APPENDIX 4 – QUALITY CONTROL PROCEDURES FOR AIR QUALITY MONITORING INCLUDING PROCEDURES FOR DATA HANDLING, VALIDATION AND RATIFICATION

The Council monitors benzene, nitrogen dioxide and PM_{10} as part of the air quality management process to review and assess air quality in Derby. A high level of quality control must be followed to ensure the accuracy of data collected and a summary of current procedures is given below. The details of quality control procedures adopted in the past are given in Derby City Council's previous local air quality management reports.

MONITORING FOR NITROGEN DIOXIDE

The Council operates 3 high resolution continuous NO_x analysers and undertakes a low resolution diffusion tube survey encompassing 73 monitoring locations in the vicinity of the inner and outer Ring Roads. The continuous monitoring is considered first followed by the diffusion tube monitoring.

Continuous Monitoring

Monitoring Sites

A summary of the monitoring sites, including the instrumentation, is given in Table A4.1. Notably all of the analysers meet the standards required for undertaking a Detailed Assessment of NO_2 as given in the Local Air Quality Management Technical Guidance LAQM. TG(03) *(Reference 1)*.

All sites continuously monitor NO_x and NO and calculate the NO_2 concentration. The 15 minute mean concentrations for NO_x, NO and NO_2 are logged using an analyser's internal memory or data logger.

Service of Analysers

The analysers are covered by a service and maintenance contract with Casella Measurement, which covers calibration checks, flow and leak checks, cleaning of components, analyser diagnostic checks and replacement of faulty components and consumables.

Table A4.1 - Summary of Continuous NO_2 Monitoring Sites				
Site Name & *Grid Ref*	**Type of Location**	**Monitor Installed**	**Description of Location**	**Instrumentation**
Council House *435474, 336252*	Urban Centre	Mid 1990s	Centre of Derby in the car park by the Council House. Over shadowed by 2 storey building to the south and 22m from Morledge road. Normally relatively open setting but since Autumn 2005 adjacent to portacabins being used as a temporary bus station.	Monitor Labs Chemiluminescence analyser, model M1 9841B NO_x Inlet 2.5m above ground level
Warwick Avenue *433678, 334533*	Roadside	October 2004	Opposite 218 Warwick Avenue 73m south of the junction with Burton Road on a slight incline. Adjacent to the Outer Ring Road and inside the AQMA for NO_2. Open setting 1m from the kerbside.	Monitor Labs Chemiluminescence analyser, model M1 9841B NO_x Inlet 2.5m above ground level
Abbey Street *434839, 335294*	Roadside/ Facade	October 2004	Junction of Abbey Street and Burton Road adjacent to 202 Burton Road and inside the AQMA for NO_2. Façade of house 2m back from the road.	Monitor Labs Chemiluminescence analyser, model M1 9841B NO_x Inlet 2.5m above ground level

A service is carried out on an analyser after installation at a monitoring location and, once every 6 months thereafter. There are also non-programmed maintenance and service visits in response to any fault on an analyser. A record is kept of any service and maintenance carried out to an analyser.

Checks and Calibrations

Daily automatic calibration

The instrument is taken out of service and certified zero air and NO/NO_x calibration gases supplied by BOC are passed through the reaction chamber to give the zero air and span calibration response.

The daily automatic calibrations are used as a check on the instrument performance and drift and to rescale the raw data from the analysers as follows:

Instrument sensitivity, F=c/(Vs-Vz)

Where c is the concentration of the calibration span gas, Vs is the span response and Vz the zero response.

The pollutant concentration is then calculated as follows:

Pollutant concentration = F(Va-Vz).

Where Va is the instrument ambient air response.

The final NO_2 concentration = NO_x concentration - NO concentration.

Analyser inspection and manual calibration

Manual calibrations are carried out once a fortnight. The instrument is taken out of service and the same certified zero air and NO/NO_x calibration gases described above are passed through the reaction chamber to give the zero air and span calibration response.

The manual calibrations are used as a check on the instrument performance and drift. If evidence suggests that the instrument is over reading or under reading by more than 7% a call out is made to the service engineer to check and reset the instrument if necessary. Occasionally (but rarely) the manual calibrations are also used to rescale the raw data in a similar manner to that described above when the daily calibrations cannot be used to that end.

Data Handling, Validation and Ratification

Data handling

The raw data (15 minute means) is downloaded via a modem into Enview software and rescaled as described above. The data is then manipulated to

calculate the hourly mean concentrations and annual mean concentrations for comparison with the air quality objectives for NO_2. Note that hourly means are considered invalid and deleted from the data unless there are 3 valid 15 minute means recorded during that hour. Annual mean concentrations are treated with caution if there is less than 90% data capture during a year.

Data validation

The data is screened by visual examination for suspicious and spurious data such as unusually high measurements. The suspect data is deleted from the rescaled data set. Problems typically arise as a result of equipment failure, power failure and human error.

The raw data set is retained so that it can be re-examined at a later date if necessary.

Data ratification

The rescaled monitoring results are checked periodically to ensure they are reliable and consistent and if necessary the data is deleted or rescaled. This includes:

- Checking the instrument history and characteristics (such as drift), including the service and maintenance reports, to ensure that an instrument has been functioning satisfactory.
- Checking calibration records to ensure they have been applied correctly.
- Comparison of monitoring results from all 3 analysers with each other and other monitoring networks to ensure they are consistent and to highlight any anomalies in the data.
- Comparison of monitoring results with other pollutants monitored by the Council to ensure they are consistent and to highlight any anomalies in the data.
- Analysis of the data to ensure it is consistent with the diurnal peaks of NO_2 that are usually associated with traffic during rush hours.
- Checking the characteristics of a monitoring site to determine whether there may have been any local changes which may have had an impact on NO_2 concentrations such as road works.

The ratified data set is used in the review and assessment process.

Diffusion Tube Monitoring

Monitoring Sites

There are 73 monitoring locations in the vicinity of the inner and outer Ring Roads. Diffusion tubes are exposed for 4/5 week periods throughout the year at each monitoring site. They are supplied and analysed by Casella CRE Air and are distributed for exposure and collected following exposure by the Council. The tubes are exposed between 1m and 1.5m above ground height. Typical locations include the facades of residential properties. Note that 3 of the monitoring locations include the continuous monitoring sites. Three diffusion tubes are co-located at the inlet of each continuous monitor so that a suitable bias correction factor can be applied to all the diffusion tube monitoring results. This is normal practice. It is assumed that the high resolution continuous monitoring results are accurate and that a correction must be made to the low resolution passive diffusion tube monitoring results.

Handling the NO_2 Diffusion Tubes

Quality control procedures adopted by Derby City Council and Casella CRE Air to ensure the integrity of monitoring results are detailed below.

Quality Control Procedures adopted by Derby City Council

All the diffusion tubes are stored in air tight bags under refrigerated conditions prior to use and used within the expiry date. Upon collection, the date, site and times are recorded. Tubes are sealed by an end cap. On the day of collection, the tubes are sent to Casella CRE Air for analysis, together with an unexposed tube as a blank 'control'. The tubes are then received and analysed by Casella CRE Air, in accordance with their quality control procedures.

Quality Control Procedures adopted by Casella CRE Air

Method of Analysis

Casella CRE Air prepares diffusion tubes using 10% TEA (triethanolamine) in water.

Quality Control Procedures

The analysis is carried out in accordance with Casella CRE Air's laboratory quality control procedures, and within their U.K.A.S. Accreditation Schedule.

The following procedures are adopted to ensure the results of the analysis are within the accepted accuracy range *(Reference 20)*:-

- A quality control nitrite solution (0.5µg/mL) is run through the spectrophotometer every 10 samples to ensure the instrumentation is working within an acceptable range (0.48-0.53µg/mL).
- The laboratory participates in a number of proficiency schemes.
- Once per month, a stock solution containing a known amount of nitrite, is received by the laboratory and measured as part of the Workplace Analysis Scheme for Proficiency (WASP). Cassella CRE Air is currently classed as 'good' and ranked 3 out of 25 laboratories.
- Once a month 3 exposed tubes are sent to the laboratory for measurement as part of the WASP scheme. The last annual report for 2004 assessed the accuracy of the measurements made by Casella CRE Air as satisfactory. The precision (mean CoV) was 7.6% against a requirement for less than 10%. The bias (95% C.I. of mean bias) was 12% against a requirement for less than +/-25%.

Data Handling, Validation and Ratification

Data handling

Casella CRE Air sends the results of the analysis to the Council once a month and the data is put into excel files. The data is then manipulated to calculate annual mean concentrations at monitoring sites. These results are then bias corrected to provide a more accurate representation of likely annual mean NO_2 concentrations at sites. The bias correction factor is derived from comparison of the diffusion tube monitoring results and continuous monitoring results as detailed below. Note that annual mean concentrations are treated with caution if there is less than 9 months monitoring data for a monitoring site during a year.

The correction factor is obtained from the following equation;

Correction factor = Cm/Dm

Where Cm is the continuous mean, and Dm is the monthly mean for the co-located tubes.

The diffusion tube bias is obtained from the following equation;
Diffusion tube bias = (Dm-Cm)/Cm

Data validation
The data is screened monthly by visual examination for spurious results and any suspect data deleted from the data set. In general results are assumed to be valid. Only extreme outliers, when compared to the monitoring results for other sites during that month, are able to be determined invalid. Problems can occur as a result of human error, tube preparation and analysis and the storage and transportation of tubes.

The raw data set is retained so that it can be re-examined at a later date if necessary.

Data ratification
The monitoring results are checked periodically to ensure they are reliable and consistent and, if necessary the data is deleted or subject to a different bias correction factor. This includes:

- Checking the bias correction factors and ensuring that they have been applied correctly.
- Comparison of monitoring results from all the sites to ensure they are consistent and to highlight any anomalies in the data.
- Checking the characteristics of monitoring sites to determine whether there have been any local changes which may have had an impact on NO_2 concentrations such as road works.

The ratified data set is used in the review and assessment process.

MONITORING FOR BENZENE

The Council operates a pumped sampler (active BTEX tubes) and undertakes a diffusion tube survey (passive BTEX tubes) encompassing 17 monitoring locations. All of the monitoring locations are in the vicinity of Acetate Products, except for one passive diffusion tube located at the Council House urban centre monitoring site.

Monitoring results from pumped samplers (active BTEX tubes) are inherently more accurate than passive BTEX diffusion tubes as:

- Passive diffusion tubes rely on the natural uptake of pollutants by a tube which can be affected by wind and moisture.
- The sampler exposes 2 tubes over the sampling period which allows for an assessment to be made on the reliability of the measured concentrations and so the accuracy of the results collected.

The National Physical Laboratory (NPL) estimate that the overall uncertainty in benzene concentrations measured using a pumped sampler (active BTEX tubes) and diffusion tubes (passive BTEX tubes) is ±12% and ±21% at the 95% confidence limit respectively *(Reference 15 and 16)*.

The monitoring using the pumped sampler is considered first, followed by the diffusion tube monitoring.

Pumped Sampler Monitoring (Active BTEX Tubes)

Monitoring Site

A summary of the monitoring site is given in Table A4.2

The sampler meets the standards required for undertaking a Detailed Assessment of benzene as given in the Local Air Quality Management Technical Guidance LAQM. TG(03) *(Reference 1)*. Notably the same sampler has been used in the UK Hydrocarbon network since 2001. It meets the requirements of BS EN14662 – 1:2005 'Ambient Air Quality – Standard Method for Measurement of Benzene Concentrations – Part 1: Pumped Sampling followed by Thermal Desorption and Gas Chromatography'. Pumped samplers are also due to be included in the European Committee for Standardisation's (CEN) list of standard methods to be used to comply with EU Directives.

The sampler pumps air at a pre-determined flow rate alternatively through 2 BTEX absorption tubes (i.e. active BTEX tubes). The tubes are exposed for 2 week periods throughout the year. At the end of the sampling period the tubes

are then subject to desorption gas chromatography to measure the mass of benzene, toluene, ethylbenzene, (m+p) - xylene and o xylene on them. This information, together with the volume of air sampled for each tube, is used to calculate the average concentration of these pollutants in the air over the sampling period. The tubes are supplied and analysed by the National Physical Laboratory and distributed for exposure and collected following exposure by the Council.

Table A4.2 - Summary of Pumped Sampler Benzene Monitoring Site

Site Name & *Grid Ref*	**Type of Location**	**Monitor Installed**	**Description of Location**	**Instrumentation**
43 Anglers Lane *440280, 334969*	Industrial/ Facade	August 2004	Back garden of number 43 approximately 75m NE and facing Acetate Products. Closest house downwind of the fugitive emission of benzene from the industrial site (worst case scenario).	National Physical Laboratory controlled flow tube sampler Inlet 2m above ground level

Service of Sampler

The sampler is covered by a service and maintenance contract with the National Physical Laboratory which covers flow and leak checks, cleaning of components and replacement of faulty components.

A service is carried out on the sampler after installation at a monitoring location and once every 12 months thereafter. There are also non-programmed maintenance and service visits in response to any fault with the sampler. A record is kept of any service and maintenance carried out to the sampler.

Checks

A visual check is undertaken of the sampler once every 2 weeks to ensure it is working correctly. This includes a check on the air flow going through the sampler.

Handling the BTEX Tubes

Quality control procedures adopted by Derby City Council and the National Physical Laboratory to ensure the integrity of monitoring results are detailed below.

Quality Control Procedures adopted by Derby City Council

All the diffusion tubes are stored in air tight bags prior to use and used within the expiry date. Upon collection, the date, times and air volumes sampled for each tube are recorded. Tubes are sealed by an end cap. On the day of collection, the tubes are sent to the National Physical Laboratory for analysis, together with an unexposed tube as a blank 'control' as appropriate. A blank BTEX control tube is provided for a 2 week period once every 2 months. The tubes are then received and analysed by the National Physical Laboratory, in accordance with their quality control procedures.

Quality Control Procedures adopted by the National Physical Laboratory

The analysis is carried out in accordance with the National Physical Laboratory's quality control procedures, and within their U.K.A.S. Accreditation Schedule.

The following procedures are adopted to ensure the results of the analysis are within the accepted accuracy range *(Reference 21)*:-

- In every run of 50 samples analysed there are 40 actual samples and 10 'calibration samples'. The calibration samples are used to check that the instrumentation is working within an acceptable range. They span the normal concentrations measured and are analysed at the beginning, middle and end of a run.
- The laboratory participates in the Workplace Analysis Scheme for Proficiency (WASP) for thermal desorption at environmental levels. The National Physical Laboratory is currently classed as Category 1, the highest category.

Data Handling, Validation and Ratification

Data handling

The National Physical Laboratory sends the results of the analysis to the Council once every 2 weeks and the data are put into MS Excel files. The mean result of the 2 active BTEX tubes is usually used in the review and assessment process. The data is then manipulated to calculate annual mean concentrations at the monitoring site. Note that annual mean concentrations are treated with caution if there is less than 9 months monitoring data for a monitoring site during a year.

Data validation

The data is screened monthly by visual examination for spurious results and any suspect data deleted from the data set. This includes examining the results from the 2 active BTEX tubes to ensure they are consistent, and checking the ratios of all pollutants measured to ensure they are within the normal ratios observed at the monitoring site. In general results are assumed to be valid and only extreme outliers, when compared to the monitoring results for other sites during that month, are able to be determined invalid. Problems can occur as a result of equipment failure, power failure, human error, tube preparation and analysis and the storage and transportation of tubes.

The average difference in benzene concentrations between duplicate active BTEX tubes reported by NPL is 3.1% *(Reference 15)*.

The raw data set is retained so that it can be re-examined at a later date if necessary.

Data ratification

The monitoring results are checked periodically to ensure they are reliable and consistent and if necessary the data is deleted. This includes:

- Checking the results from the 2 active BTEX tubes.
- Checking the ratios for all pollutants measured by the active BTEX tubes to ensure they are within the normal ratios observed at the monitoring site.
- Comparison of monitoring results from all the BTEX monitoring sites to ensure they are relatively consistent and highlight anomalies in the data.

- Checking the sampler history, including service and maintenance reports, to ensure it has been functioning satisfactory.
- Checking the characteristics of the monitoring sites to determine whether there have been any local changes which may have had an impact on measured benzene concentrations.

The ratified data set is used in the review and assessment process.

Diffusion Tube Monitoring (Passive BTEX Tubes)

Monitoring Sites

There are 17 monitoring locations, 16 of which are within the vicinity of Acetate Products. The remaining monitoring location is at the Council's urban centre site at the Council House in the city centre. **Two** diffusion tubes are exposed for 2 week periods throughout the year at each monitoring site. They are housed in "bird boxes" to protect them from wind and moisture with the sampling end of the tube protruding from the base of the box. They are supplied and analysed by the National Physical Laboratory and distributed for exposure and collected following exposure by the Council. The tubes are exposed between 1m and 1.5m above ground height. Typical locations include dwellings, nurseries and schools downwind of Acetate Products. Note that 1 monitoring location includes the pumped sampler monitoring site. Three passive BTEX tubes are co-located at the inlet of the pumped sampler so that a suitable bias correction factor can be applied to all the passive BTEX tube monitoring results. It is assumed that the results from the pumped sampler (active BTEX tubes) are accurate and that a correction must be made to the diffusion tube (passive BTEX tubes) monitoring results.

Handling the BTEX Diffusion Tubes

Quality control procedures adopted by Derby City Council and the National Physical Laboratory to ensure the integrity of monitoring results are detailed below.

Quality Control Procedures adopted by Derby City Council

All the diffusion tubes are stored in air tight bags prior to use and used within the expiry date. Upon collection, the date, site and times are recorded. Tubes

are sealed by an end cap. On the day of collection, the tubes are sent to the National Physical Laboratory for analysis, together with an unexposed tube as a blank 'control'. A blank BTEX control tube is provided every 2 weeks. The tubes are then received and analysed by the National Physical Laboratory, in accordance with their quality control procedures.

Quality Control Procedures adopted by the National Physical Laboratory
The same quality control procedures for the pumped sampler are adopted, as detailed above.

Additionally the laboratory periodically undertakes an internal audit to check the accuracy of the results from the passive BTEX diffusion tubes prepared and analysed by them against results from pumped samplers. In 2002 an internal audit was undertaken for 24 monitoring sites over a 12 month period and 20 sites over a 1 to 3 month period. The average bias correction factor across all sites was found to be 1.22 *(Reference 17)*.

Data Handling, Validation and Ratification
Data handling
The National Physical Laboratory sends the results of the analysis to the Council once every 2 weeks and the data are put into MS Excel files. The mean result of the 2 passive BTEX tubes at each monitoring site is usually used in the review and assessment process. The data is then manipulated to calculate annual mean concentrations at monitoring sites. These results are then bias corrected to provide a more accurate representation of likely annual mean benzene concentrations at sites. The bias correction factor is derived from comparison of the passive BTEX diffusion tube monitoring results and active BTEX tube monitoring results from the pumped sampler as detailed below. Note that annual mean concentrations are treated with caution if there is less than 9 months monitoring data for a monitoring site during a year.

The correction factor is obtained from the following equation;
Correction factor = Cm/Dm
Where Cm is the mean of the active BTEX tubes from the pumped sampler, and Dm is the mean for the co-located passive BTEX diffusion tubes.

The diffusion tube bias is obtained from the following equation;

Diffusion tube bias = (Dm-Cm)/Cm

Data validation

The data is screened monthly by visual examination for spurious results and any suspect data deleted from the data set. This includes examining the results from the 2 passive BTEX tubes at each monitoring site to ensure they are consistent, and checking the ratios of all pollutants measured by the BTEX tubes to ensure they are within the normal ratios observed at each of the monitoring sites. In general, results are assumed to be valid and only extreme outliers, when compared to the monitoring results for other sites during that month, are able to be determined invalid. Problems can occur as a result of human error, tube preparation and analysis and the storage and transportation of tubes.

The raw data set is retained so that it can be re-examined at a later date if necessary.

Data ratification

The monitoring results are checked periodically to ensure they are reliable and consistent and if necessary the data is deleted or subject to a different bias correction factor. This includes:

- Checking the results from the 2 passive BTEX tubes at a monitoring site.
- Checking the ratios for all pollutants measured by the passive BTEX tubes to ensure they are within the normal ratios observed at a monitoring site.
- Comparison of monitoring results from all the BTEX monitoring sites to ensure they are relatively consistent and highlight anomalies in the data.
- Checking the bias correction factors and ensuring that they have been applied correctly.
- Checking the characteristics of the monitoring sites to determine whether there have been any local changes which may have had an impact on benzene concentrations measured.

The ratified data set is used in the review and assessment process.

MONITORING FOR PM_{10}

The Council operates 3 Tapered Element Oscillating Microbalance (TEOM) analysers and one gravimetric sampler. The TEOM analysers are located by the Council House, outer ring road and the Victory Road PM_{10} AQMA. The gravimetric sampler is co-located with the TEOM analyser by the Victory Road PM_{10} AQMA.

Monitoring results from the gravimetric sampler can be compared directly with the objectives for PM_{10}, as it is the reference method for measuring PM_{10}. Notably the filter in the gravimetric sampler is held at fluctuating ambient conditions during exposure. However, results from the TEOM analysers must be adjusted to gravimetric equivalent concentrations for comparison with the objectives. This is because the heated inlet on the TEOM analysers, which is used to minimise errors associated with the evaporation and condensation of water vapour, leads to the loss of volatile particles. Whilst there is some loss of volatiles from gravimetric samplers, this is less than for TEOM analysers. The advantage of TEOM analysers is that they continuously measure PM_{10} whereas gravimetric samplers provide an average PM_{10} concentration over the exposure period of a filter.

The monitoring using the TEOM analysers is considered first, followed by the gravimetric sampler.

TEOM Monitoring

Monitoring Sites

A summary of the monitoring sites, including the instrumentation, is given in Table A4.3. Notably all of the analysers meet the standards required for undertaking a Detailed Assessment of PM_{10} as given in the Local Air Quality Management Technical Guidance LAQM. TG(03) *(Reference 1)*.

Air is continuously drawn into the analyser, with the PM_{10} sampling head ensuring that only PM_{10} is drawn into the instrument. The PM_{10} is collected on a filter which is attached to a vibrating hollow tapered glass element; the

frequency of its oscillation being a function of the mass on the filter. A microprocessor converts the frequency of oscillation to a mass and then to the concentration of PM_{10} in the air.

Table A4.3 - Summary of TEOM PM_{10} Monitoring Sites

Site Name & *Grid Ref*	**Type of Location**	**Monitor Installed**	**Description of Location**	**Instrumentation**
Council House *435474, 336252*	Urban Centre	Mid 1990s	Centre of Derby in the car park by the Council House. Over shadowed by 2 storey building to the south and 22m from Morledge road. Normally relatively open setting but since Autumn 2005 adjacent to portacabins being used as a temporary bus station.	Rupprecht and Patashnick Co inc series 1400a analyser PM_{10} inlet head 2.5m above ground level
Warwick Avenue *433678, 334533*	Roadside	October 2004	Opposite 218 Warwick Avenue 73m south of the junction with Burton Road on a slight incline. Adjacent to the Outer Ring Road and inside the AQMA for NO_2. Open setting 1m from the kerbside.	Rupprecht and Patashnick Co inc series 1400a analyser PM_{10} inlet head 2.5m above ground level
Sinfin B *435804, 332916*	Industrial	Late 1990s	Just east of the Victory Road AQMA for PM_{10} on the Rolls Royce Sinfin B site. Approximately 250m north-east (downwind) and facing, the site previously occupied by the QDF foundry.	Rupprecht and Patashnick Co inc series 1400a analyser PM_{10} inlet head 2.5m above ground level

All sites continuously monitor PM_{10} concentrations. The 15 minute mean concentrations are logged using a sampler's internal memory or data logger.

Service of Analysers

The analysers are covered by a service and maintenance contract with Casella Measurement, which covers calibration checks, flow and leak checks, cleaning of components including the sampling head, sampler diagnostic checks and replacement of faulty components and consumables.

A service is carried out on an analyser after installation at a monitoring location and once every 6 months thereafter. There are also non-programmed maintenance and service visits in response to a fault on an analyser. A record is kept of any service and maintenance carried out to an analyser.

It is important to note that checks include the performance of the tapered element against a pre-weighed reference filter. If it is outside the acceptable range (KO factor ± 2.5%) the monitoring results are rescaled accordingly. The KO factor is the stated calibration constant of that particular TEOM tapered element.

Checks

A visual check is undertaken of an analyser every day using the remote connection to ensure it is working correctly. This includes a check on the air flow going through an analyser.

Data Handling, Validation and Ratification

Data handling

The raw data (15 minute means) is downloaded via a modem into Enview software and adjusted as necessary, having regard to the analyser performance against the KO factor as detailed above. The data is then manipulated to calculate the 1 hour, 24 hour and annual mean concentrations. The 24 hour and annual mean concentrations are calculated for comparison with the air quality objectives for PM_{10}. Note that hourly means are considered invalid and deleted from the data unless there are 3 valid 15 minute means recorded during that hour. Similarly, the 24 hour means are considered invalid and deleted from the data unless there are 18 valid hourly means recorded

during that 24 hour period. Annual mean concentrations are treated with caution if there is less than 90% data capture during a year.

The data is then rescaled to reflect gravimetric equivalent concentrations. Monitoring results from the Council House and Warwick Avenue monitoring sites are multiplied by a factor of 1.3 as detailed in The Local Air Quality Management Technical Guidance LAQM. TG(03) *(Reference 1)*. Monitoring results from the Sinfin B monitoring site are either multiplied by this same factor or a site specific correction factor using monitoring data from the co-located gravimetric sampler as detailed below.

The correction factor is obtained from the following equation;
Correction factor = Cm/Dm
Where Cm is the mean of the Gravimetric sampler, and Dm is the mean for the co-located TEOM analyser.

The TEOM bias is obtained from the following equation;
TEOM bias = (Dm-Cm)/Cm

Data validation
The data is screened by visual examination for suspicious and spurious data and any suspect data is deleted from the data set. Problems typically arise as a result of equipment failure, power failure and human error and the following data are generally considered invalid:

- Several consecutive 'zero' readings
- Sudden changes in PM_{10} concentrations
- Data marked by the analyser as invalid
- PM_{10} concentrations less than -4µg/m^3. Note that a loss in filter weight can arise following periods of heavy rainfall as water on the filter is initially recorded as PM_{10} which subsequently evaporates. Only PM_{10} concentrations above -4µg/m^3 are considered valid.

The raw data set is retained so that it can be re-examined at a later date if necessary.

Data ratification

The rescaled monitoring results are checked periodically to ensure they are reliable and consistent and if necessary the data is deleted or rescaled. This includes:

- Checking an analyser's history and characteristics, including the service and maintenance reports, to ensure it has been functioning satisfactory.
- Comparison of monitoring results from all 3 TEOM analysers with each other and the gravimetric sampler, as well as other monitoring networks, to ensure they are consistent and to highlight any anomalies in the data.
- Comparison of monitoring results with other pollutants monitored by the Council to ensure they are consistent and to highlight any anomalies in the data.
- Checking the characteristics of a monitoring site to determine whether there may have been any local changes which have had an impact on PM_{10} concentrations such as road works.

The ratified data set is used in the review and assessment process.

Gravimetric Monitoring

Monitoring Site

A summary of the monitoring site is given in Table A4.4. Notably the sampler meets the standards required for undertaking a Detailed Assessment of PM_{10} as given in the Local Air Quality Management Technical Guidance LAQM. TG(03) *(Reference 1)*.

Air is continuously drawn into the sampler, with the PM_{10} sampling head ensuring that only PM_{10} is drawn into the instrument. The PM_{10} is collected onto a pre-weighed filter. The sampler has 15 filter cassettes stacked in a magazine to allow an automated and accurate filter change and is set up so that filters are each exposed for a 24 hour period from midnight to midnight. Following exposure, filters are then reweighed and the weight of PM_{10} deposited on a filter is used to calculate the 24 hour average PM_{10} concentration. The sampler is set up with a flow rate of 16.7 litres per minute. It

also has a temperature and pressure compensated probe, so as to precisely measure the air flow rates at ambient and standard conditions.

Table A4.4 - Summary of Gravimetric PM_{10} Monitoring Site				
Site Name & *Grid Ref*	**Type of Location**	**Monitor Installed**	**Description of Location**	**Instrumentation**
Sinfin B *435804, 332916*	Industrial	October 2004	Just east of the Victory Road AQMA for PM_{10} on the Rolls Royce Sinfin B site. Approximately 250m north-east (downwind) and facing the site previously occupied by the foundry operated by QDF.	Rupprecht and Patashnick Co inc model 2025 co-located by the TEOM analsyer PM_{10} inlet head 2m above ground height, same height as the head of the TEOM sampler

Casella CRE Air provides the pre-weighed filters and re-weighs exposed filters. The Council distributes filters for exposure and collects them following exposure every 14 days.

Service of Samplers

The sampler is covered by a service and maintenance contract with Casella Measurement, which covers calibration checks, flow and leak checks, cleaning of components including the sampling head, sampler diagnostic checks and replacement of faulty components and consumables.

The sampler is serviced after installation at a monitoring location and once every 6 months thereafter. There are also non-programmed maintenance and service visits in response to any fault on the sampler. A record is kept of any service and maintenance carried out to the sampler.

Checks

A visual check is undertaken of the sampler everyday using the remote connection, and the site is visited and checked once every 14 days, to ensure it is working correctly. This includes a check on the air flow going through the sampler.

Handling the Filters

Quality control procedures adopted by Derby City Council and Casella CRE Air to ensure the integrity of monitoring results are detailed below.

Quality Control Procedures adopted by Derby City Council

The magazine containing the pre-weighed filters is kept in a metal case prior to use. Upon collection, the magazine (which includes 14 exposed filters and a blank control) is taken out of the sampler and placed in a metal case. The dates, times and air flows for each 24 hour period are also recorded. On the day of collection, the magazine containing the exposed filters is sent to Casella CRE Air for re-weighing. The magazine is then received and processed by Casella CRE Air, in accordance with their quality control procedures.

Quality Control Procedures adopted by Casella CRE Air

The weighing of filters is carried out in accordance with Casella CRE Air's laboratory quality control procedures, and within their U.K.A.S. Accreditation Schedule.

The following procedures are adopted to ensure the results are within the accepted accuracy range *(Reference 20)*:-

- Prior to weighing filters (prior to exposure and following exposure) filters are preconditioned in a balance room for 48 hours at 20 ±1^{o}C and a relative humidity of 50 ±3%.
- A 'quality control' filter is weighed at the start of each batch to ensure the balance is working within an acceptable range (± 0.020mg).
- Two check weights are weighed on the balance every 10 filters to ensure the balance is working within an acceptable range (100.014 ±0.014mg and 200.014 ±0.014mg).

- Once every few years, filters spiked with sodium borate are received and weighed as part of the Workplace Analysis Scheme for Proficiency (WASP). In 2005 Cassella CRE Air were classified as 'A' (good) for all 3 filters.

Data Handling, Validation and Ratification

Data handling

Casella CRE Air sends the results of the exposed filters to the Council once every 2 weeks and the data are put into MS Excel files. The data is then manipulated to calculate annual mean concentrations at the monitoring sites. Annual mean concentrations are treated with caution if there is less than 90% data capture during a year. The 24 hour and annual mean concentrations are compared with the air quality objectives for PM_{10}.

Data validation

The data is screened monthly by visual examination for spurious results and any suspect data deleted from the data set. This includes examination of the results from the co-located TEOM analyser. Results are generally assumed to be valid. Only extreme outliers, when compared to the monitoring results from the co-located TEOM analyser and other monitoring sites, that cannot be explained, are able to be determined invalid.

The raw data set is retained so that it can be re-examined at a later date if necessary.

Data ratification

The monitoring results are checked periodically to ensure they are reliable and consistent and if necessary the data is deleted or rescaled. This includes:

- Checking the sampler's history and characteristics, including the service and maintenance reports, to ensure it has been functioning satisfactory.
- Comparison of monitoring results with those from all 3 TEOM analysers, as well as other monitoring networks, to ensure they are consistent and to highlight any anomalies in the data.
- Comparison of monitoring results with other pollutants monitored by the Council to ensure they are consistent and to highlight any anomalies in the data.

- Checking the characteristics of a monitoring site to determine whether there have been any local changes which may have had an impact on PM_{10} concentrations such as road works.

The ratified data set is used in the review and assessment process.