Dunclug and Ballykeel Detailed Assessment of Air Quality

PM_{10} modelling study

Report for Ballymena Borough Council

AEA in confidence
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Issue Number 1
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Executive summary

Local authorities are required to review and assess the air quality in their areas following a prescribed timetable to determine whether the air quality objectives are likely to be met. Where the likelihood of exceedences of air quality objectives has been identified in areas of significant public exposure, an Air Quality Management Area (AQMA) should have been declared, followed by a further assessment, and the formulation of an action plan to work toward eliminating exceedences.

This study is a Detailed Assessment, which aims to assess the likelihood of exceeding the PM_{10} daily mean objective in the Ballymena AQMAs. Detailed Assessments also aim to provide the spatial extent of any predicted exceedences.

A programme of switching domestic properties from solid fuel to gas combustion has been ongoing in the areas which would be expected to have a beneficial impact on local PM_{10} concentrations.

This modelling study, in consultation with 2009 monitoring and meteorological data for the Ballymena area, suggests that the current AQMAs could be revoked as there are no predicted exceedences of the daily mean PM_{10} objective.

However, the Ballymena AQMA still experiences concentrations that are quite close to the objective. Given the unavoidable uncertainties in assessments such as this it may therefore be prudent to revoke the Dunclug AQMA in the first instance, and amend the Ballykeel AQMA to reflect the most recent predictions. If monitoring data in Ballykeel continues to show further improvements in PM_{10} then the AQMA could be completely revoked at a later date.

In light of this detailed assessment BCC should consider revoking the Dunclug AQMA. In addition BCC should consider amending the Ballykeel AQMA with a view to revoking it at a later date where monitoring is indicative of general reductions in PM_{10} in the area (reflecting fuel switching programmes that are ongoing in the area).

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1 Introduction

1.1 Policy framework

Local authorities in the UK are required to review and assess the air quality in their areas following a prescribed timetable to determine whether the air quality objectives are likely to be met. Where the likelihood of exceedences of air quality objectives has been identified in areas of significant public exposure, an Air Quality Management Area (AQMA) should have been declared, followed by a further assessment, and the formulation of an action plan to work toward eliminating exceedences.

The air quality objectives applicable to LAQM in Northern Ireland are set out in the Air Quality Regulations (Northern Ireland) 2003, Statutory Rules of Northern Ireland 2003, no. 342, and are shown in Table 1.1. This table shows the objectives in units of micrograms per cubic metre ($\mu g/m^3$) (milligrammes per cubic metre, mg/m^3 for carbon monoxide) with the number of exceedences in each year that are permitted (where applicable).

Table 1.1 Air Quality Objectives included in Regulations for the purpose of Local Air Quality Management in Northern Ireland.

Pollutant	Concentration	Measured as
Benzene	16.25 $\mu g/m^3$	Running annual mean
	3.25 $\mu g/m^3$	Running annual mean
1,3-Butadiene	2.25 $\mu g/m^3$	Running annual mean
Carbon monoxide	10.0 mg/m^3	Maximum daily running 8-hour mean
Lead	0.5 $\mu g/m^3$	Annual mean
	0.25 $\mu g/m^3$	Annual mean
Nitrogen dioxide	200 $\mu g/m^3$ not to be exceeded more than 18 times a year	1-hour mean
	40 $\mu g/m^3$	Annual mean
Particles (PM_{10}) (gravimetric)	50 $\mu g/m^3$, not to be exceeded more than 35 times a year	24-hour mean
	40 $\mu g/m^3$	Annual mean
Sulphur dioxide	350 $\mu g/m^3$, not to be exceeded more than 24 times a year	1-hour mean
	125 $\mu g/m^3$, not to be exceeded more than 3 times a year	24-hour mean
	266 $\mu g/m^3$, not to be exceeded more than 35 times a year	15-minute mean

1.2 Purpose of this assessment

This study is a Detailed Assessment, which aims to assess the likelihood of exceeding the PM_{10} daily mean objective in the Ballymena AQMAs. Detailed Assessments also aim to provide the spatial extent of any predicted exceedences.

When carrying out the review and assessment of air quality it is only necessary to focus on areas where the public are likely to be regularly present and are likely be exposed over the averaging period of the objective. In the case of the PM_{10} objectives, it is reasonable to assume that these apply at residential locations.

1.3 Overview of the approach taken

The general approach taken to this detailed assessment was to:

- Collect and interpret data from previous review and assessment reports
- Collect and analyse all available domestic fuel use data, air quality monitoring data and background concentration data for use in the models
- Identify potential hotspots where it is likely that the AQS objectives would not be met
- Model PM_{10} concentrations surrounding these hotspots
- Produce contour plots of the modelled pollutant concentrations
- Recommend whether Ballymena Borough Council (BBC) should retain, revoke or amend the Dunclug and Ballykeel AQMAs.

The methodologies outlined in Technical Guidance LAQM.TG(09)[1] were used throughout this detailed assessment.

1.4 Conclusions of relevant previous reports for PM_{10}

A summary of recent review and assessment reports relevant to the Ballymena AQMAs is provided below.

Third stage review and assessment (2004)

The outcome of domestic fuel combustion modelling resulted in declaration of two AQMAs broadly named Dunclug and Ballykeel in respect of predicted exceedence of the daily PM_{10} objective. BBC proceeded to declare two AQMAs in respect of PM_{10} on 25th October 2004.

The department's technical guidance stresses the importance of verifying the dispersion modelling by conducting local monitoring. Therefore a decision was taken to colocate a PM_{10} Real Time analyser with the existing SO_2 Real Time analyser within the Ballykeel AQMA.

Stage Four Review and Assessment (2004/05).

With updated fuel use data obtained in late 2004 NETCEN were commissioned to conduct a Stage 4 Air Quality Review for domestic emissions sources within both AQMAs. Importantly at this stage NIHE had embarked on a fuel conversion scheme with the Dunclug AQMA. Fresh data in respect of both areas was incorporated into the study.

The Stage 4 study represented a more accurate modelling exercise using more up to date information than the previous stage 3 modelling. The modelling indicated that PM_{10} emissions arising from domestic fuel combustion in BBC was predicted to cause an exceedence of the daily PM_{10} objective at relevant receptors within the assessed areas, specifically Ballykeel.

[1] Local Air Quality Management Technical Guidance LAQM.TG(09), Defra, 2009

The modelling predicted an exceedence of the PM_{10} daily mean objective. The designation of an AQMA remained valid subject to verification of the modelling using local monitoring data.

Update and Screening Report (2009)

The Air Quality Regulations state that PM_{10} gravimetric concentration as a daily average of 50ug/m^3 should not be exceeded more than 35 times per annum; in addition a target annual mean of 40ug/m^3 should be achieved.

Local monitoring in 2008 has shown these objectives are being achieved even within the worst case contour for which the conversion to gas will not be completed until 2011.

2 Air Quality Management Areas

BBC declared two AQMAs (Ballykeel and Dunclug) in 2004 for exceedences of the daily PM_{10} objective. The boundaries of the AQMAs are shown in Figure 2.1 and Figure 2.2 below (concentration contours on the maps are in µg/m^3 and show the 90th percentile of the daily mean- if this value is over 50 µg/m^3 this corresponds to an exceedence of the daily objective).

Figure 2.1 Air Quality Management Areas (AQMA) boundaries within Air Quality Management Area (Ballykeel and surrounding area) Order No.1.

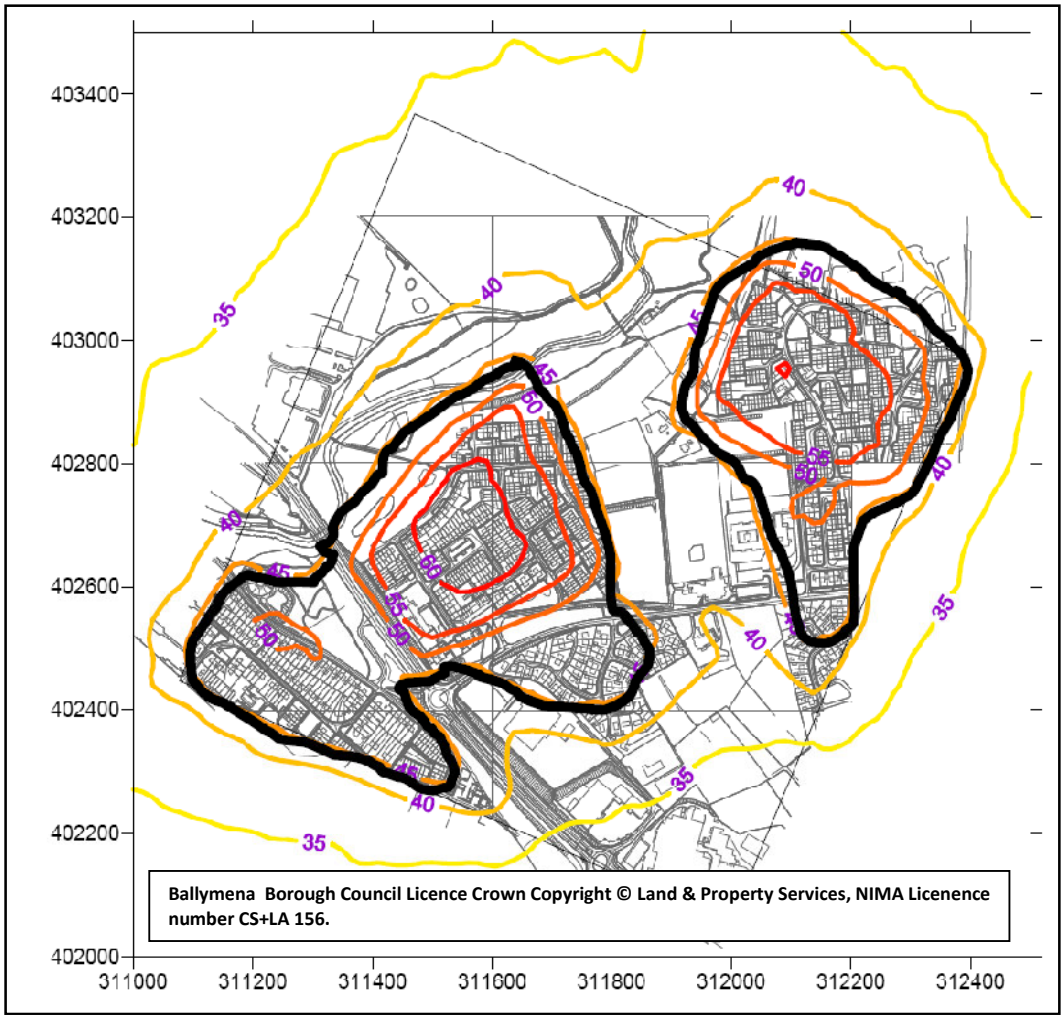
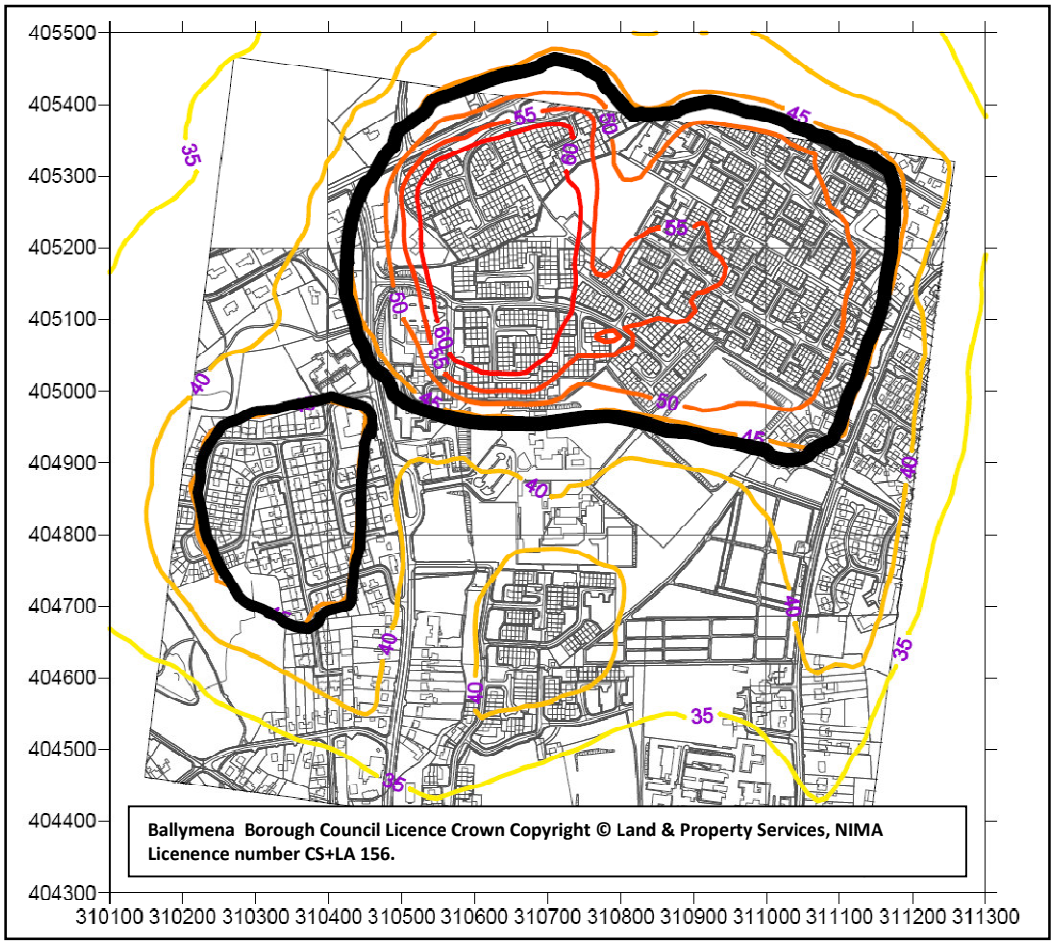


Figure 2.2 Air Quality Management Areas (AQMA) boundaries within Air Quality Management Area (Dunclug and surrounding area) Order No.2



3 Assessment methodology

The assessment is concerned with predicting PM_{10} concentrations in the two Ballymena AQMAs. The main source of particles in both areas is domestic fuel combustion. As such, the starting point requires an estimation of the amount of fuel being used in the areas; this estimate is then used to inform a calculation of PM_{10} emissions. It should be noted that the data had to be manipulated in such a way as to make the emissions data suitable for input to the dispersion modelling software so that ambient predictions can be made.

It was decided that modelling the AQMAs with a series of individual area sources of PM_{10} was as robust as any comparable method. This meant that the methodology had to take available fuel use data and derive emissions for the area source in grams per metre squared per second. We have tried to minimise uncertainty in these calculations but assessments of this nature will always carry notable uncertainties regardless. Verifying the model against local monitoring is the main way of reducing uncertainty in dispersion modelling predictions (after standard checks of input data quality) and this has carried out for this assessment.

Clearly there are several steps to moving from household fuel consumption to PM_{10} concentrations and these are outlined in subsequent sections.

3.1 Mapping of the AQMAs and properties therein

GIS maps of the AQMA areas were provided by BBC along with a data set comprising the x,y coordinates of every residential property in the area. The residential areas within the AQMAs were split into a series of eight subdomains and the number of properties within each was estimated using ArcGIS. The size of each subdomain and the number of properties within each are shown in Table 3-1 below (and shown spatially in Figure 3.1 and Figure 3.2).

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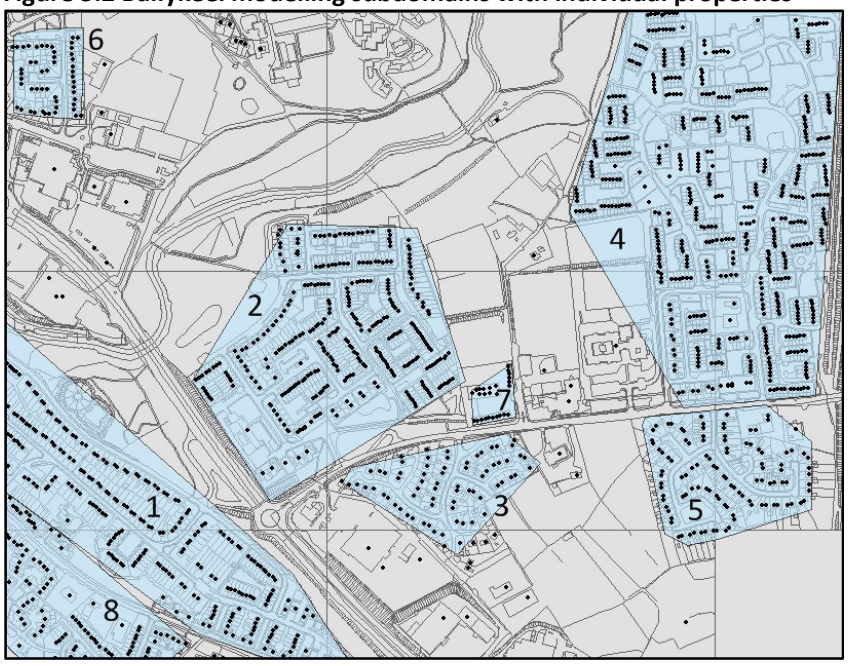
Table 3-1 Residential areas modelled in Ballykeel and Dunclug

Ballykeel subdomain	area m^2	number of properties	Dunclug subdomain	area m^2	number of properties
1	152033	455	1	135093	306
2	111295	438	2	15072	28
3	29863	67	3	139272	185
4	201067	569	4	19131	12
5	44016	110	5	280031	834
6	14238	55	6	68459	190
7	4491	26	7	18386	51
8	70086	246	8	5701	21
Total	**627089**	**1966**	**Total**	**681145**	**1627**

Figure 3.1 Dunclug modelling subdomains with individual properties

Figure 3.2 Ballykeel modelling subdomains with individual properties



It should be noted that the shapes used for the area sources are to some extent informed by the requirements of ADMS- it cannot make calculations for area sources which are concave.

3.2 Monitoring data- PM_{10}

3.2.1 2009 data

BBC currently measures PM_{10} in the Ballykeel AQMA with a TEOM FDMS analyser (in conjunction with an SO_2 analyser).

The data provided in Table 3-2 shows that there were no exceedences of PM_{10} air quality objectives at the monitoring site.

Table 3-2 PM_{10} monitoring data from the Ballykeel AQMA with ratified data for 2009

Site	Site type	Easting, Northing	Data Capture 2009 (%)	Daily PM_{10} exceedences (50µg m^{-3})	90th percentile of daily means	Annual mean PM_{10} (µg m^{-3})
Ballykeel Estate	Urban background	312367, 402938	89.6	6	36	25
See Appendix 1 for 2009 Air Pollution Report produced by AEA for the site						

3.2.2 QA/QC

All continuous monitoring stations in Ballymena are part of the Calibration Club managed by AEA. Data from these sites are quality assured to the same standards as the AURN. In addition, a QA/QC audit which includes calibration of the analysers using zero gas standards, and other tests for efficiency is undertaken by AEA. Data are fully ratified by AEA using procedures as applied to data from the AURN.

Full QA/QC information is provided in Appendix 2.

3.3 Treatment of background concentrations

The background concentrations of PM_{10} in each of the AQMAs were derived from the maps produced by Defra and the devolved administrations. Each modelled area falls within more than one 1km map square and so an average for the squares intersecting each AQMA was used, minus the contribution from domestic sources in the area (this is removed to avoid double counting). For the purposes of verifying the model at Ballykeel, the contribution to the total concentration from local sources is therefore the monitored value minus the average background concentration in Table 3-3.

The background data used in the assessment is shown Table 3-3 and

Table *3-4* below.

Table 3-3 Ballykeel background PM_{10} values 2009 (µg/m^3)

x	y	Total background	Domestic contribution	Total minus domestic
126500	559500	14.06	1.91	12.15
127500	559500	12.48	0.94	11.54
126500	560500	12.45	1.41	11.04
127500	560500	12.31	1.14	11.17
	Average	**12.82**	**1.35**	**11.47**

Table 3-4 Dunclug background PM_{10} values 2009 (µg/m^3)

x	y	Total background	Domestic contribution	Total minus domestic
125500	562500	11.62	1.12	10.50
126500	562500	12.74	1.38	11.36
125500	561500	12.26	1.24	11.02
126500	561500	12.60	1.43	11.17
	Average	**12.31**	**1.29**	**11.01**

3.4 Emissions data

Data from a recent fuel use survey carried out by BBC was used to calculate emissions rates within the AQMAs. The fuel use survey did not include every property in the AQMA so it was used to extrapolate average emissions to properties which were not surveyed. Information was provided as to the number of properties using either coal, oil, mains/ bottled gas or electricity along with typical fuel consumption rates and the x,y coordinates of each property.

The percentage of surveyed houses (see Table 3-5 and Table 3-6) in the AQMAs burning each type of fuel was used to apportion emissions to the areas described above. This means that the emissions estimates are reasonably bespoke to the AQMA in question.

The data shows that the prevalence of solid fuel combustion is still quite high in Ballykeel and less so in Dunclug, which will correlate with local PM_{10} emissions in both areas.

Table 3-5 Fuel use in Dunclug- survey data

Fuel type- Dunclug	Number of properties using the fuel	As % of total houses surveyed
Oil	274	33.8
Electricity	125	15.4
Coal/solid fuel	166	20.5
Mains gas	246	30.3
Bottled gas	1	0.1

Table 3-6 Fuel use in Ballykeel- survey data

Fuel type- Ballykeel	Number of properties using the fuel	As % of total houses surveyed
Oil	400	39.0
Electricity	158	15.4
Coal/solid fuel	356	34.7
Mains gas	112	10.9
Bottled gas	0	0

The fuel use survey was used to establish the average fuel consumption for the properties which was then multiplied by the appropriate emissions factor to derive an average fuel specific emission rate for each property. It should be noted that the survey data stated that oil burning properties also use coal from time to time as a backup fuel supply and this has been factored into the average emissions calculation for these properties.

The emissions factors used were the most recent available at the time of writing from the National Atmospheric Emissions Inventory and are shown in Table 3-7 below. Since the emissions of PM_{10} from gas combustion are negligible, these were discounted from the study.

The derived "per property" emissions rates are shown in Table 3-8 below.

Table 3-7 2008 NAEI Emissions factors for PM_{10} from domestic combustion

Fuel type	PM_{10} 2008 emission factor (g/kg)
Burning oil	0.139
Coal	11
Natural gas	0.00005

Table 3-8 PM_{10} emission rates for an average property

Emission type	Emission quantity
Emission per coal burning property per year	40.68kg
Emission per coal property per second	**0.0013 g**
Emission per oil property per year	2.46 kg
Emission per oil property per second	**0.000078g**

The average emission rate was multiplied by the number of properties burning each fuel in each of the eight subdomains, and the emission in each was calculated as an area source.

The total emission for each was divided by the area in square metres to give an emission rate in grams per metre squared per second for input to ADMS4.2.

The derived emissions rates used in the ADMS model are provided in Table 3-9 and

Table *3-10* below.

Table 3-9 Dunclug area PM_{10} emission rates

Dunclug area	total emission kg/yr	total emission g/s	area emission g/m^2/s
1	4612.69	1.46E-01	1.08E-06
2	422.08	1.34E-02	8.88E-07
3	2788.72	8.84E-02	6.35E-07
4	180.89	5.74E-03	3.00E-07
5	12571.84	3.99E-01	1.42E-06
6	2864.09	9.08E-02	1.33E-06
7	768.78	2.44E-02	1.33E-06
8	316.56	1.00E-02	1.76E-06

Table 3-10 Ballykeel area PM_{10} emission rates

Ballykeel area	total emission kg/yr	total emission g/s	area emission g/m^2/s
1	6858.74	2.17E-01	1.43E-06
2	6602.48	2.09E-01	1.88E-06
3	1009.97	3.20E-02	1.07E-06
4	8577.19	2.72E-01	1.35E-06
5	1658.16	5.26E-02	1.19E-06
6	829.08	2.63E-02	1.85E-06
7	391.93	1.24E-02	2.77E-06
8	3708.24	1.18E-01	1.68E-06

3.5 Dispersion modelling

The most recent version of Atmospheric Dispersion Modelling System (v4.2) was used in the assessment. The emissions data calculated above were input to the model alongside the model parameters shown in Table 3-11 below.

One year (2009) of hourly sequential meteorological data was sourced from the third party supplier for the Belfast Aldergrove site- the data from this site was judged by the vendor to be of good quality. A wind rose of the 2009 data is provided in Appendix 3.

As described previously the sources were modelled as area emissions at ambient temperature- since the emissions are spread over quite large areas it seems reasonable to assume low ambient release temperature.

A source height of 5m was selected, and values for surface roughness and limit of Monin-Obhukov length were selected from model defaults that best describe the areas being modelled.

Table 3-11 ADMS model parameters

Model parameter	Model input
Source type	Area
Meteorology*	1 year (hourly sequential)
Surface roughness	0.5m
Source height	5m
Source temperature	As ambient
Monin-Obukhov length	10m
Output grid resolution	Approx 20m
*meteorological data from Belfast Aldergrove, 2009	

3.5.1 Model verification

In the first instance the Ballykeel model outputs were verified by comparing the annual mean predictions with the ratified PM_{10} monitoring data for the same time interval. For the purposes of verifying the model at Ballykeel, the contribution to the total concentration from local sources is therefore the monitored value minus the average background concentration in Table 3-3.

When the background component of PM_{10} is removed from the annual mean measurement, and the model predictions are checked against the remaining locally contributed component, **the model was found to underpredict the contribution from local sources by a factor of 1.9 (see Table Table *3-12*).**

Table 3-12 Model verification and adjustment derivation

Location	x	Y	Modelled PM_{10}	Monitored PM_{10}	adjustment factor
Auto analyser	312367	402938	7.0	13.5	**1.9**

It is very common for dispersion models to underpredict concentrations on comparison with real measurements. The reason for the underprediction in this case could be the result of uncertainties in the fuel survey data which are then carried through to the emissions estimates and eventual concentration predictions. To account for these uncertainties the correction factor was applied to all model outputs (the background is then added back in to give a total concentration for plotting in the GIS).

As described, the model was verified against the measured annual mean so it was necessary to convert the annual mean predictions to a value for comparison with the 90th percentile of daily means.

The relationship between the measured annual mean and the 90th percentile of daily means at the automatic monitoring site was used. **The measured annual mean was 25µg/m3 with a 90th percentile of daily mean of 36 µg/m^3- therefore the adjustment factor is 1.44. All annual mean predictions have been multiplied by 1.44 to derive the appropriate value for comparison with the daily mean PM_{10} objective.**

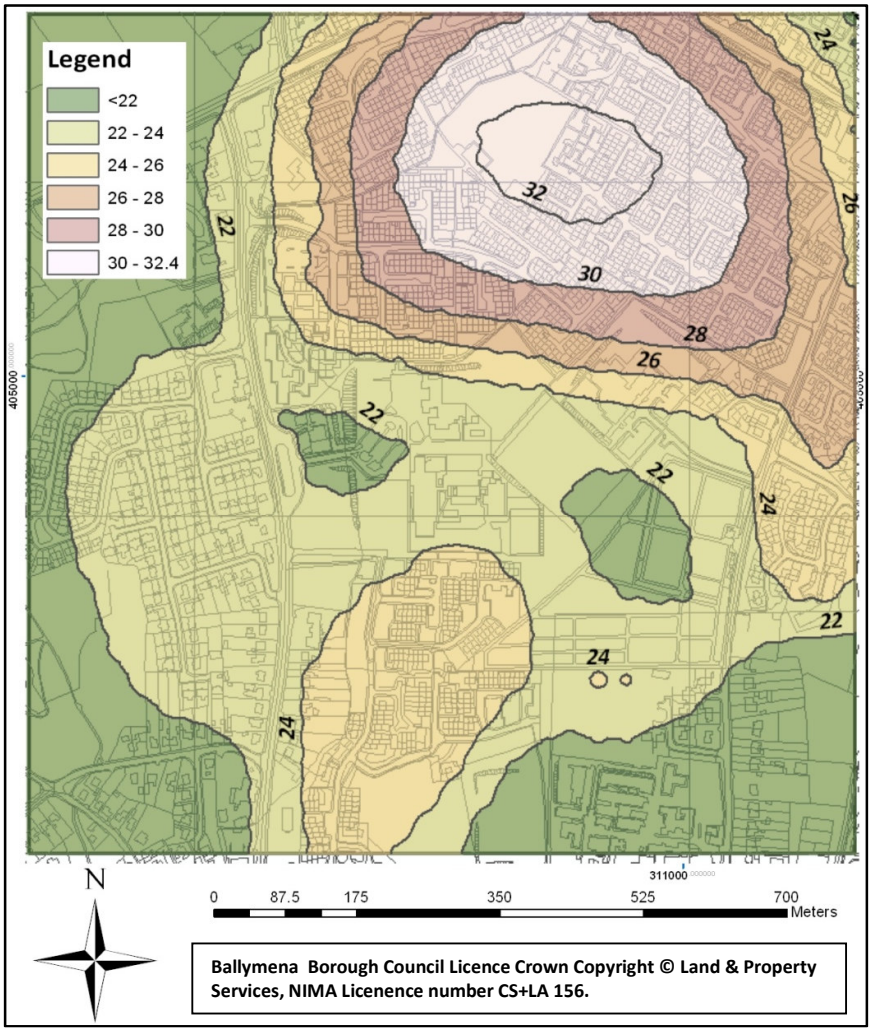
4 PM_{10} modelling results

The modelled concentrations of PM_{10} in 2009 in both AQMA locations are provided below. The modelling indicates that there are no exceedences of the daily mean PM_{10} objective (Figures 4.1 and 4.3- concentration isopleths of 50µg/m^3 would be suggestive of exceedences). Given that the daily objective is probably being achieved; it is very unlikely that the annual mean objective for PM_{10} is at risk of being exceeded.

That said, the daily mean objective is still approached in a small area in Ballykeel so it would be prudent to encourage further switching away from solid fuel use to further drive down PM_{10} concentrations. The dispersion modelling exercise indicates that BBC should consider revoking the current AQMAs, though concentrations in Ballykeel are still quite close to the objective in one small area.

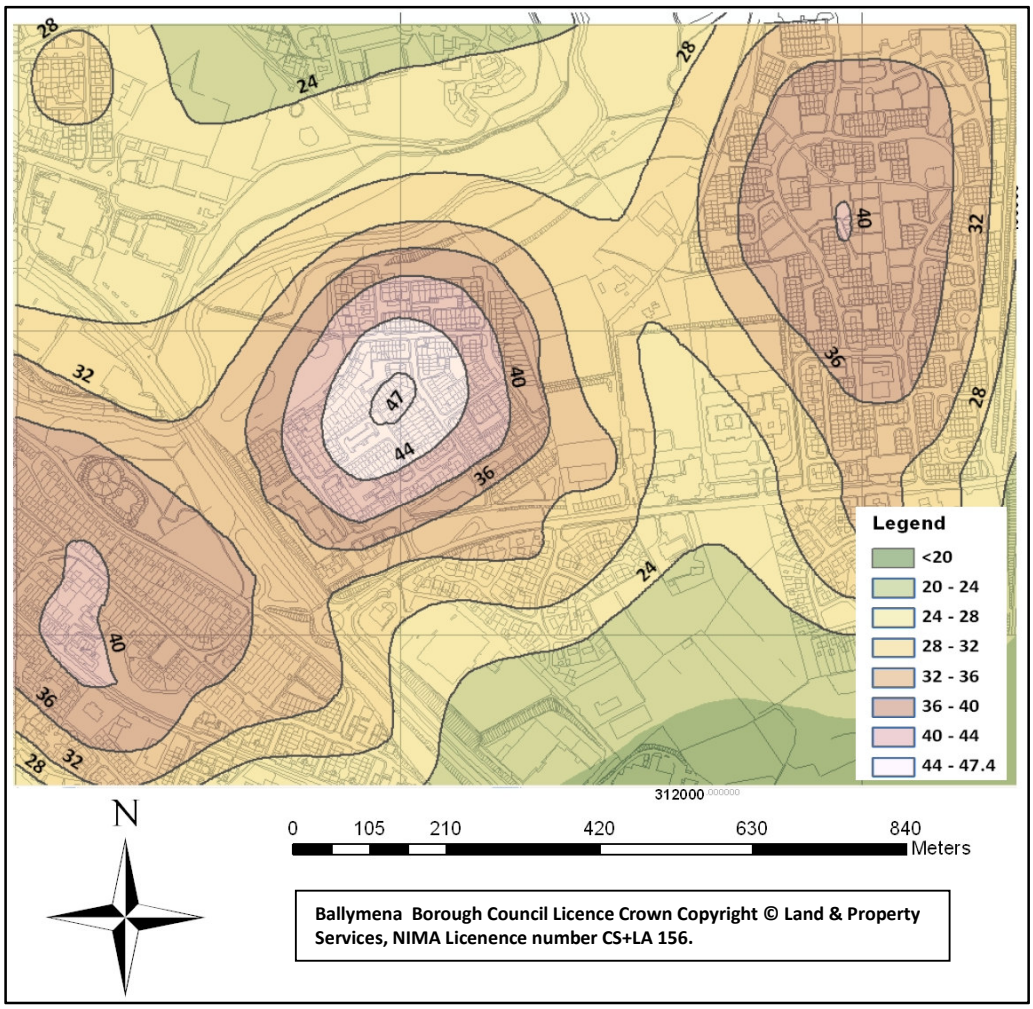
4.1 Dunclug

Figure 4.1 Dunclug 90th percentile of PM_{10} daily means 2009 (µg/m^3)



4.2 Ballykeel

Figure 4.2 Ballykeel 90th percentile of PM_{10} daily means 2009 (µg/m^3)



5 Summary and conclusion

This modelling study, in consultation with 2009 monitoring and meteorological data for the Ballymena area, suggests that the current AQMAs could be revoked as there are no predicted exceedences of the daily mean PM_{10} objective.

However, the Ballykeel AQMA still experiences concentrations that are quite close to the objective. Given the unavoidable uncertainty in assessments of this nature, it may therefore be prudent to revoke the Dunclug AQMA in the first instance, and amend the Ballykeel AQMA to reflect the most recent predictions. If monitoring data in Ballykeel continues to show further improvements in PM_{10} then the AQMA could be completely revoked at a later date.

In light of this detailed assessment BCC should consider revoking the Dunclug AQMA. In addition BCC should consider amending the Ballykeel AQMA with a view to revoking it at a later date where monitoring is indicative of general reductions in PM_{10} in the area (reflecting fuel switching programmes that are ongoing in the area).

6 Acknowledgements

AEA gratefully acknowledge the help and support of Ballymena Borough Council, in particular Sinead Sargent.

Appendix 1 – Air pollution monitoring report

BALLYMENA BALLYKEEL
01 January to 31 December 2009

Produced by AEA on behalf of Ballymena BC

These data have been fully ratified by AEA

POLLUTANT	PM_{10}*+
90th percentile of daily means	36 µg m^{-3}
Average	25 µg m^{-3}
Data capture	89.6 %

+ PM_{10} as measured by a FDMS using a gravimetric factor of 1
All mass units are at 20'C and 1013mb

Pollutant	Air Quality Regulations (Northern Ireland) 2003	Exceedences	Days
PM_{10} Particulate Matter (Gravimetric)	Daily mean > 50 µg m^{-3}	6	6
PM_{10} Particulate Matter (Gravimetric)	Annual mean > 40 µg m^{-3}	0	-

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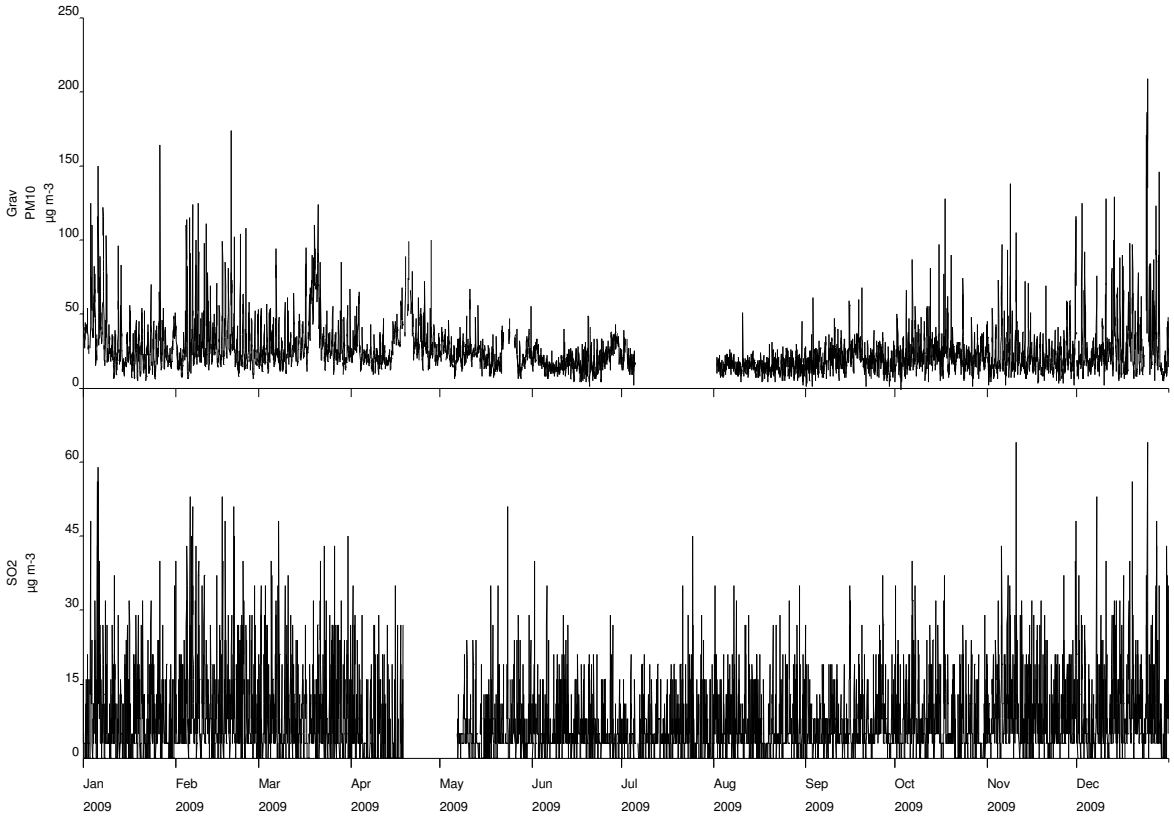
Produced by AEA on behalf of Ballymena BC

Ballymena Ballykeel Air Monitoring
Hourly Mean Data for 01 January to 31 December 2009

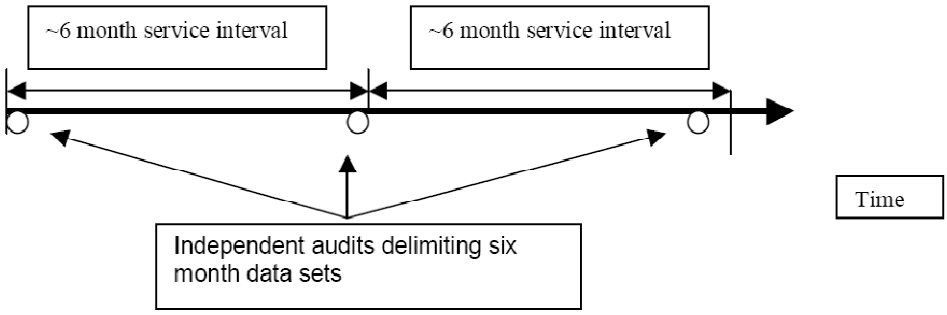


SH NONE

Appendix 2 – Monitoring QA/QC

The purpose of quality control audits is to rigorously test air pollution analysers in order to obtain an assessment of the analyser performance on the day of test. This information, in conjunction with the full analyser data set and additional calibration and service records, helps ensure data quality specifications are being met during the preceding data period. Additionally, six-monthly assessment of the station calibration cylinder concentration ensures that the cylinder concentration, used to scale ambient data, remains stable and thus suitable for scaling purposes.

In April 2007 Ballymena Borough Council commenced a 3 year QA/QC contract with AEA. During the three year contract period, the station will receive seven audits, one took place shortly after commencement of the contract and further scheduled six-monthly audits will be conducted to delimit the station data sets. To aid the data management process for the stations, all equipment support service schedules have been brought into line with the audit schedules as illustrated below:



Station Audits

All station audits are undertaken using the procedures described in AEA's internal quality assurance document, Group Working Instruction AEAT/GW1/05/RAMP/43.01 and the audit results recorded on form AEAT/GF/05/RAMP/43.F1. This GWI and associated documents form AEA's extension to UKAS accreditation as Calibration Laboratory 0401 for field calibrations of air quality monitoring stations. AEA currently audits over 1000 air pollution analysers each year. Analyser performance/parameters tested are:

- **Accuracy** – this is a measure of how closely the measurement system can estimate the concentration of a test sample compared to the "true value" of the concentration. The gaseous analysers are calibrated using UKAS accredited calibration standards and the resulting calibration factors are reported on the UKAS certificate of calibration.
- **Response Time** – this is the time taken for the system to respond to a step change in concentration at its inlet. Response time is defined as the time taken for the system to achieve 90% of its maximum value. Both rise and fall times are checked.
- **Site Calibration Standard Concentration Check** – Site calibration cylinders form the basis of the gaseous calibration systems at the stations and hence make scaling of data from the SO2 and NOx analyser possible. It is therefore important to know the concentration of the gas mixture accurately. An assessment of the concentration of the onsite gas mixtures will be made – based upon the response to gas from the AEA audit transfer standard. This assessment will highlight if a calibration cylinder concentration is drifting and therefore requires replacing. These assessments are undertaken using audit calibration standards certified within AEA's own UKAS accredited calibration laboratory.
- **Linearity –** this is a measure of the relationship of analyser response with changing concentration. For conventional analysers, the relationship should be linear, i.e. twice the concentration will produce twice the output signal etc.
- **Noise Levels –** this is a measure of the change in system output when the pollutant concentration remains constant. Both zero noise, when the concentration is zero, and span noise, when the concentration is held at a particular value, are examined.

- **SO2 Analyser Hydrocarbon Interference Test** – this test checks the efficiency of the hydrocarbon removal system used on the SO2 analysers. The purpose of the hydrocarbon removal system is to ensure that hydrocarbon species do not interfere with the measurement of SO2.

As well as these tests, other assessments of the sampling and pneumatic systems are carried out. These include system leak checks, and, where possible, manifold pressure drop and flow rate measurements (useful to assess the residence time of sample gas within the manifold system, which should be minimised).

General Principles Adhered to During Station Audits

- Where practicable, test gases are introduced to the analysers via the sample lines that connect the analysers/instrument rack to the sampling manifold. This is to ensure that as much of the ambient sampling line as possible, including the sample inlet filter, is tested.
- While analysers are under test, data should be flagged as audit data as opposed to ambient data. This will utilise the appropriate method for the stations (either "out of service" switches where fitted or by instruction to the data management unit for the stations). This will ensure that data during the audit is not disseminated as ambient data.
- A resettling period of 5 minutes is allowed after completion of the test before the "out of service" switch is reset to signal the collection of ambient data. This period allows the analysers to stabilise on ambient sampling.
- All analyser outputs (with the exception of particulate analyser tests) are taken from the relevant data collection system as un-scaled raw data.
- The pressure in all calibration gas cylinders is checked to ensure it is greater than 300 psi.

UKAS Certificate of Calibration

The output from each audit is in the form of a letter report outlining the results of each six-month audit and a UKAS Certificate of Calibration. The Certificate of Calibration provides a method by which the data management process for the respective stations can be checked (via comparison of the certificate calibration factors with those used to scale the station data). Where AEA undertake the stations data management, the letter report will be combined with the output from the stations data management process (described below).

The UKAS Certificate of Calibration provides the following information:

- The calibration and zero response factors for the analysers under test on the day of the audit.
- Uncertainties associated with the above values.

Data Management

The following sections describe the data management package that is provided under the Calibration Club. This includes data acquisition, validation and ratification of the inorganic and particulate pollutants measured by the two monitoring stations.

The AEA data acquisition and management system consists of a central computer and telemetry facility that has been developed specifically for the UK's air quality monitoring programmes. Particular benefits of this system include:

- **Flexibility** – it can be easily modified to incorporate the measurement of new species, or the introduction of new data-logging or communications technology.
- **Efficiency** – the system is resident on the AEA Technology Computer Network, enabling a number of processing functions to be carried out rapidly and simultaneously.
- **Proven capability** – the system has been used to provide rapid high quality data from national monitoring programmes for many years.
- **Modular** – the system uses standard PCs and accessories. These can be simply replaced in the event of failure or run in parallel to boost performance.

The AEA system is housed within a specifically designed air-conditioned network control centre at AEA, Culham. All critical computer systems have uninterruptible power supplies installed to minimise downtime in the event of power cuts. AEA uses state of the art computer systems to automatically retrieve raw 15-minute (or hourly data depending of the station equipment) averaged measurements from monitoring stations on a daily basis.

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A wide range of data management activities are routinely performed by AEA and these are integrated into the streamlined automatic data management system. Each day, measurement data is retrieved automatically from the monitoring stations (data acquisition). The data is then rapidly processed by applying the latest available calibration factors (data scaling) and carefully screened using specifically developed computer algorithms to identify suspect data or equipment faults (data validation). The provisional data is then appended to the site database (data archiving). These operations are carried out automatically by computer systems, with the output manually checked by AEA.

Once validated in this way, the previous day's results can be made available for dissemination to the respective Councils and other interested parties (as advised by the owning Council) on a daily basis via e-mail.

Data Acquisition and Processing

The monitoring site is polled daily to retrieve averaged raw output from station instruments. This data is transmitted via MODEM and automatically appended to the AEA air quality site database. The results of automatic overnight auto-calibration checks are also retrived and data based.

Scaling factors, based on the most recent manual calibrations undertaken by this department are applied to the pollutant measurements to produce concentrations in the relevant units. The scaled data is stored as a separate database file, the original raw data is retained at all times.

From the raw values, the hourly averaged results are then calculated. These are the averaging period used for the reporting of both validated and ratified data for all pollutants. Additionally 15-minute data files are provided for SO2 to allow direct comparison with the legislative 15-minute objective.

Initial Validation of Data

To ensure high quality data is obtained with correspondingly high data capture rates, initial data screening is essential. AEA manually reviews data from the stations every day (in addition to their automatic software diagnostics) ensuring that problems are identified as soon as they occur. All incoming data from the monitoring stations will be screened prior to the release of validated data sets. Experienced staff are on hand to investigate instances of suspect data.

AEA has developed a number of specially developed algorithms for identifying flagging and editing suspect data.

The automatic screening procedures provide data of the highest quality and lead to the rapid diagnosis of any instrument malfunctions.

Should equipment or site problems be identified, it is possible for data management staff to contact the monitoring station by MODEM manually, in order to access further information. If necessary, this department will be contacted in order to invoke emergency call-out procedures for their equipment support unit.

Final Ratification of Data

A number of essential quality assurance/control details are collated in order to produce a final ratifieddata set every six months. These are as follows:

- Results of the routine instrument calibrations (undertaken by the relevant local authority)
- Instrument and site infrastructure service records
- Meteorological data (AEA receives daily met reports from the Met Office)
- Results of six-monthly station audits

At the end of each six monthly period, AEA uses this information for each of the stations, together with the following procedures, in order to formulate the final ratified data sets.

- A time series graph and calibration control chart of the validated data for the six months is plotted and reviewed.
- Data is automatically loaded one month at a time into the AEA data-handling package. This will enable 15-minute averaged raw data, scaled concentration data and calibration results to be examined. A site information database containing all comments entered as a result of call out visits or fault investigations, it also opened on screen.
- Concentration values will be deleted where appropriate e.g. during site visits or instrument failures. Raw data will however always be preserved.
- Some adjustments to the data may be necessary for a variety of reasons including:

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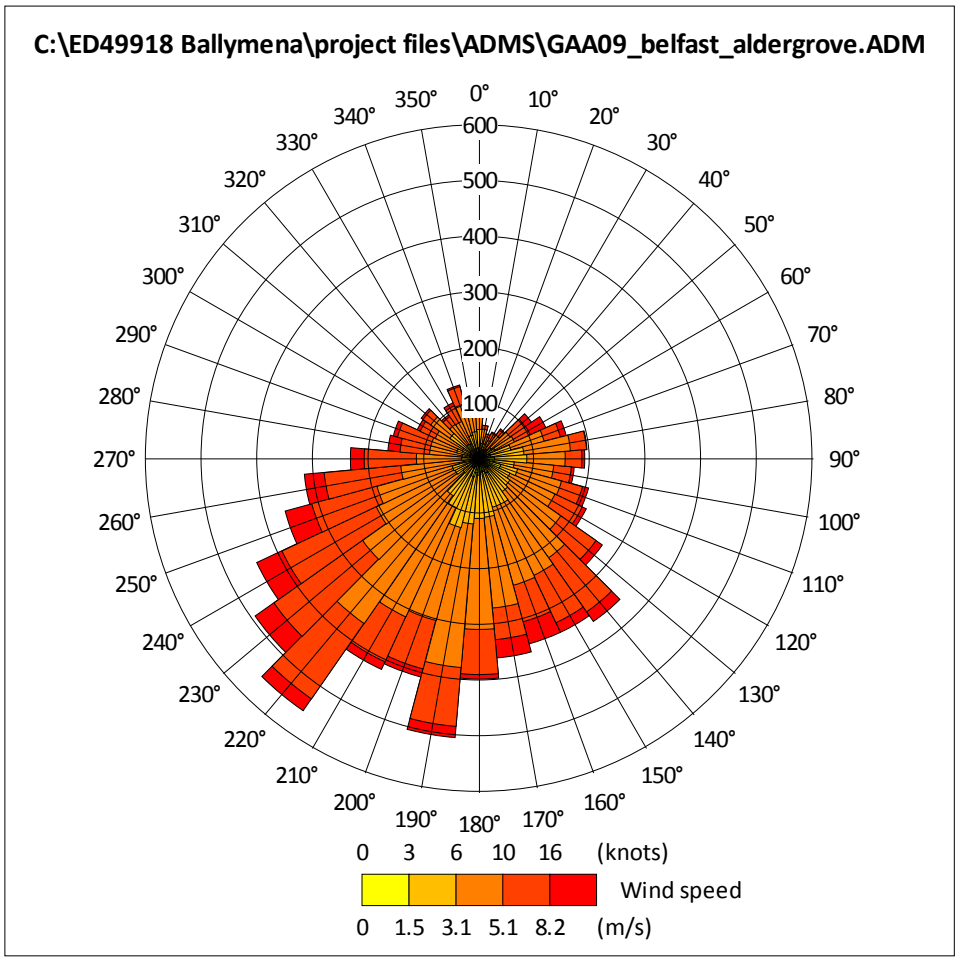
    - Spikes in the processed zeros or scaling factors
    - Inconsistencies in the site calibrations
    - Inclusion of spurious auto-calibration data
    - Smoothing of calibration and zero drifts
- Daily zero or sensitivity factors may be modified to produce a smooth progression throughout the month, consistent with the auto-calibration response and/or manual calibrations.
- Site operation and data ratification notes are prepared for each instrument. These notes are used for discussion of data quality issues in the six-monthly report.
- Once all modifications to the monthly files have been made, time-series and calibration control charts for the entire six months are again plotted, annotated and examined.
- Following any final corrections, the ratified six-monthly data sets are available to this department.

Data Throughput Activity

A full table of operating tasks to be carried out by the project team is detailed below.

	Automated Systems	**Data Management**	**Project Manager**
Daily	Collect raw 15-minute averaged results Collect daily autocalibration results Apply calibration factors to calculate hourly averaged results Apply algorithms to screen data Database hourly results Collate provisional results for daily report	Investigate any suspicious data View previous 48 hours data & latest autocal and calibration factors Enter calibration results from routine and call out visits Send daily e-mail report	Contact Council to investigate instrument problems flagged by data manager
6-Monthly	List out files of RATIFIED results Calculate statistics	Ratify data Supply printouts of data on request Provide data analysis	Review site performance Write report to Council

Appendix 3 – Belfast Aldergrove Wind Rose 2009



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