720	1,727	1,729	1.6	2.1	2.0	2.1	25	40	40	40
J8-S	21,926	23,484	23,587	23,588	1.2	1.3	1.3	1.3	25	42	42	42
J9-N	18,506	18,344	18,466	18,461	1.7	1.5	1.4	1.4	21	29	29	29
J9-S	22,523	22,040	22,178	22,191	2.5	1.7	1.7	1.7	23	44	44	44
J9-E	11,910	14,477	14,582	14,575	2.1	1.5	1.5	1.5	24	39	39	39
J9W	13,752	11,136	11,221	11,232	2.0	1.6	1.6	1.6	25	39	39	39
J10-N	14,087	14,156	14,229	14,228	1.2	1.3	1.3	1.3	23	32	32	32
J10-S	16,062	15,885	15,994	15,999	2.2	1.6	1.6	1.6	24	41	41	41
J10-E	19,133	19,639	19,777	19,791	2.8	2.4	2.4	2.4	23	33	33	33
J11-N	16,507	16,842	16,968	16,970	2.0	1.5	1.5	1.5	21	31	31	31
J11-S	341	276	275	276	0.8	0.0	0.0	0.0	32	42	42	42
J11-W	7,735	7,052	7,095	7,105	5.1	4.8	4.7	4.7	32	43	43	42
J12-N	18,110	17,414	17,547	17,555	1.7	1.6	1.6	1.6	19	31	31	31
J12-S	19,036	20,334	20,478	20,490	2.8	2.4	2.4	2.4	23	35	35	35
J12-E	14,739	13,719	13,824	13,833	1.9	2.0	2.0	2.0	23	37	37	37
J13-N	21,769	22,460	22,612	22,621	4.0	3.7	3.7	3.7	22	33	33	33
J13-S	18,303	18,606	18,748	18,757	1.7	1.6	1.6	1.6	19	31	31	31
J13-E	13,867	13,733	13,816	13,826	4.4	4.2	4.2	4.2	21	38	38	38
J13-W	18,191	19,175	19,301	19,306	0.0	4.0	4.0	3.9	20	35	36	34
J13-EW	19,671	21,289	21,108	21,434	0.0	4.0	2.5	4.0	22	32	34	31
J14-N	7,798	7,922	7,971	7,977	0.0	1.6	1.5	1.6	21	33	34	33
J14-EEB	15,388	15,606	15,675	15,723	6.0	5.2	5.2	5.2	22	36	36	36
J14-EEBE	17,705	18,474	18,600	18,629	4.6	4.1	4.2	4.1	20	34	35	39
J14-ENOR RD	3,707	3,835	3,851	3,862	2.6	0.9	0.9	0.9	22	30	30	30
J14-COP RD	10,904	10,690	10,734	10,706	2.5	1.8	1.9	1.8	24	39	39	39
J14-SB	17,349	18,033	18,102	18,152	5.0	4.6	4.7	4.6	22	32	32	32
J14-S	29,492	29,297	29,152	29,127	5.2	4.8	4.8	4.8	26	41	41	41
J14-NS	16,491	16,146	16,035	16,030	5.5	4.6	4.7	4.6	24	41	41	41
J15-N	21,120	20,017	19,889	19,865	4.3	3.4	3.4	3.4	24	38	38	38
J15-S	16,153	15,075	14,934	14,998	5.5	3.9	3.5	4.0	24	43	42	42
J15-ESLIP	17,272	16,401	16,295	16,276	2.9	3.9	3.9	3.9	23	42	42	42
J15-W	16,576	16,734	16,632	16,620	4.2	4.3	4.4	4.3	24	39	38	38
J15-MAIN	14,037	13,230	13,173	13,164	6.1	6.3	6.3	6.3	24	46	46	46
J16-NNB	15,782	16,150	16,071	16,061	4.5	4.5	4.5	4.5	25	39	42	42
J16-S	13,020	13,350	13,242	13,219	3.1	4.1	4.1	4.2	23	39	39	39
J16-E	17,415	17,896	17,737	17,707	2.6	3.4	3.4	3.4	25	33	34	33
J16-W	4,002	4,102	4,076	4,065	0.1	0.1	0.1	0.1	24	47	47	46
J16-NSB	4,113	3,761	3,731	3,726	1.3	1.4	1.5	1.4	24	30	30	30
J16-N	8,121	8,303	8,236	8,224	2.2	2.4	2.2	2.4	24	38	39	38
J17-N	8,345	8,339	8,300	8,279	2.6	2.8	2.8	2.9	24	34	34	34
J17-S	13,840	13,839	13,748	13,708	2.1	2.9	2.9	2.9	26	31	32	31
J17-E	4,925	4,345	4,333	4,320	1.1	1.2	1.2	1.2	25	26	26	25
J17-W	13,946	12,636	12,577	12,551	1.9	2.4	2.4	2.4	23	43	43	43
J17-WS	8,401	8,453	8,368	8,361	2.6	4.2	4.3	4.2	26	29	32	29
J18-N	11,133	10,817	10,748	10,725	2.3	3.1	3.1	3.1	25	34	35	34
J18-S	16,745	16,792	16,668	16,640	2.6	7.1	7.1	7.1	25	63	66	62
J18-W	16,058	14,647	14,583	14,542	2.2	3.0	2.9	2.9	26	37	37	37
J19-NNB	23,149	20,718	20,664	20,605	2.2	2.5	2.5	2.5	24	38	39	38
J19-NSB	22,393	19,894	19,878	19,780	2.0	1.7	1.7	1.7	25	41	42	41

Link Description	AADT				HGV %				Speed (kph)			
	BY	DM	DS1	DS2	BY	DM	DS1	DS2	BY	DM	DS1	DS2
J19-SSB	14,442	13,388	13,353	13,302	1.7	1.7	1.7	1.8	25	39	39	39
J19-SNB	484	402	408	403	1.2	0.5	0.5	1.4	25	34	34	34
J19-W	17,986	15,840	15,810	15,736	3.5	3.0	2.9	2.9	24	38	39	38
J22-N	27,925	27,822	27,820	27,817	4.5	4.6	4.5	4.6	27	34	34	34
J22-S	16,703	16,429	16,420	16,439	2.5	1.7	1.7	1.7	27	38	38	39
J22-E	26,902	26,415	26,407	26,400	3.1	2.7	2.7	2.7	34	48	48	48
J22-W	28,061	27,629	27,628	27,632	4.5	4.6	4.6	4.6	27	34	34	34
J23-N	19,469	18,953	18,948	18,948	6.3	1.4	1.4	1.4	27	41	41	41
J23-S	11,398	11,217	11,227	11,206	1.8	1.6	1.6	1.5	27	28	28	29
J23-E	6,384	6,599	6,590	6,599	1.3	1.9	1.8	1.9	27	28	28	28
J23-W	23,765	23,291	23,288	23,290	5.4	3.0	3.0	3.0	27	37	37	37
J24-N	850	1,109	1,099	1,099	0.3	1.3	1.3	1.3	19	33	33	33
J24-S	4,708	5,583	5,628	5,617	7.4	7.4	7.3	7.3	19	25	25	25
J24-E	10,262	12,169	12,168	12,161	2.0	3.1	3.2	3.1	19	37	37	37
J24-W	10,292	12,683	12,683	12,681	3.8	4.5	4.5	4.6	19	30	30	30

Appendix E: Location of Sensitive Receptors

Figure 8: Location of Sensitive Receptors

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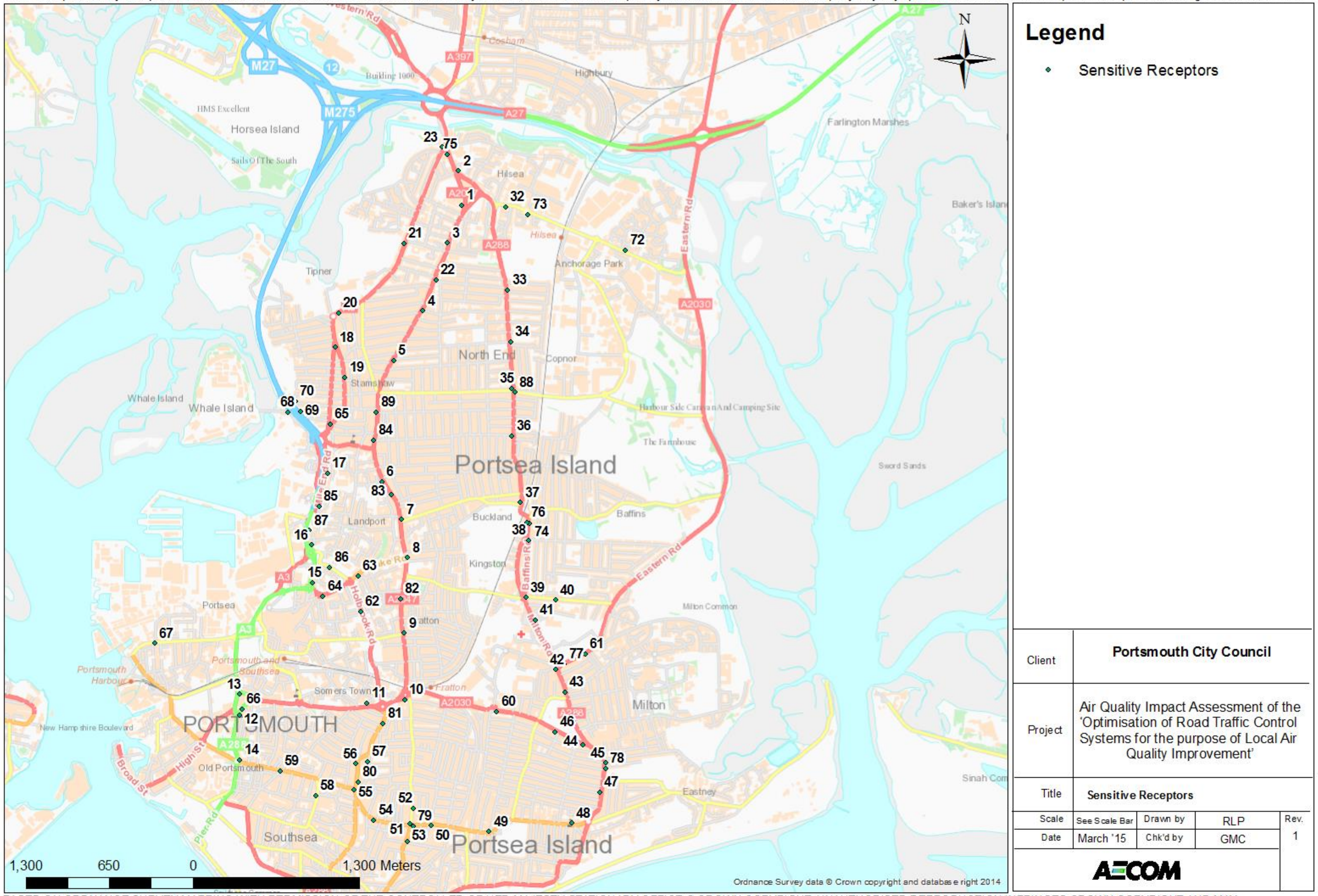
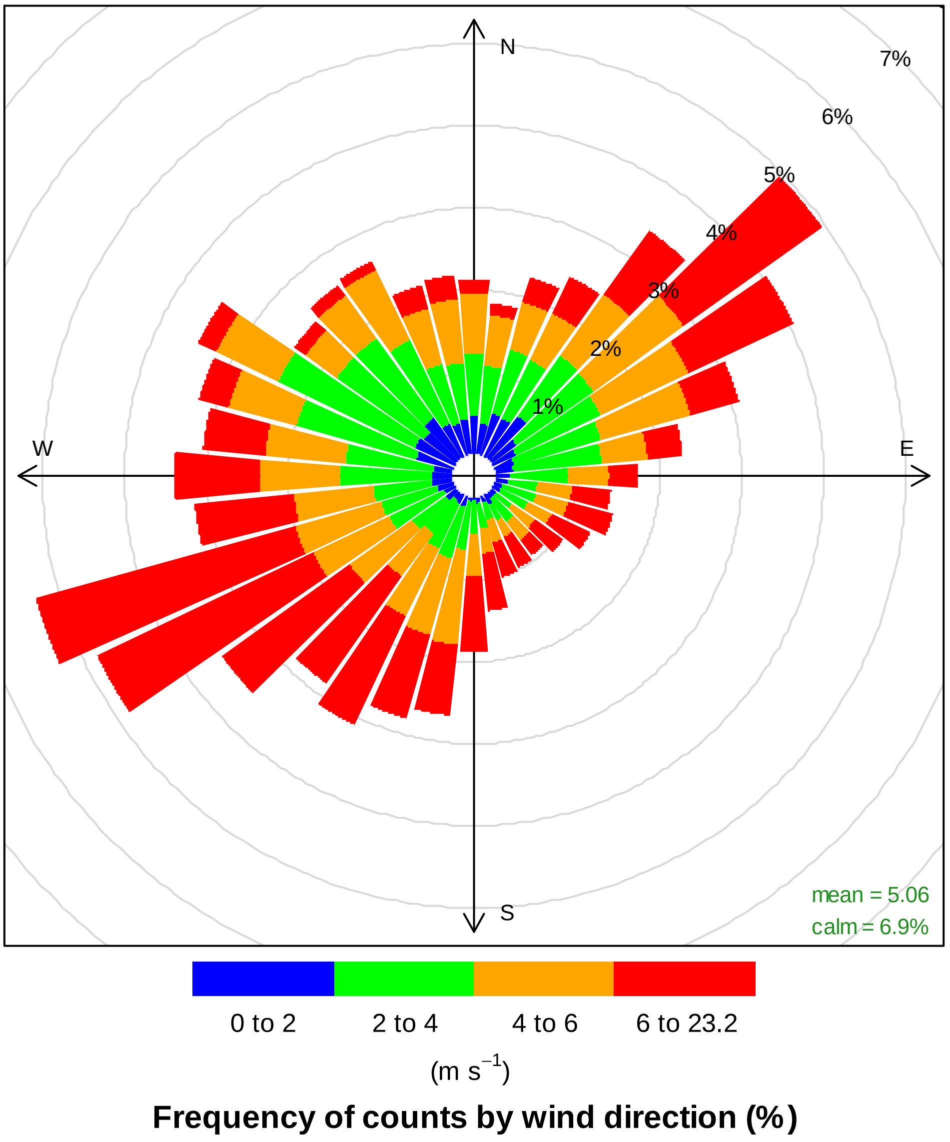


Appendix F: Meteorological Data

The meteorological dataset used in the model was recorded at the meteorological station on Thorney Island, in 2013, located approximately 12 km away from Portsmouth. The Solent meteorological station is located slightly closer to Portsmouth (9 km away); however, the station is exposed and therefore the meteorological conditions at the station on Thorney Island were considered to better represent the meteorological conditions in Portsmouth.

The meteorological data were used to produce a wind/stability rose (Figure 9). This illustrates the wind direction and wind speed as a function of the proportion of the year.

Figure 9: Wind Rose for Thorney Island, 2013



Appendix G: Model Verification

The model was verified by comparison with results from the Portsmouth City Council NO_2 diffusion tube Survey for 2013 and data from three continuous monitoring stations in the city. All modelled NO_X concentrations were adjusted in accordance with the procedure detailed in technical guidance LAQM.TG(09) prior to conversion to total NO_2 concentrations.

Table 13: Comparison of Monitored and Unadjusted Modelled NO_2 Concentrations, 2013

Monitoring Site	Monitor Type	Monitored Total NO_2	Modelled Total NO_2	% Difference [(modelled-monitored)/monitored]
Lord Montgomery Way	DT	41.3	33.4	-19%
Queen Street	DT	30.4	34.3	13%
119 Whale Island Way	DT	27.5	28.7	5%
88 Stanley Road	DT	38.6	29.9	-22%
138 Lower Derby	DT	30.0	27.3	-9%
6 Northern Road	DT	32.0	31.8	0%
Anchorage Road*	DT	29.5	35.0	18%
4 Merlyn Drive*	DT	21.6	34.7	60%
29 Milton Road	DT	28.2	25.8	-9%
Parade Court, London Road	DT	34.1	29.3	-14%
4 Milton Road	DT	27.8	25.4	-9%
7 Velder Avenue	DT	30.7	28.4	-8%
136 Eastney Rd	DT	27.4	24.5	-11%
116 Albert Road	DT	34.0	26.4	-22%
2 Victoria Road North	DT	28.7	28.7	0%
106 Victoria Road North	DT	32.2	29.9	-7%
221 Fratton Road	DT	42.5	31.5	-26%
117 Kingston Road	DT	38.7	33.8	-13%
The Tap London Road*	DT	51.7	38.3	-26%
Market Tavern (Mile End Rd)	DT	37.7	34.1	-10%
Larch Court, Church Rd	DT	31.1	31.3	1%
Mile End Road	CM	35.9	34.3	-4%
Burrfields	CM	33.5	31.7	-5%
London Road	CM	39.7	34.2	-14%

Notes: DT=Diffusion Tube CM = Continuous Monitor. * Sites excluded from verification. Anchorage Road and 4 Merlyn Drive excluded due to monitored annual mean NO_2 concentrations being lower than the mapped background concentration. The Tap London Road omitted due to spurious reading in September 2013 that appeared to skew the annual mean result.

An adjustment factor was calculated as follows:

$NO_{X\ [monitored,\ traffic\ contribution]} = NO_{X\ [monitored]} - NO_{X\ [background]}$

$NO_{X\ [modelled,\ traffic\ contribution]} = NO_{X\ [modelled]} - NO_{X\ [background]}$

$$\text{Adjustment Factor} = NO_{X\ [monitored,\ traffic\ contribution]} / NO_{X\ [modelled,\ traffic\ contribution}$$

An adjustment factor of 1.43 was calculated.

The adjustment factor was subsequently applied to the modelled NO_X concentrations, and background NO_X added to give the adjusted modelled NO_X concentrations:

$NO_{X\ [model\ adjusted,\ traffic\ contribution]} = NO_{X\ [modelled,\ traffic\ contribution]}$ x Adjustment Factor

$NO_{X\ [model\ adjusted]} = NO_{X\ [model\ adjusted,\ traffic\ contribution]} + NO_{X\ [background]}$

The adjusted NO_X concentrations were converted to NO_2 using Version 4.1 of the 'NO_2 to NO_X' calculator provided by the Air Quality Archive and in accordance with the technical guidance, LAQM.TG(09).

Table 14: Comparison of Monitored and Unadjusted Modelled Road NO_X Concentrations

Monitoring Site	Monitored Total NO_2	Monitored Road NO_X	Modelled Road NO_X
Lord Montgomery Way	41.3	41.7	22.6
Queen Street	30.4	7.1	15.8
119 Whale Island Way	27.5	11.2	13.9
88 Stanley Road	38.6	36.8	16.4
138 Lower Derby	30.0	16.7	10.8
6 Northern Road	32.0	20.9	20.6
29 Milton Road	28.2	17.8	12.6
Parade Court, London Road	34.1	27.9	16.8
4 Milton Road	27.8	17.0	11.9
7 Velder Avenue	30.7	24.5	19.2
136 Eastney Rd	27.4	20.1	13.8
116 Albert Road	34.0	35.8	18.3
2 Victoria Road North	28.7	15.8	15.7
106 Victoria Road North	32.2	23.6	18.5
221 Fratton Road	42.5	49.8	22.6
117 Kingston Road	38.7	38.2	26.4
Market Tavern (Mile End Rd)	37.7	32.5	23.8
Larch Court, Church Rd	31.1	16.5	17.0
Mile End Road	35.9	28.2	24.4
Burrfields	33.5	23.3	19.1
London Road	39.7	39.6	26.1

Figure 10: Unadjusted Modelled Road NO_X Versus Monitored Road NO_X Concentrations

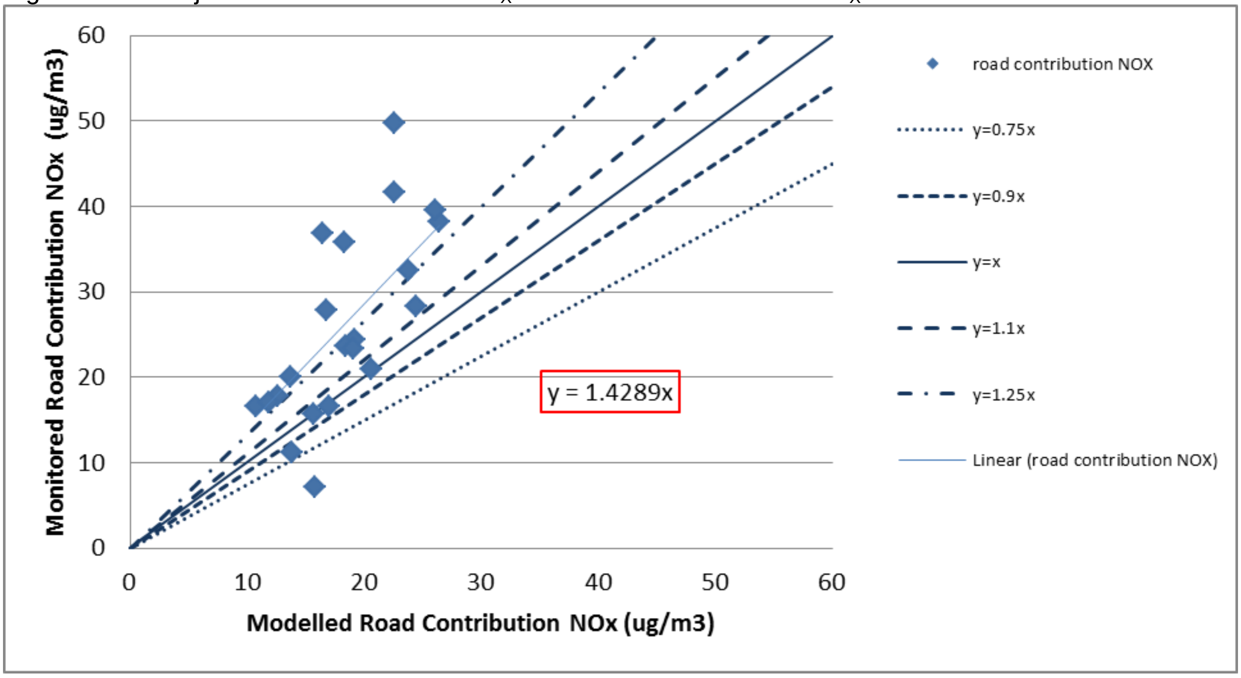
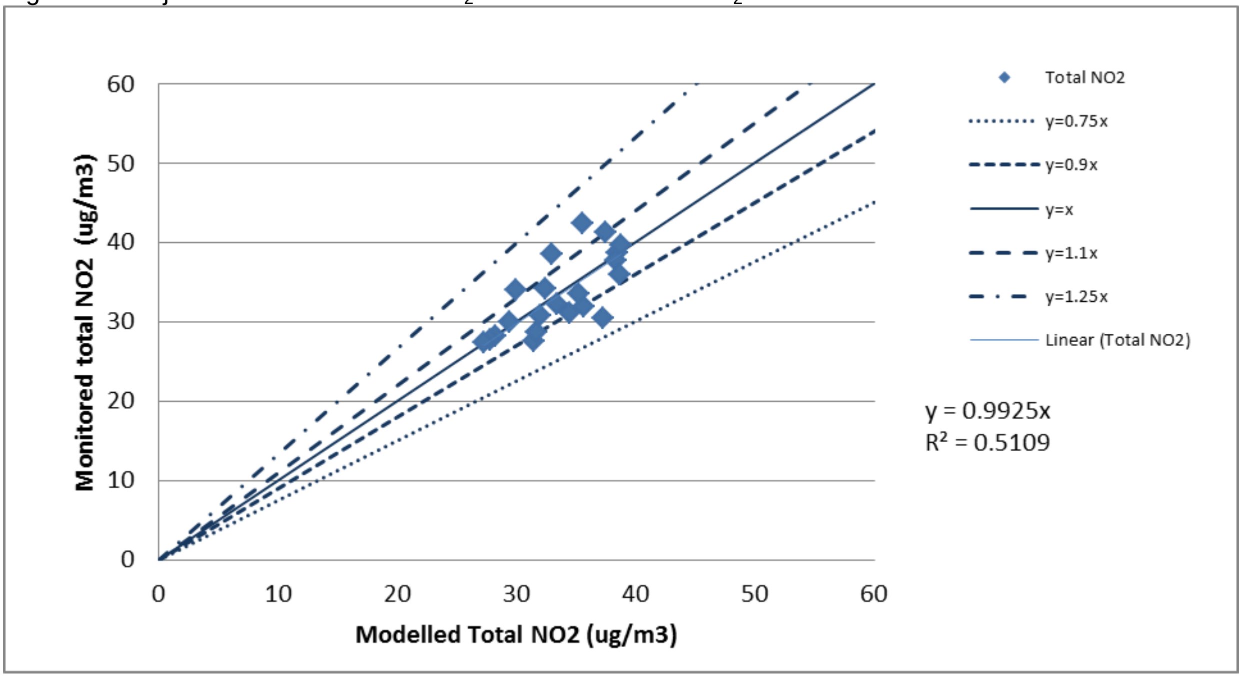


Table 15: Determination of the Adjustment Factor and Total Adjusted NO_2

Monitoring Site	Adjustment Factor for Modelled Road Contribution	Adjusted Modelled Road Contribution NO_X	Adjusted Modelled Total NO_2	Monitored Total NO_2	% Difference [(mod-mon)/mon]
Lord Montgomery Way	1.43	32.3	37.5	41.3	-9%
Queen Street	1.43	22.5	37.3	30.4	22%
119 Whale Island Way	1.43	19.8	31.4	27.5	14%
88 Stanley Road	1.43	23.5	33.0	38.6	-14%
138 Lower Derby	1.43	15.4	29.4	30.0	-2%
6 Northern Road	1.43	29.5	35.6	32.0	11%
29 Milton Road	1.43	18.0	28.2	28.2	0%
Parade Court, London Road	1.43	24.0	32.5	34.1	-5%
4 Milton Road	1.43	17.0	27.8	27.8	0%
7 Velder Avenue	1.43	27.5	32.0	30.7	4%
136 Eastney Rd	1.43	19.7	27.2	27.4	-1%
116 Albert Road	1.43	26.1	29.9	34.0	-12%
2 Victoria Road North	1.43	22.4	31.7	28.7	10%
106 Victoria Road North	1.43	26.4	33.4	32.2	4%
221 Fratton Road	1.43	32.3	35.6	42.5	-16%
117 Kingston Road	1.43	37.7	38.5	38.7	-1%
Market Tavern (Mile End Rd)	1.43	34.0	38.3	37.7	2%
Larch Court, Church Rd	1.43	24.3	34.5	31.1	11%
Mile End Road	1.43	34.9	38.7	35.9	8%
Burrfields	1.43	27.3	35.2	33.5	5%
London Road	1.43	37.3	38.8	39.7	-2%

Figure 11: Adjusted Modelled Total NO_2 versus Monitored NO_2 Concentrations



Appendix H: Location of Monitoring Sites

Figure 12: Location of Monitoring Sites

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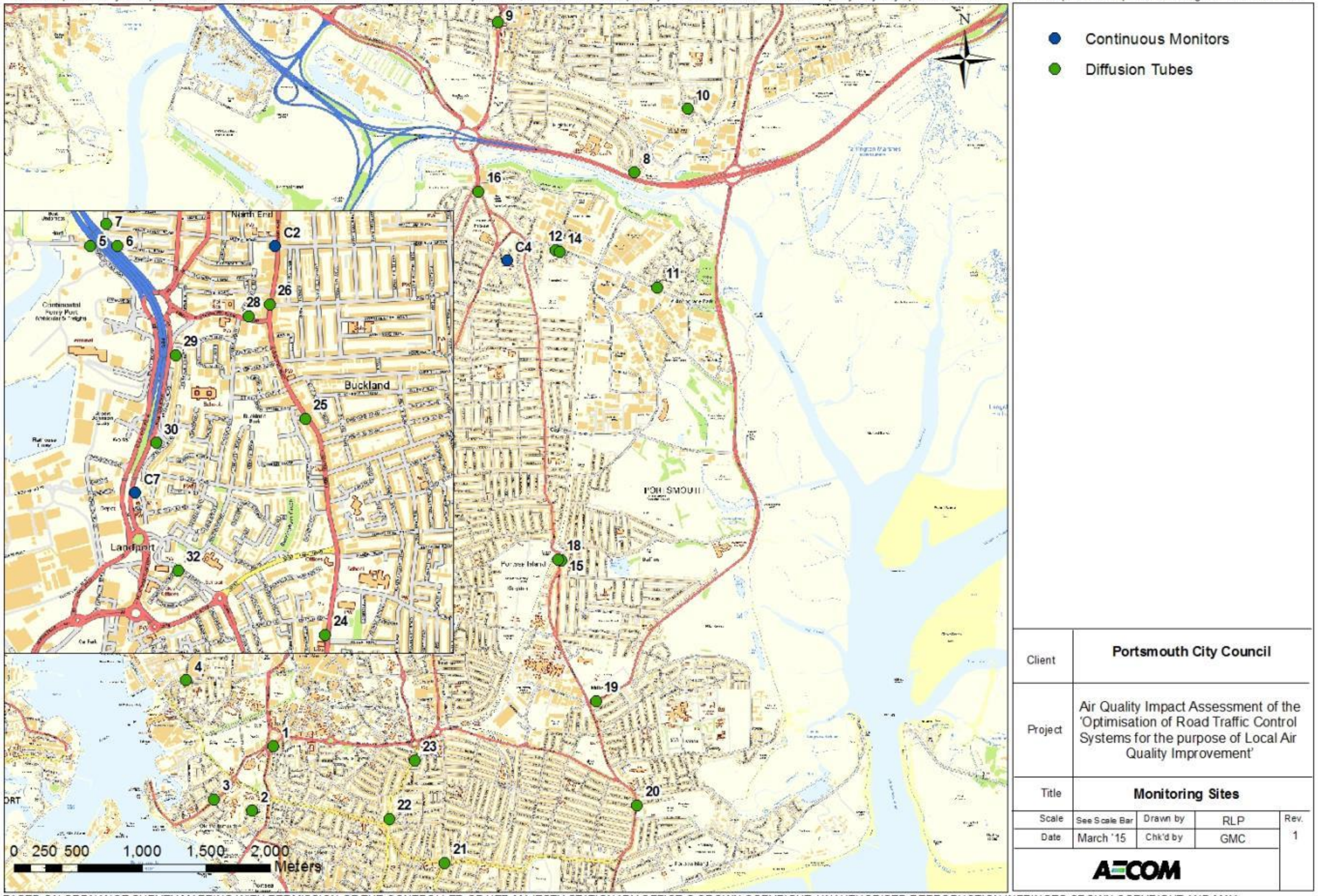

Appendix I: Background Pollutant Concentrations

Table 16: Background NO_2 Concentrations for Cartesian Grid Modelling

Background NO_2 Concentrations (μg/m^3)				
	Grid X	**Grid Y**	**2013**	**2015**
Corridor 1				
Area A	464500	101500	23.1	22.8
	464500	102500	22.1	21.9
	465500	101500	21.7	21.3
	465500	102500	22.0	21.7
	Average		**22.2**	**21.9**
Area B	463500	100500	27.1	26.2
	463500	101500	28.7	28.6
	464500	100500	23.3	22.7
	464500	101500	23.1	22.8
	Average		**25.6**	**25.1**
Area C	463500	99500	23.0	22.8
	463500	100500	27.1	26.2
	464500	99500	21.2	20.9
	464500	100500	23.3	22.7
	Average		**23.6**	**23.2**
Corridor 2				
Area A	464500	99500	21.2	20.9
	464500	100500	23.3	22.7
	465500	100500	20.9	20.5
	465500	99500	19.6	19.3
	Average		**21.2**	**20.9**
Area B	464500	100500	23.3	22.7
	464500	101500	23.1	22.8
	465500	100500	20.9	20.5
	465500	101500	21.7	21.3
	Average		**22.2**	**21.8**
Area C	464500	101500	23.1	22.7
	464500	102500	22.1	21.8
	465500	101500	21.7	21.3
	465500	102500	22.0	21.7
	Average		**22.2**	**21.9**
Corridor 3				
Area A	465500	103500	22.1	21.6
	465500	104500	21.3	20.8
	466500	103500	30.3	28.7
	466500	104500	25.9	24.7

Background NO_2 Concentrations (μg/m^3)				
	Grid X	**Grid Y**	**2013**	**2015**
	Average		**24.9**	**23.9**
Area B	465500	101500	21.7	21.3
	465500	102500	22.0	21.7
	466500	102500	22.8	22.2
	466500	101500	19.6	19.3
	Average		**21.5**	**21.1**
Area C	465500	100500	20.9	20.5
	465500	101500	21.7	21.3
	466500	101500	19.6	19.3
	466500	100500	19.2	18.8
	Average		**20.3**	**20.0**
Area D	465500	99500	19.6	19.3
	465500	100500	20.9	20.5
	466500	100500	19.2	18.8
	466500	99500	17.8	17.5
	Average		**19.4**	**19.0**
Corridor 4				
Area A	464500	104500	20.7	20.5
	464500	105500	20.6	20.3
	465500	105500	22.2	21.8
	465500	104500	21.3	20.8
	Average		**21.2**	**20.9**
Corridor 5				
Area A	464500	98500	19.3	19.1
	464500	99500	21.2	20.9
	465500	98500	17.6	17.4
	465500	99500	19.6	19.3
	Average		**19.4**	**19.2**
Area B	464500	98500	19.3	19.1
	464500	99500	21.2	20.9
	465500	99500	19.6	19.3
	465500	98500	17.6	17.4
	Average		**19.4**	**19.2**

Note: Grid X and Grid Y are the coordinates corresponding to the centre-point of each 1-km grid square. Contributions of modelled roads to background NO_2 concentrations within each grid square have been removed in accordance with the prescribed guidance to avoid double-counting.

Table 17: Background NO_2 Concentrations used for Sensitive Receptor Modelling

Receptor	X	Y	Grid X	Grid Y	Background NO_2 Concentrations (µg/m^3)	
					2013	2015
1	465589	103808	465500	103500	22.1	21.6
2	465560	104076	465500	104500	21.3	20.8
3	465479	103513	465500	103500	22.1	21.6
4	465283	102984	465500	102500	22.0	21.7
5	465056	102597	465500	102500	22.0	21.7
6	464964	101651	464500	101500	23.1	22.8
7	465119	101355	465500	101500	21.7	21.3
8	465166	101057	465500	101500	21.7	21.3
9	465140	100469	465500	100500	20.9	20.5
10	465143	99949	465500	99500	19.6	19.3
11	464849	99921	464500	99500	21.2	20.9
12	463851	99829	463500	99500	23.0	22.8
13	463853	99992	463500	99500	23.0	22.8
14	463857	99479	463500	99500	23.0	22.8
15	464423	100863	464500	100500	23.3	22.7
16	464414	101158	464500	101500	23.1	22.8
17	464543	101716	464500	101500	23.1	22.8
18	464602	102699	464500	102500	22.1	21.9
19	464678	102465	464500	102500	22.1	21.9
20	464629	102966	464500	102500	22.1	21.9
21	465135	103511	465500	103500	22.1	21.6
22	465387	103227	465500	103500	22.1	21.6
23	465436	104262	465500	104500	21.3	20.8
24	465659	105588	465500	105500	22.2	21.8
25	465711	105661	465500	105500	22.2	21.8
26	465646	105696	465500	105500	22.2	21.8
27	465478	105689	465500	105500	22.2	21.8
28	465514	105513	465500	105500	22.2	21.8
29	465103	105798	465500	105500	22.2	21.8
30	465146	105562	465500	105500	22.2	21.8
31	464894	105796	464500	105500	20.6	20.3

Receptor	X	Y	Grid X	Grid Y	Background NO_2 Concentrations ($\mu g/m^3$)	
					2013	2015
32	465933	103795	465500	103500	22.1	21.6
33	465949	103148	465500	103500	22.1	21.6
34	465974	102742	465500	102500	22.0	21.7
35	465976	102379	465500	102500	22.0	21.7
36	465982	102007	465500	102500	22.0	21.7
37	466048	101489	466500	101500	19.6	19.3
38	466108	101192	466500	101500	19.6	19.3
39	466092	100747	466500	100500	19.2	18.8
40	466322	100726	466500	100500	19.2	18.8
41	466162	100569	466500	100500	19.2	18.8
42	466324	100183	466500	100500	19.2	18.8
43	466394	100009	466500	100500	19.2	18.8
44	466535	99596	466500	99500	17.8	17.5
45	466712	99455	466500	99500	17.8	17.5
46	466319	99698	466500	99500	17.8	17.5
47	466669	99229	466500	99500	17.8	17.5
48	466450	98985	466500	98500	16.0	15.9
49	465802	98920	465500	98500	17.6	17.4
50	465350	98971	465500	98500	17.6	17.4
51	465182	98982	465500	98500	17.6	17.4
52	465208	99102	465500	99500	19.6	19.3
53	465162	98844	465500	98500	17.6	17.4
54	464902	99009	464500	99500	21.2	20.9
55	464748	99243	464500	99500	21.2	20.9
56	464764	99450	464500	99500	21.2	20.9
57	464852	99465	464500	99500	21.2	20.9
58	464450	99201	464500	99500	21.2	20.9
59	464172	99391	464500	99500	21.2	20.9
60	465863	99855	465500	99500	19.6	19.3
61	466553	100306	466500	100500	19.2	18.8
62	464798	100639	464500	100500	23.3	22.7
63	464779	100914	464500	100500	23.3	22.7

Receptor	X	Y	Grid X	Grid Y	Background NO_2 Concentrations (µg/m^3)	
					2013	2015
64	464505	100757	464500	100500	23.3	22.7
65	464561	102099	464500	102500	22.1	21.9
66	463872	99874	463500	99500	23.0	22.8
67	463190	100390	463500	100500	27.1	26.2
68	464230	102194	464500	102500	22.1	21.9
69	464331	102197	464500	102500	22.1	21.9
70	464291	102279	464500	102500	22.1	21.9
71	465621	105528	465500	105500	22.2	21.8
72	466869	103457	466500	103500	30.3	28.7
73	466107	103733	466500	103500	30.3	28.7
74	466120	101324	466500	101500	19.6	19.3
75	465474	104205	465500	104500	21.3	20.8
76	466097	101332	466500	101500	19.6	19.3
77	466392	100226	466500	100500	19.2	18.8
78	466712	99415	466500	99500	17.8	17.5
79	465209	98964	465500	98500	17.6	17.4
80	464778	99306	464500	99500	21.2	20.9
81	464976	99765	464500	99500	21.2	20.9
82	465111	100737	465500	100500	20.9	20.5
83	465036	101547	465500	101500	21.7	21.3
84	464902	101976	464500	101500	23.1	22.8
85	464478	101457	464500	101500	23.1	22.8
86	464559	100980	464500	100500	23.3	22.7
87	464399	101270	464500	101500	23.1	22.8
88	466004	102348	466500	102500	22.8	22.2
89	464922	102195	464500	102500	22.1	21.9

Note: Grid X and Grid Y are the coordinates corresponding to the centre-point of each 1-km grid square. Contributions of modelled roads to background NO_2 concentrations within each grid square have been removed in accordance with the prescribed guidance to avoid double-counting.

Appendix J: Model Output

Figure 13: Base Year Annual Mean NO_2 Concentrations, Corridor 1, Junction 1

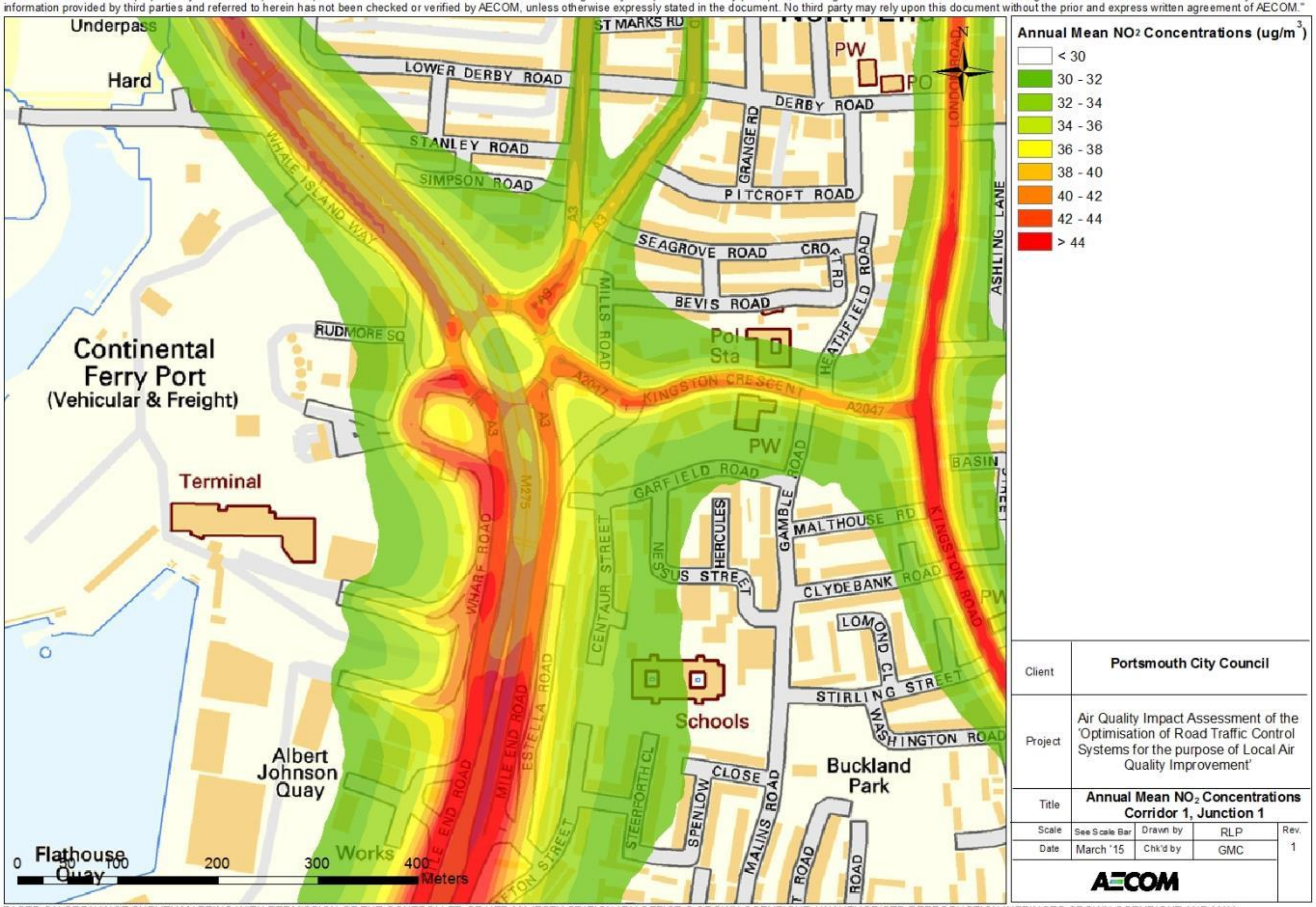

Figure 14: Base Year Annual Mean NO_2 Concentrations, Corridor 1, Junctions 2, 3 and 4

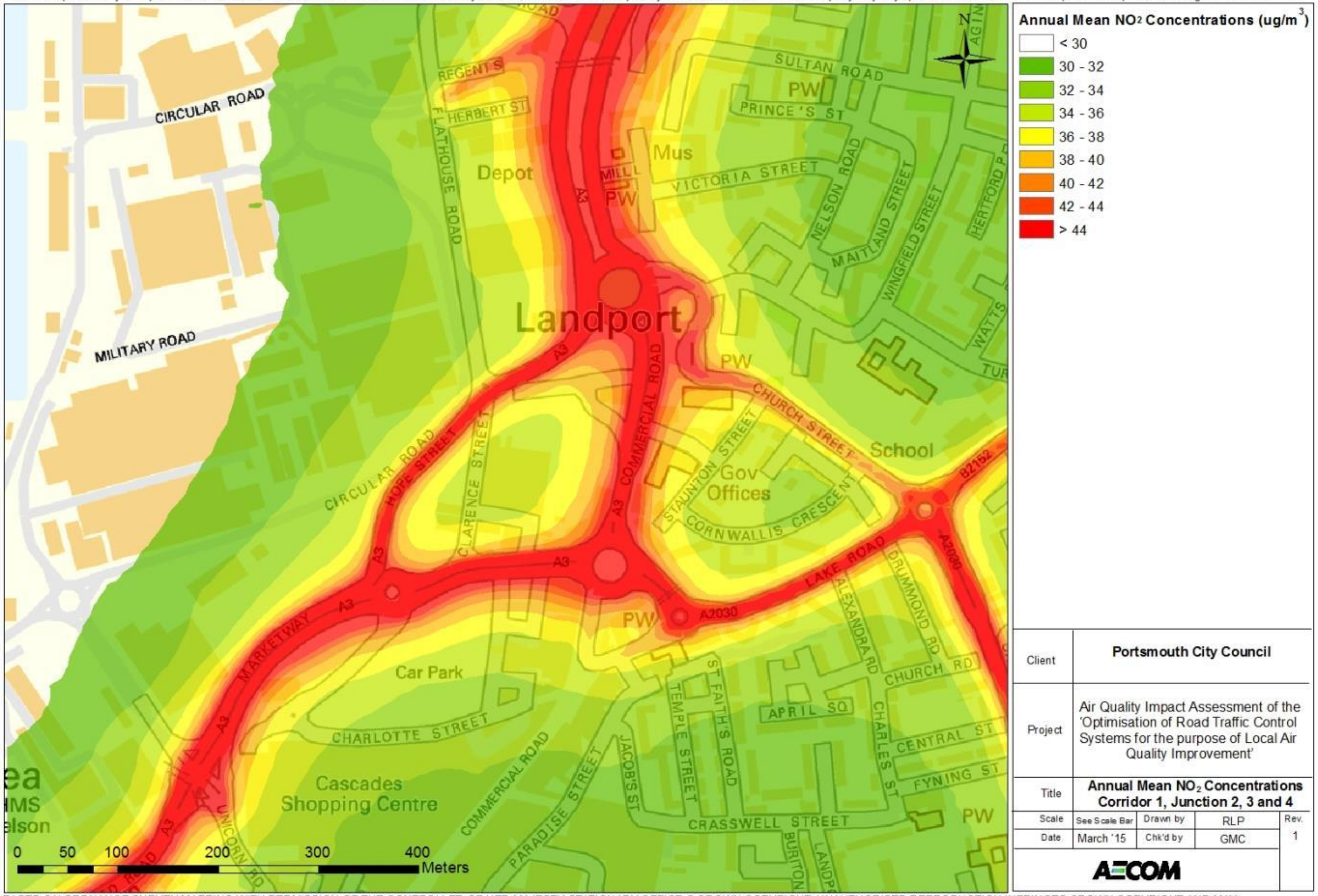

Figure 15: Base Year Annual Mean NO_2 Concentrations, Corridor 1, Junctions 5 and 6

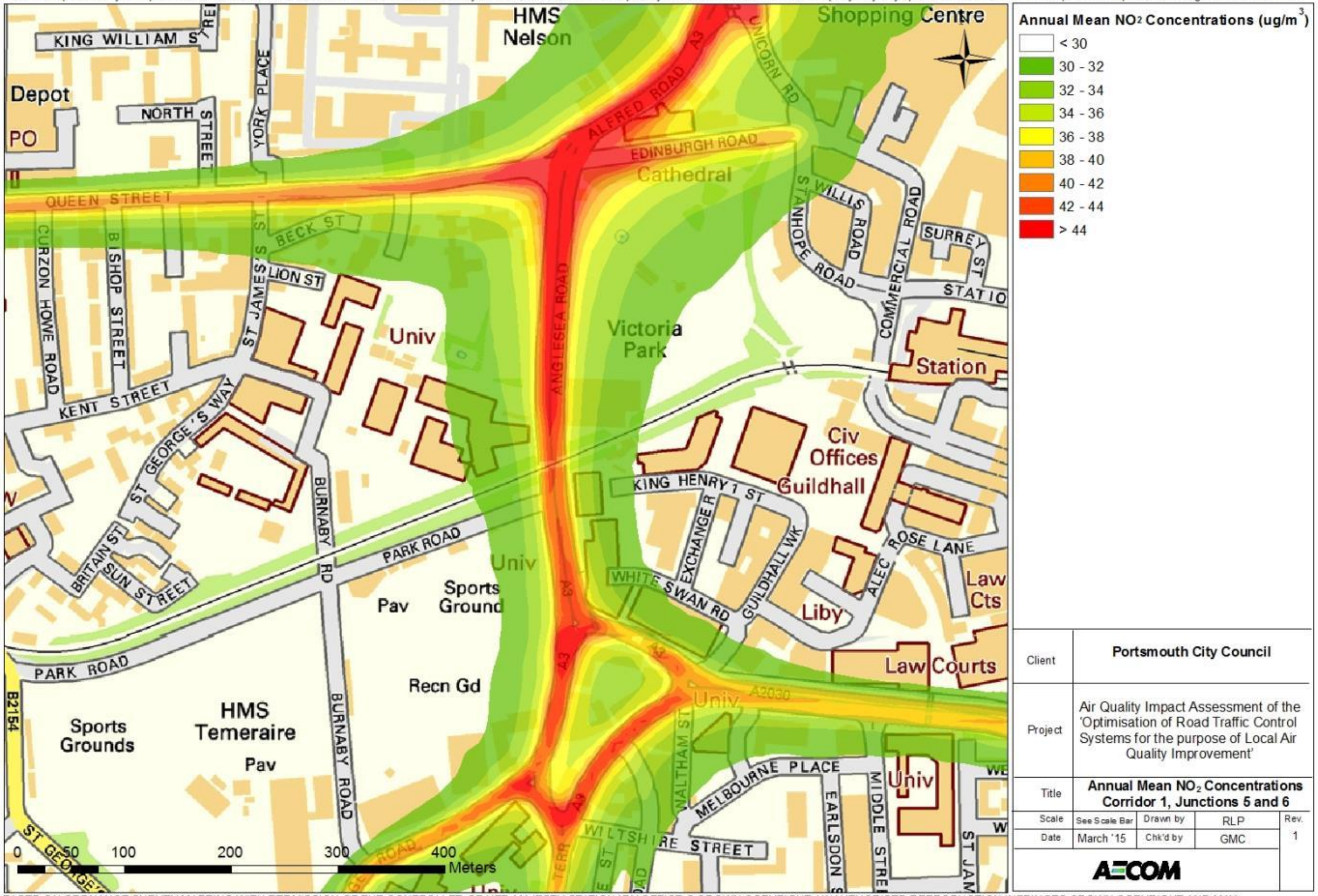

Figure 16: Base Year Annual Mean NO_2 Concentrations, Corridor 2, Junctions 7 and 8

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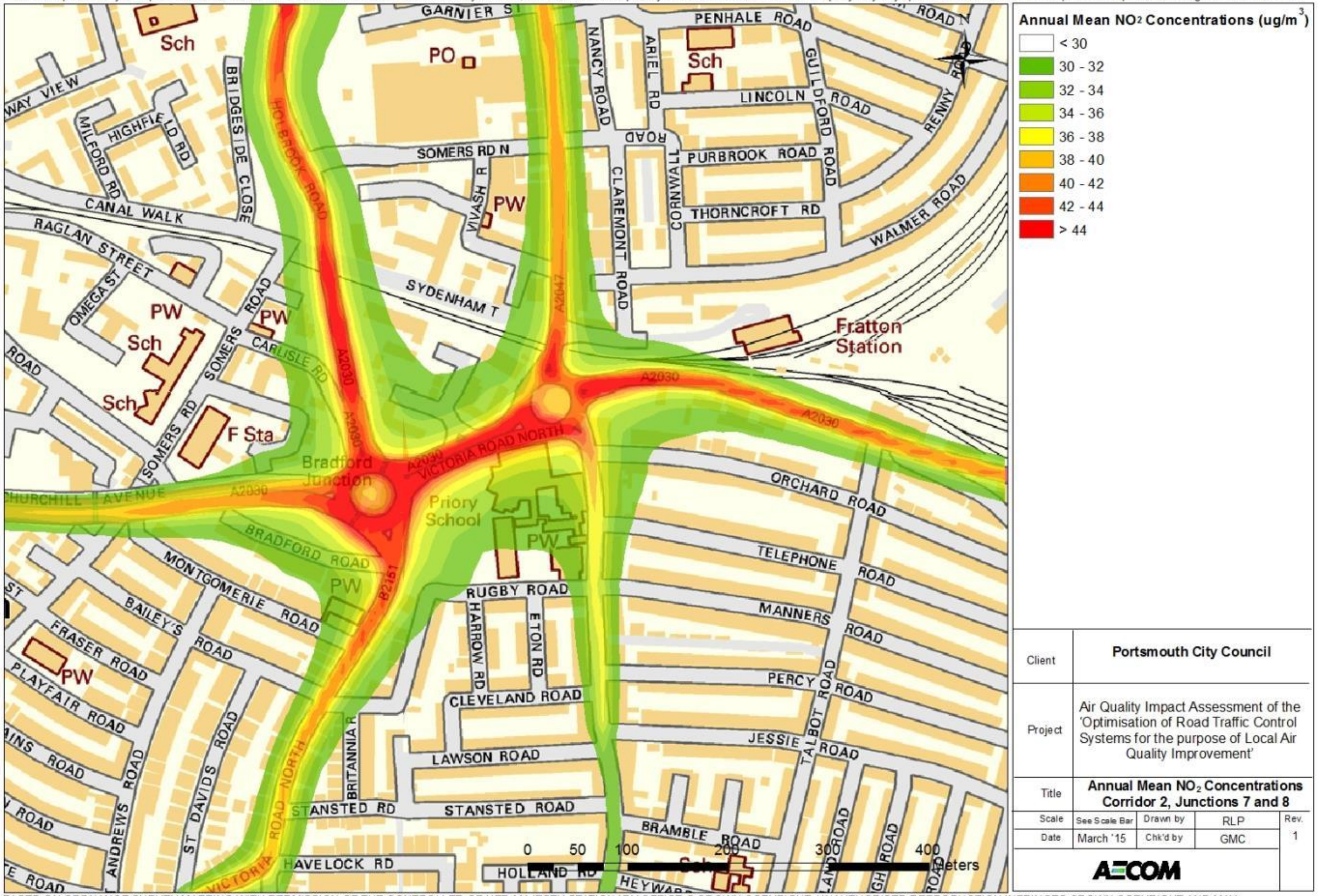

Figure 17: Base Year Annual Mean NO_2 Concentrations, Corridor 2, Junctions 9, 10 and 11

Figure 18: Base Year Annual Mean NO_2 Concentrations, Corridor 2, Junctions 12 and 13

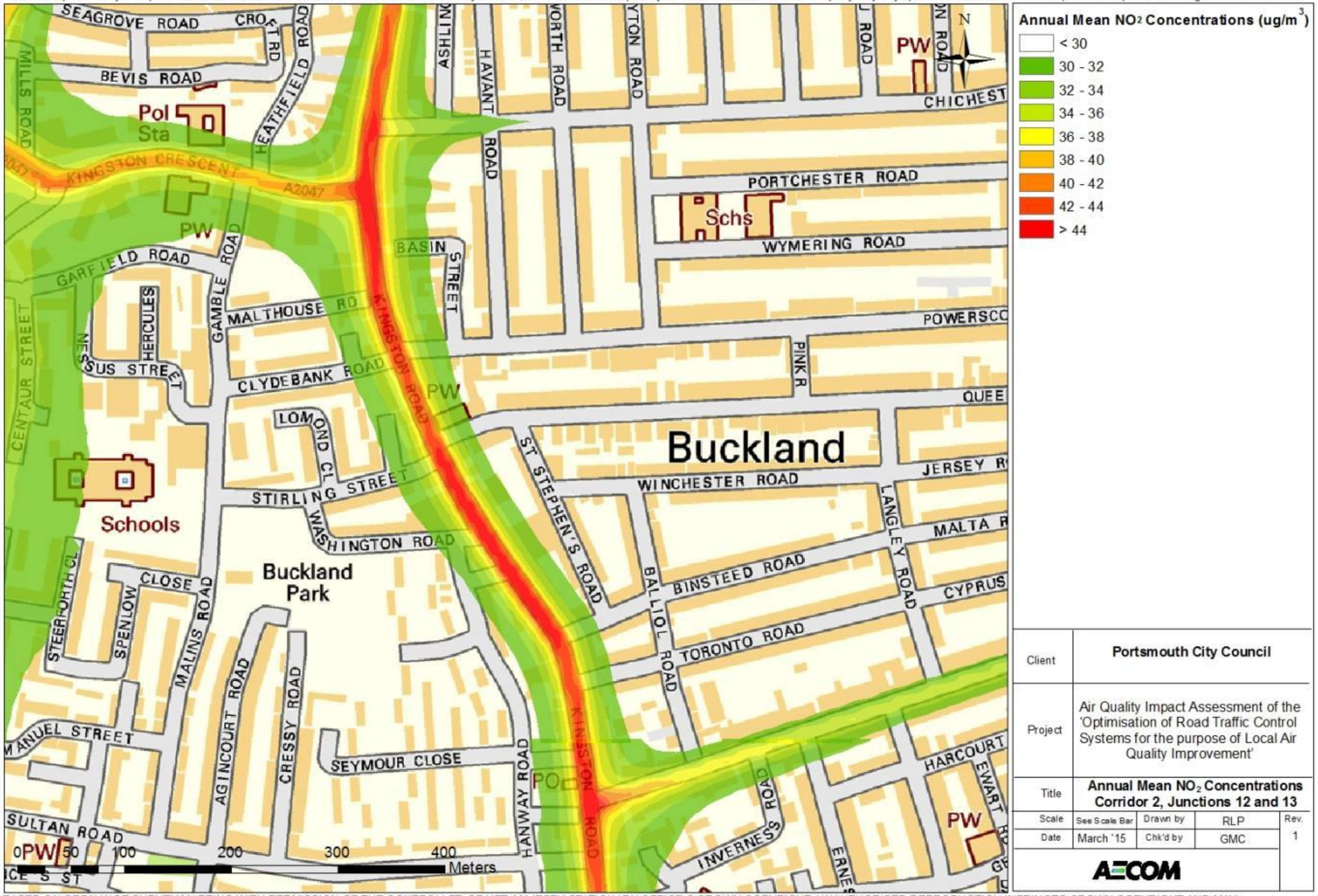

Figure 19: Base Year Annual Mean NO_2 Concentrations, Corridor 3, Junction 15

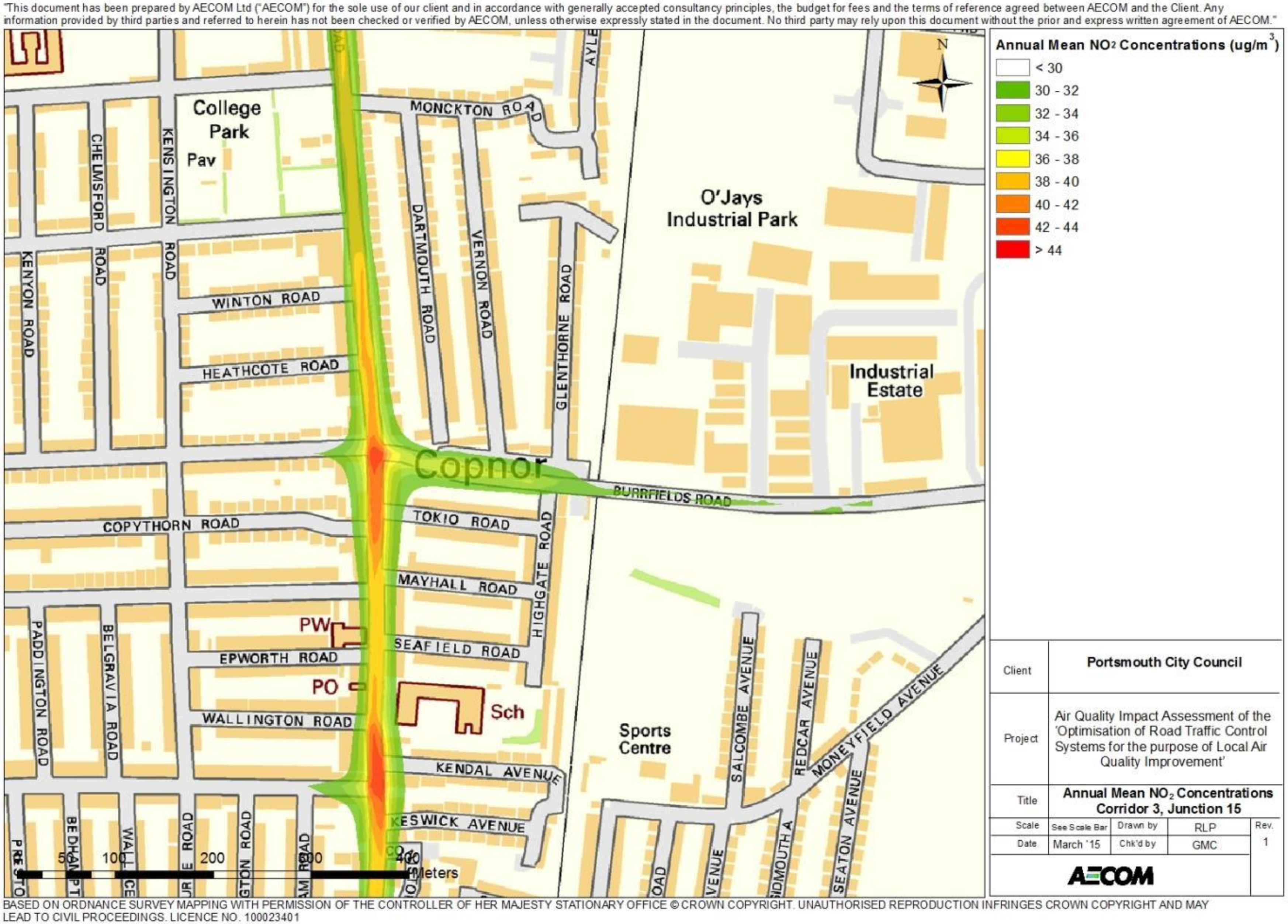

Figure 20: Base Year Annual Mean NO_2 Concentrations, Corridor 3, Junctions 14 and 19

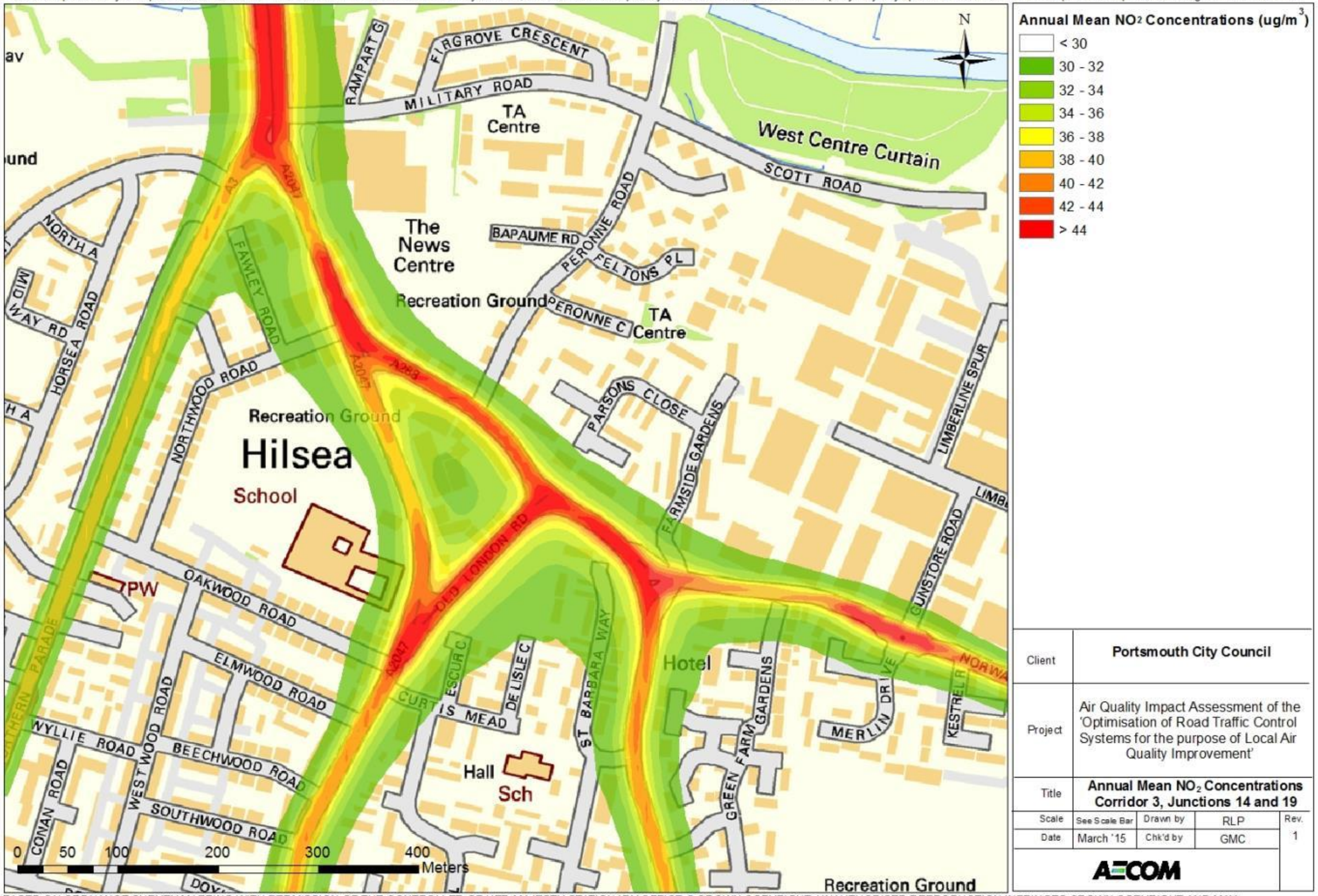

Figure 21: Base Year Annual Mean NO_2 Concentrations, Corridor 3, Junctions 16 and 17

Client	Portsmouth City Council
Project	Air Quality Impact Assessment of the 'Optimisation of Road Traffic Control Systems for the purpose of Local Air Quality Improvement'
Title	Annual Mean NO_2 Concentrations Corridor 3, Junction 16 and 17
Scale	See Scale Bar; Drawn by: RLP; Rev. 1
Date	March '15; Chk'd by: GMC

AECOM

Figure 22: Base Year Annual Mean NO_2 Concentrations, Corridor 3, Junctions 17 and 18

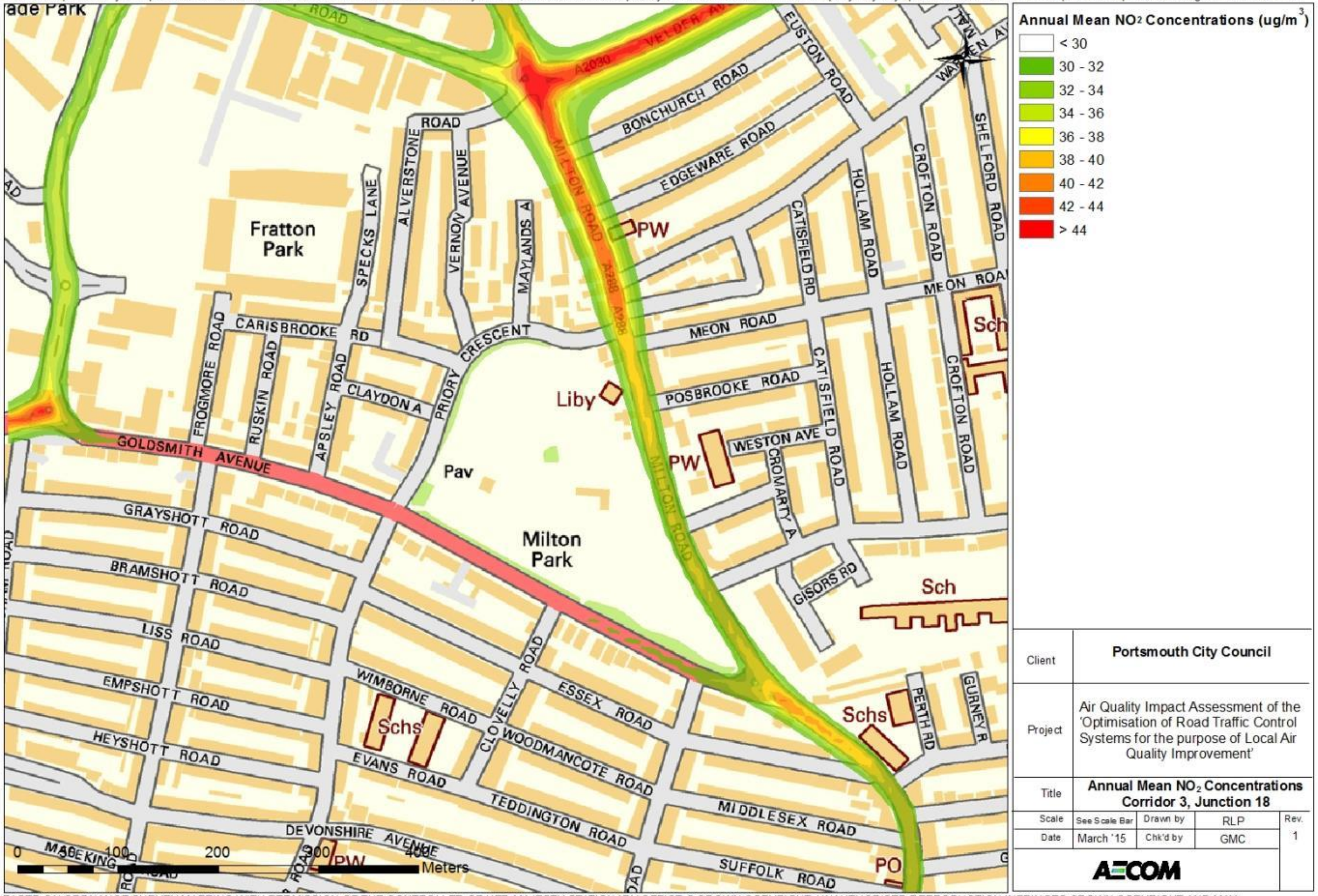

Figure 23: Base Year Annual Mean NO_2 Concentrations, Corridor 4, Junctions 20 and 21

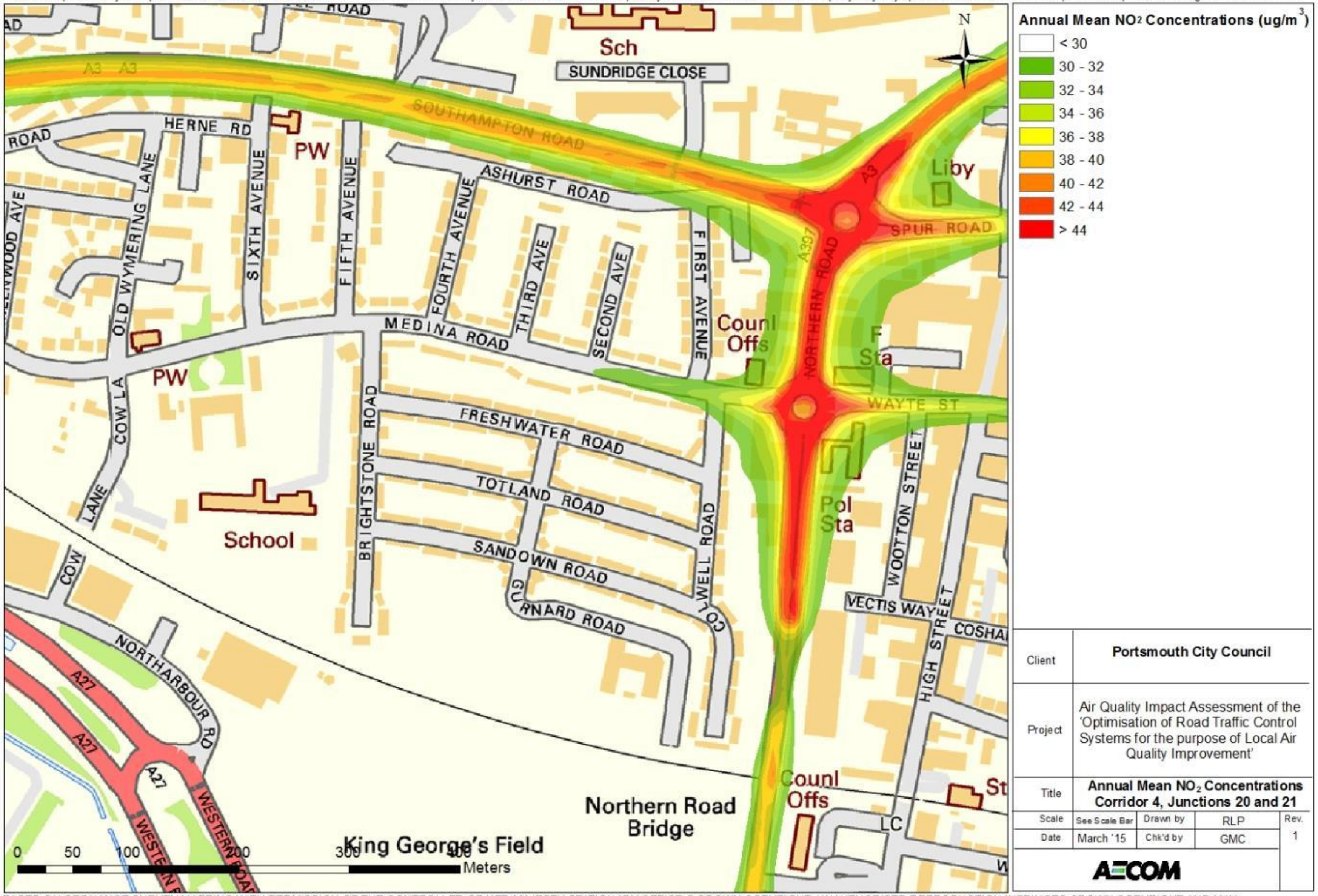

Figure 24: Base Year Annual Mean NO_2 Concentrations, Corridor 5, Junction 24

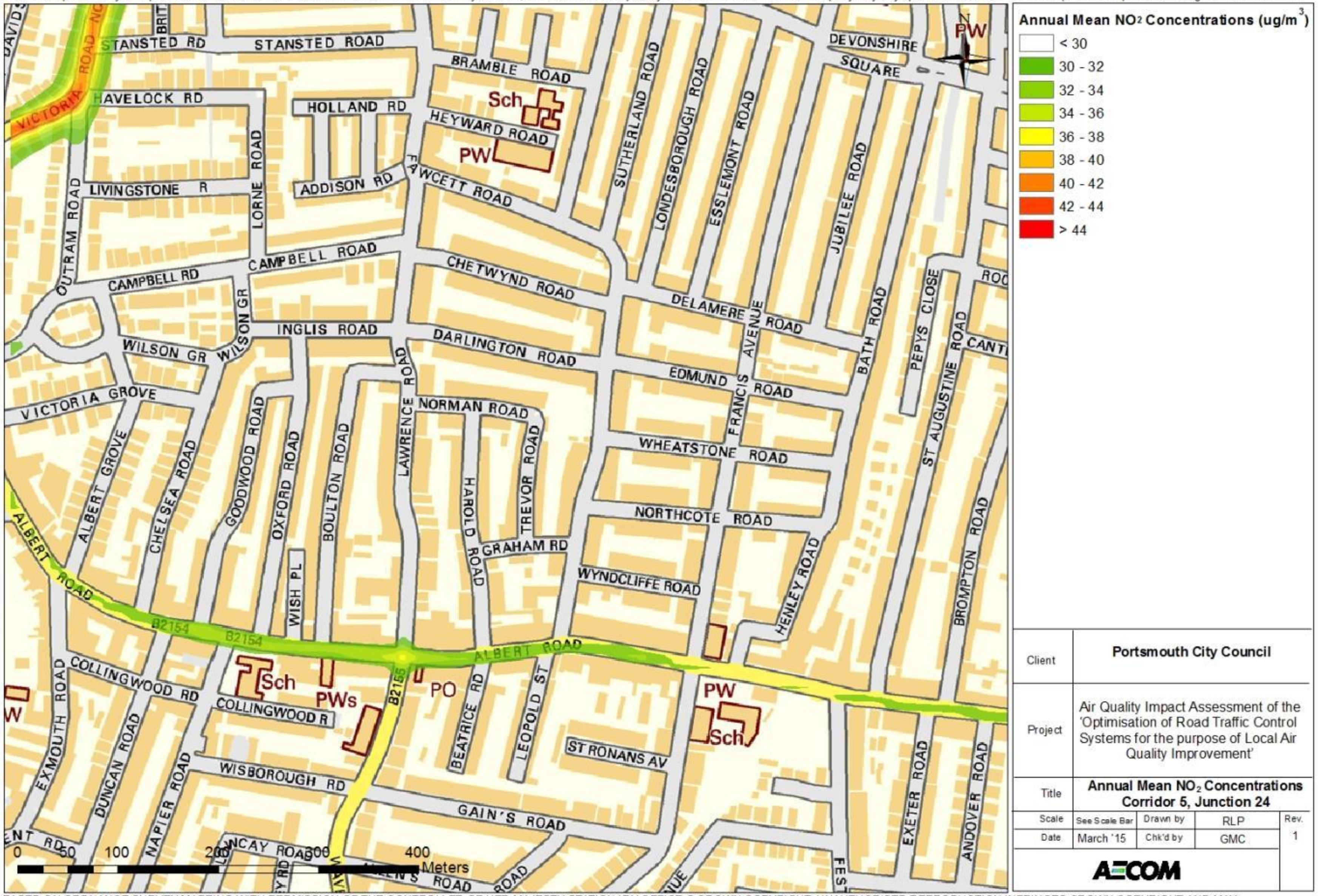

Figure 25: Base Year Annual Mean NO_2 Concentrations, Corridor 5, Junctions 22 and 23

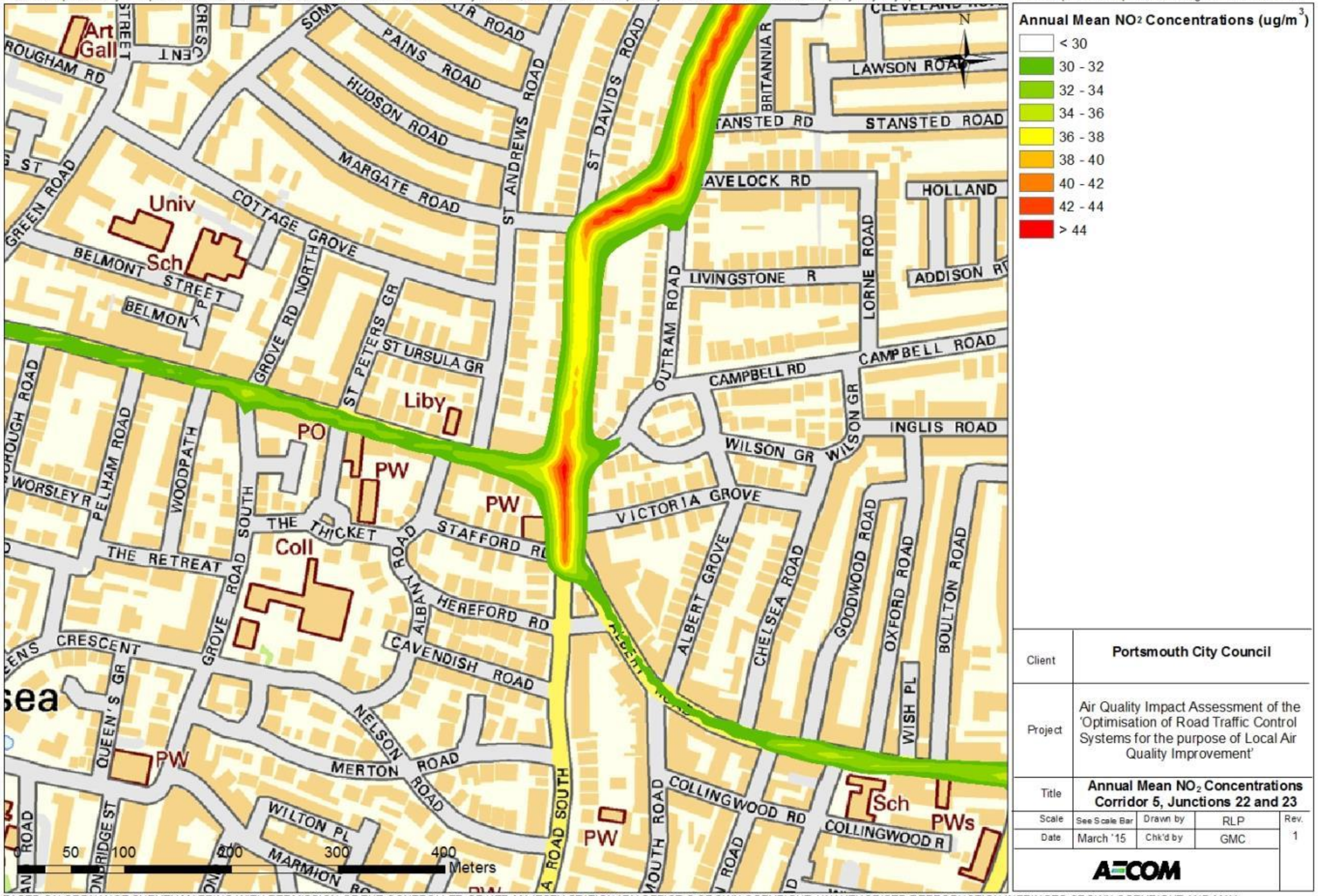

Figure 26: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 1, Junction 1

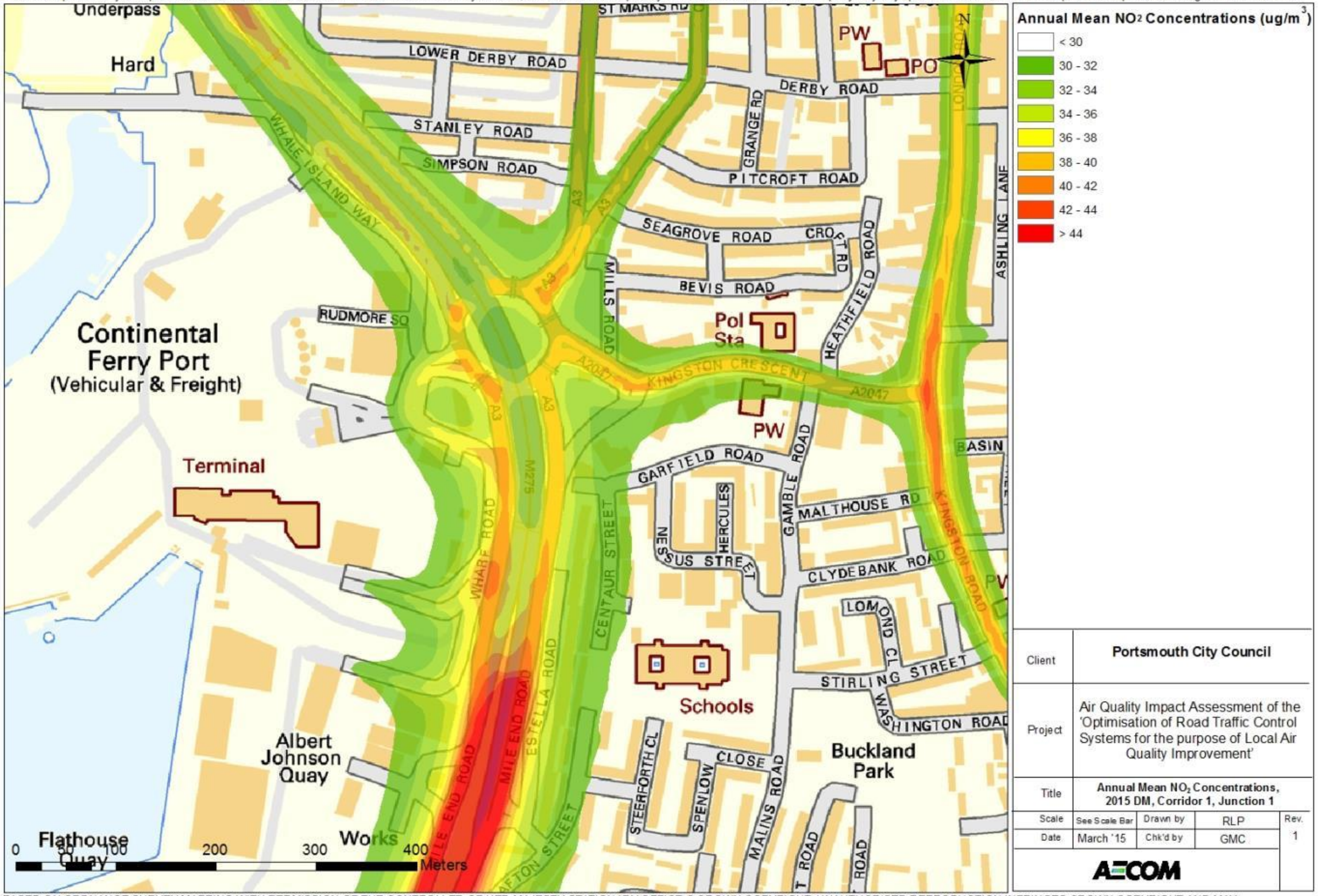

Figure 27: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 1, Junctions 2, 3 and 4

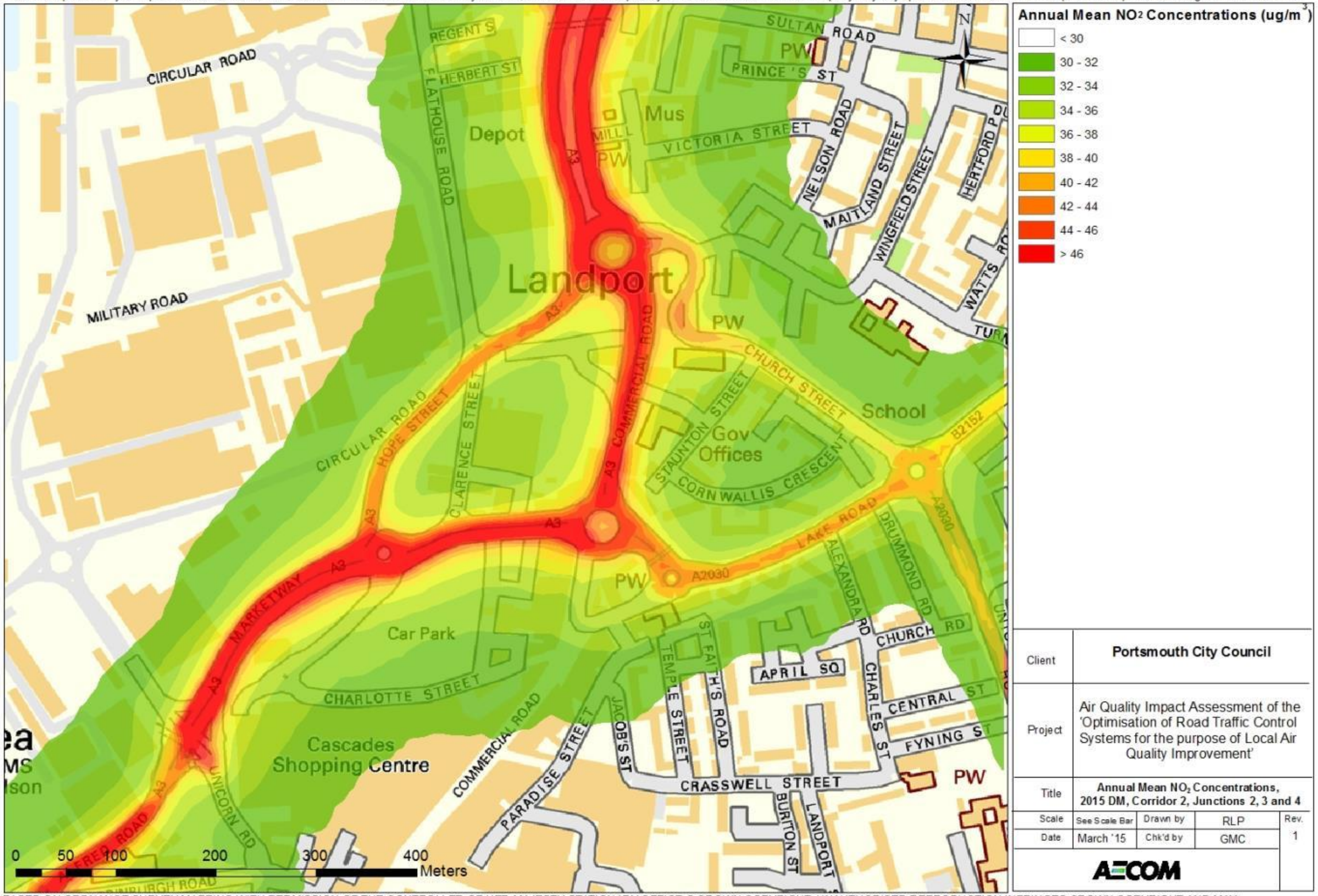

Figure 28: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 1, Junctions 5 and 6

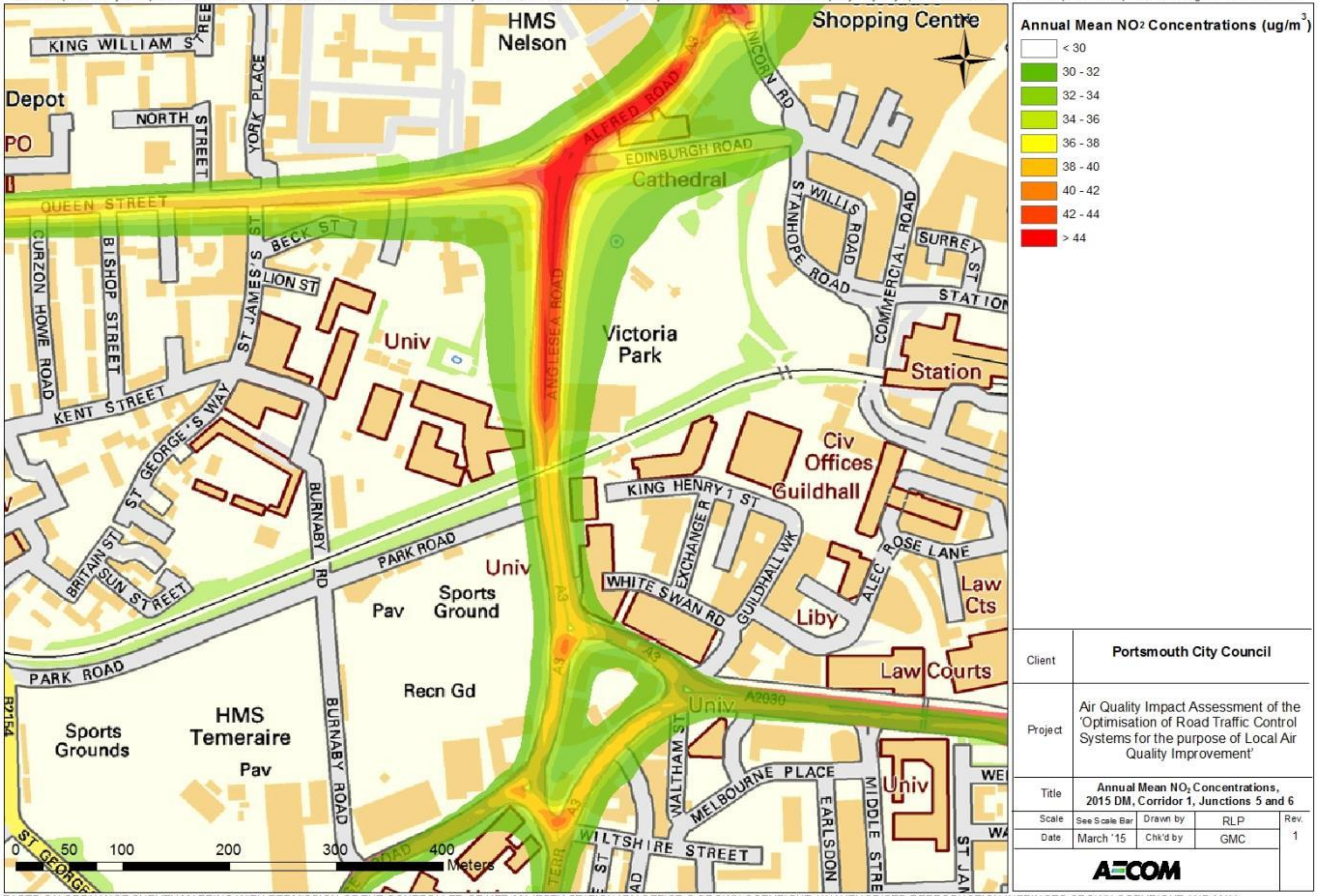

Figure 29: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 2, Junctions 7 and 8

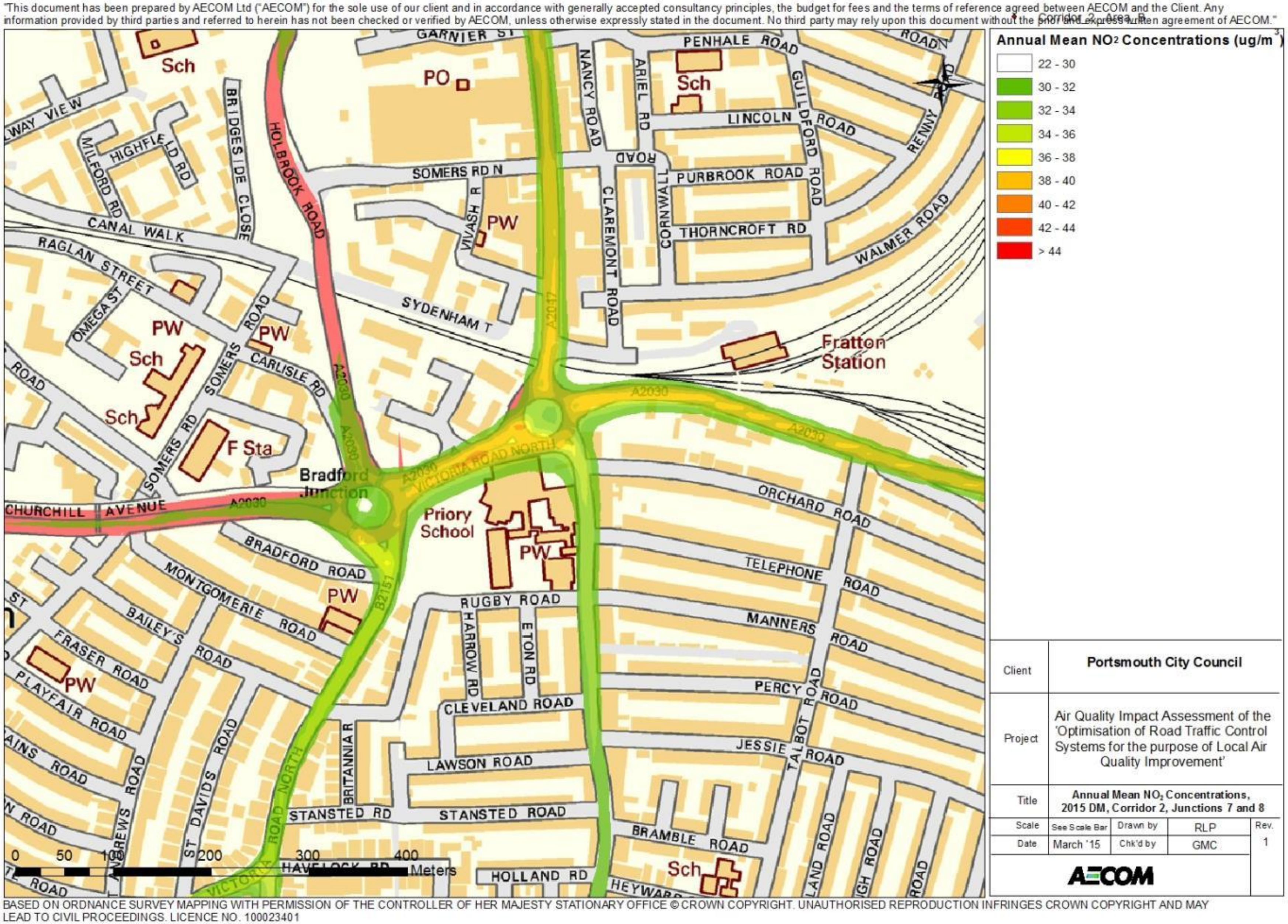

Figure 30: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 2, Junctions 9, 10 and 11

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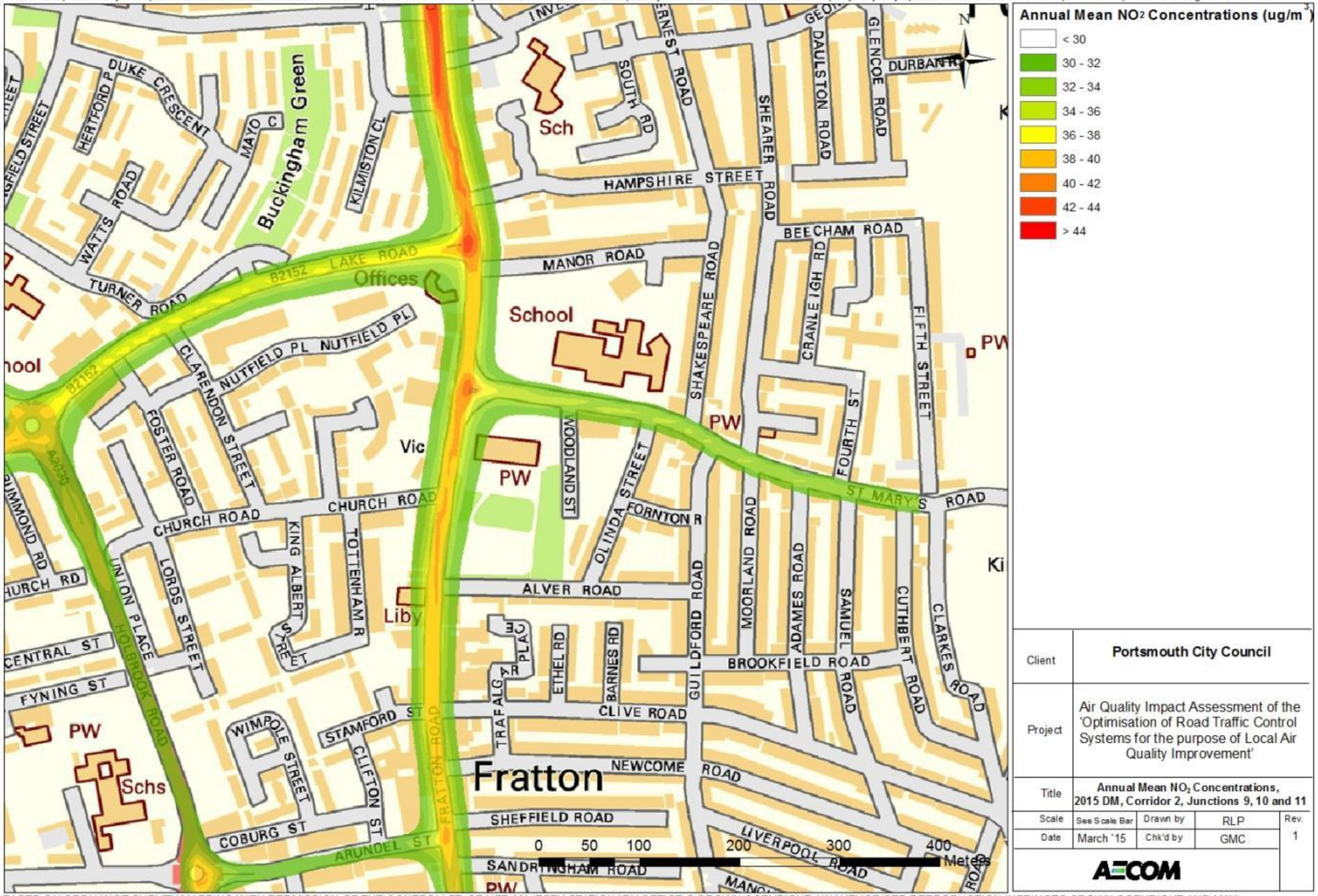

Figure 31: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 2, Junctions 12 and 13

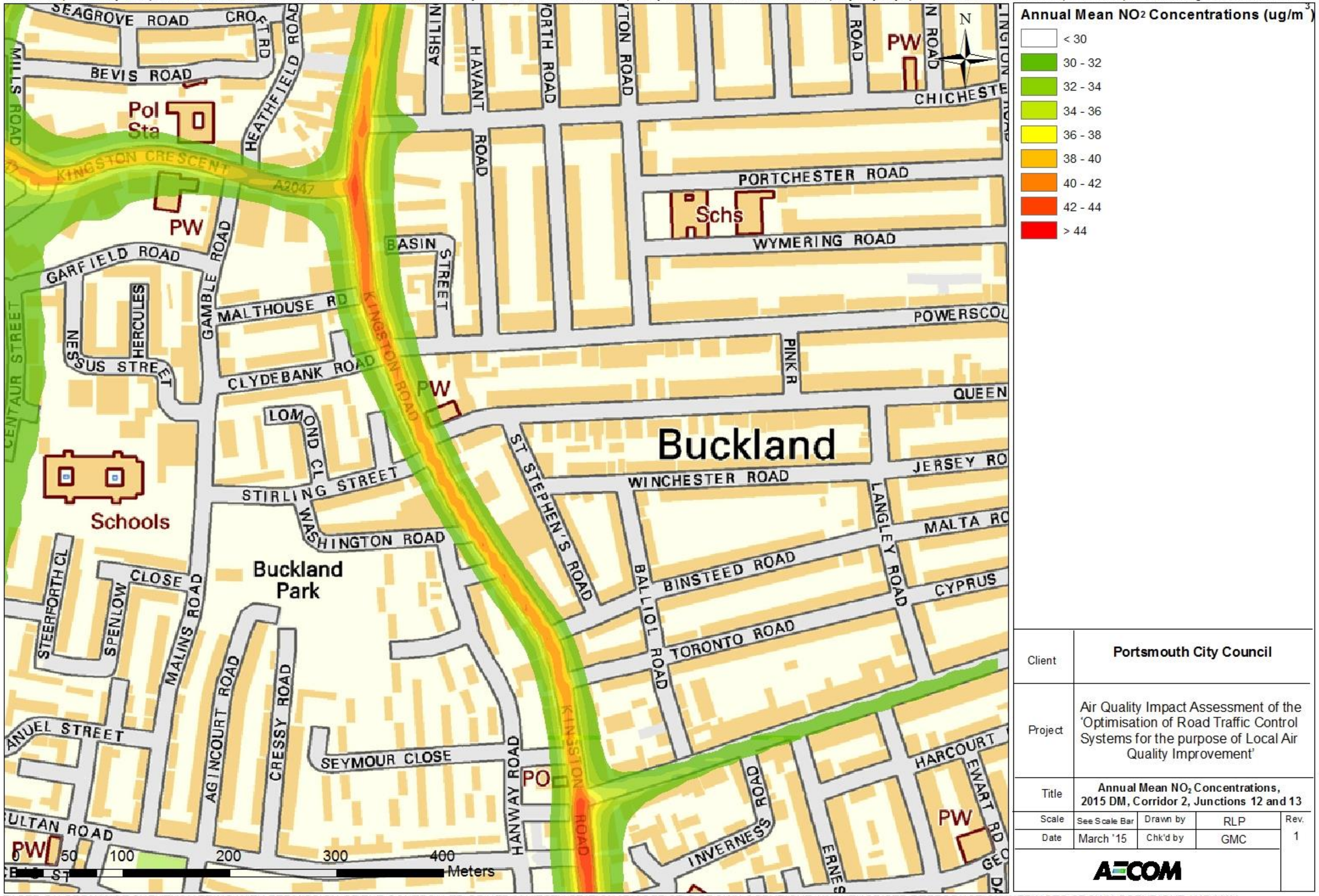

Figure 32: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 3, Junctions 14 and 19

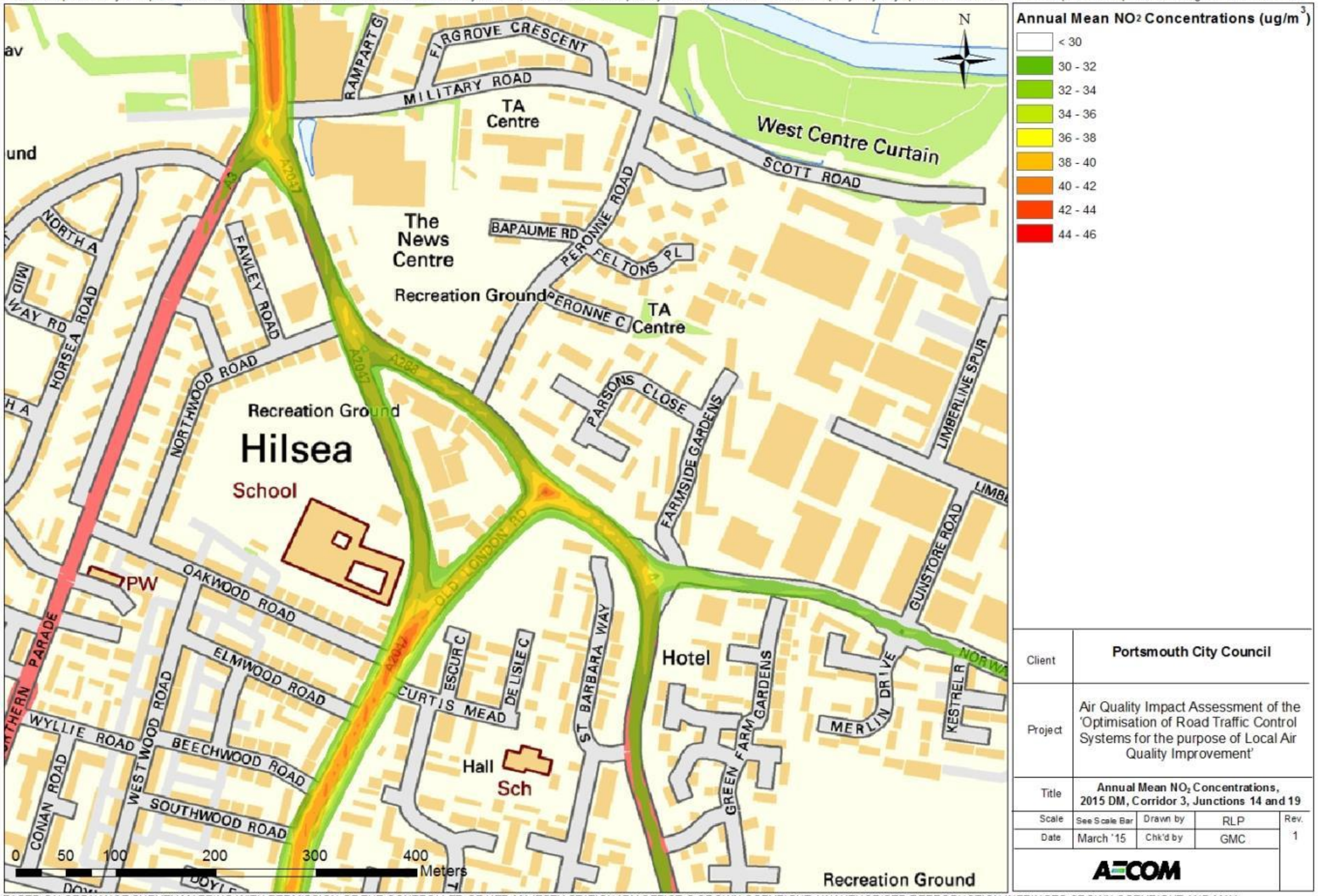

Figure 33: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 3, Junction 15

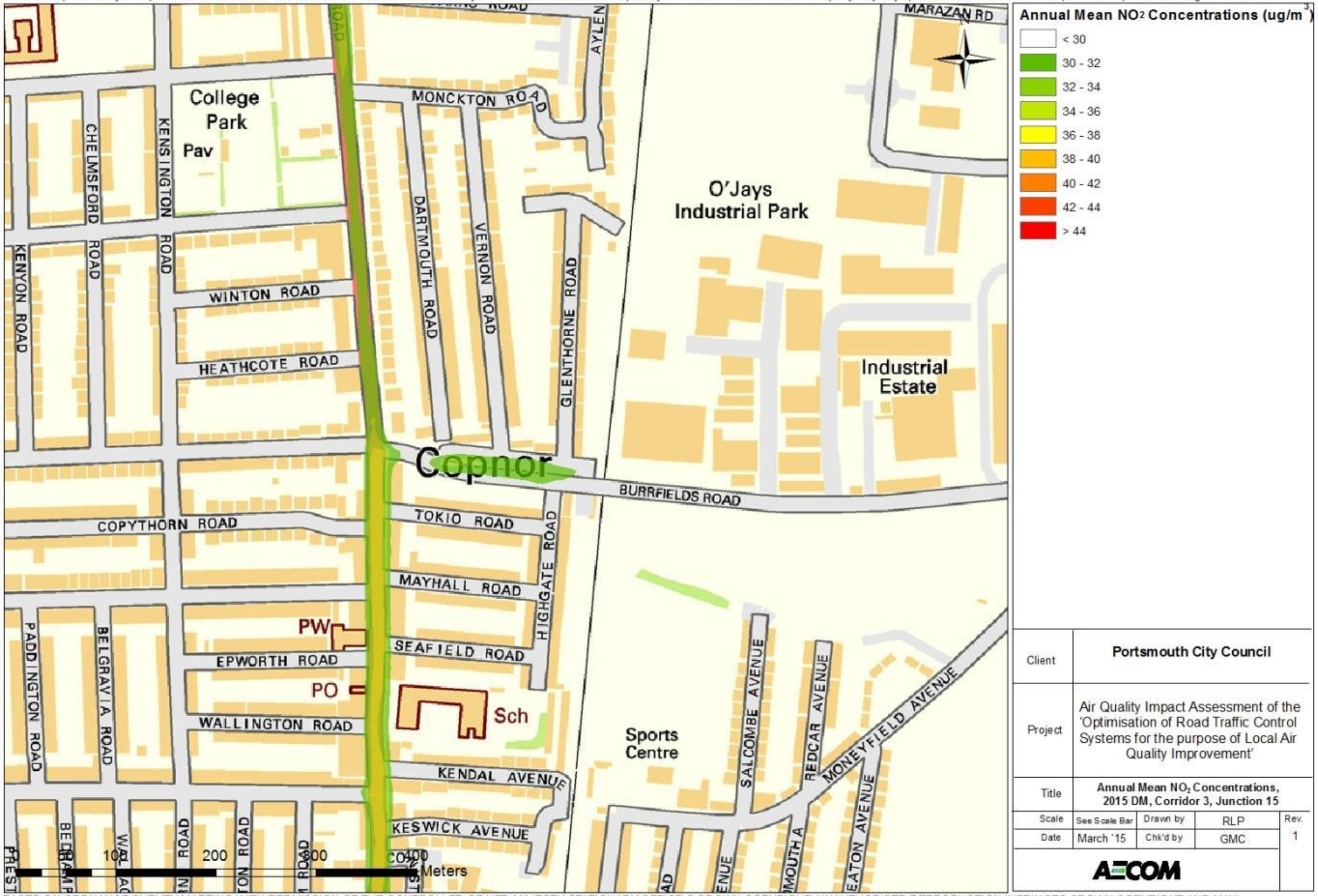

Figure 34: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 3, Junctions 16 and 17

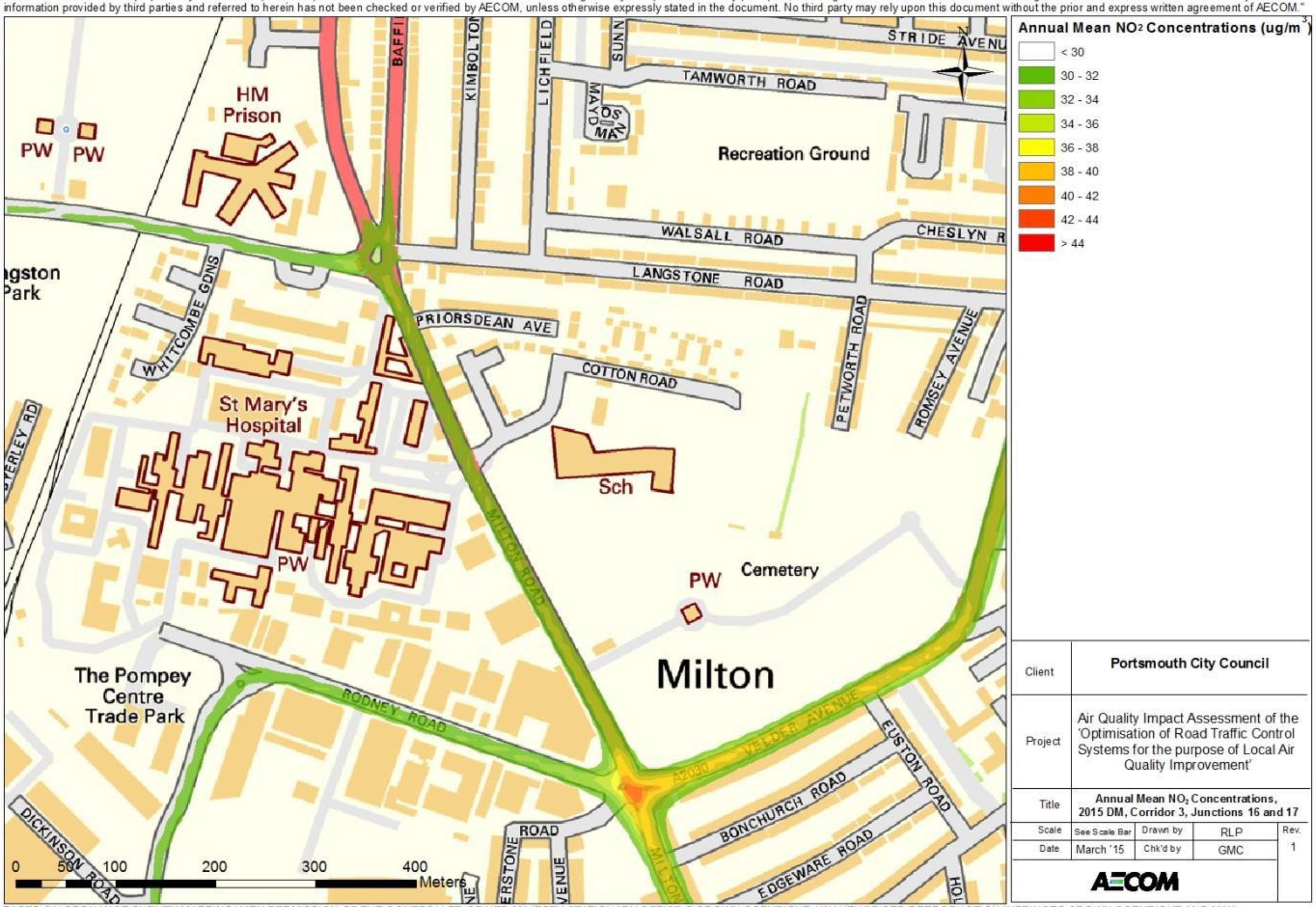

Figure 35: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 3, Junctions 17 and 18

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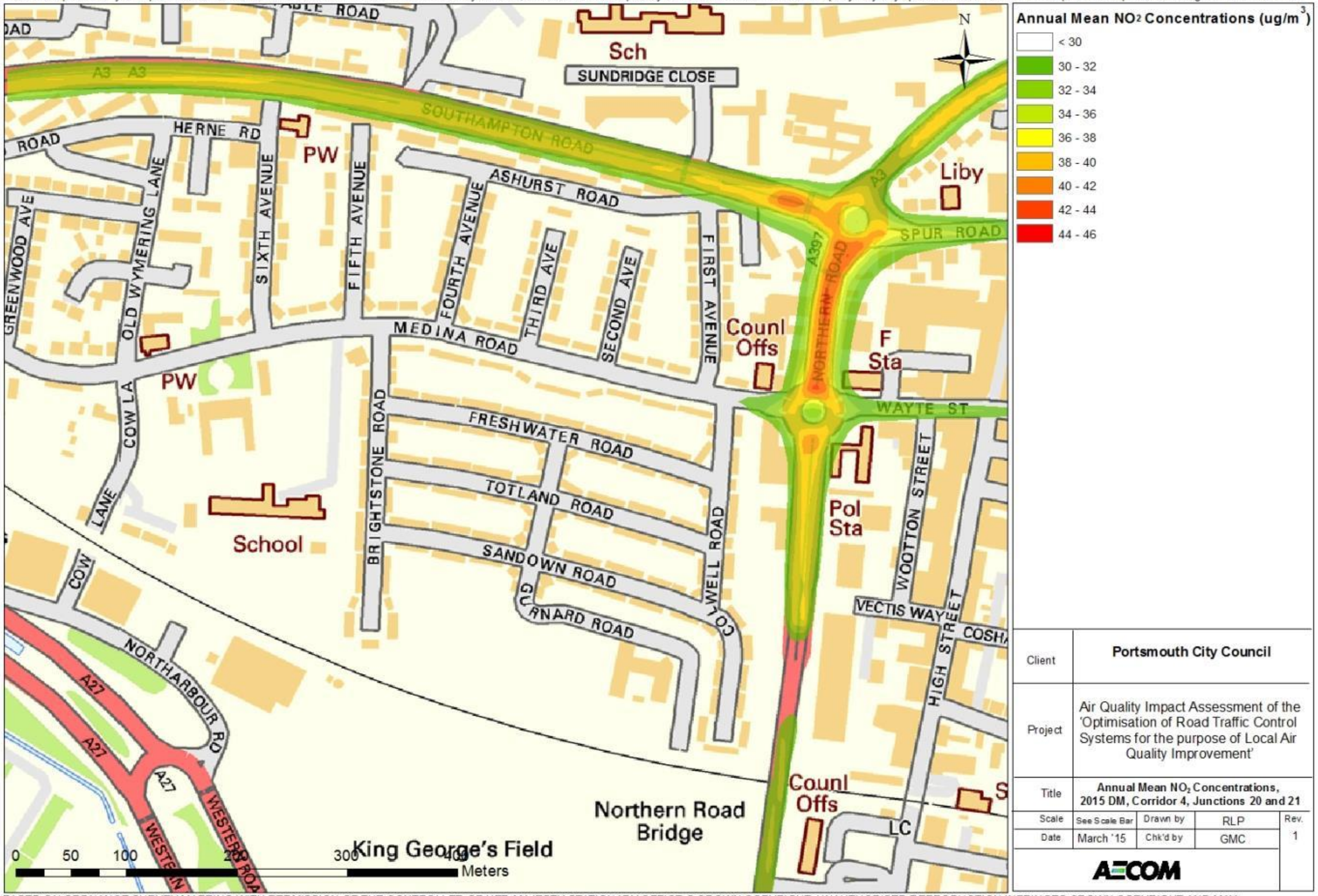
Figure 36: Annual Mean NO_2 Concentrations, 2015 DM*, Corridor 4, Junctions 20 and 21



* There is no DM scenario for Corridor 4. The 2015 DM scenario for Corridor 4 uses base year traffic data with 2015 emission rates and background concentrations.

Figure 37: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 5, Junctions 22 and 23

Figure 38: Annual Mean NO_2 Concentrations, 2015 DM, Corridor 5, Junctions 24