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AIR QUALITY ASSESSMENT OF THE TEMPORARY BOILERS AT CONNAH'S QUAY POWER STATION

prepared for
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SUMMARY

E.ON UK has discovered significant cracks in the auxiliary boiler at Connah's Quay power station resulting in its consequent failure and removal from service. Without the auxiliary boiler the power station is unable to produce the steam supplies required to start the combined cycle gas turbines (CCGT) at the station and, therefore, are unable to generate electricity. E.ON UK has installed two temporary boilers at the site as a substitute whilst the auxiliary boiler is being repaired.

The Environment Agency has requested that an assessment is carried out of the potential impact the temporary boilers may have on the local air quality. Initially a H1 assessment was carried out which concluded that air dispersion modelling was required to predict more accurately the impact of the two temporary boilers. This study has assessed the emissions of nitrogen oxides (NO_x) and carbon monoxide (CO) from the two temporary boilers.

The predicted ground level annual mean nitrogen dioxide concentrations are a maximum of 44 µg/m³ including background which is above the Air Quality Strategy (AQS) objective of 40 µg/m³. The process contribution is 14 µg/m³. However, the modelling study assumes that the temporary boilers operate all year at baseload. In reality, the temporary boilers will only operate at baseload for approximately three hours every day that the main station is required to operate. This will be a maximum of three hours per day throughout the year which would significantly reduce the process contribution.

It is worth noting that even under this unrealistic operating scenario the process contribution from the temporary boilers is only 48% of background concentrations and, therefore, the majority of the predicted environmental concentration is due to background concentrations which comprise 75% of the AQS objective.

The maximum predicted environmental concentration occurs during 2011. For all other meteorological years modelled the predicted environmental concentration is below the AQS objective.

The predicted environmental concentration of the 99.79th percentile of hourly mean concentrations is 80% of the AQS objective of 200 µg/m³ demonstrating that the AQS objective is easily met. The predicted process contribution to the 99.79th percentile of hourly mean concentrations is 21% of the AQS objective.



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The maximum predicted process contribution to the annual mean carbon monoxide concentration is 10% of the Environmental Assessment Level (EAL) of 350 $\mu\text{g}/\text{m}^3$. The predicted environmental concentration (i.e. the process contribution and background concentrations) is a maximum of 82% of the EAL. Background concentrations contribute 72% of the EAL. However, even with background concentrations included, the EAL is easily met.

The predicted process contribution to the maximum running 8 hourly mean of carbon monoxide concentrations is 2% of the AQS objective of 10,000 $\mu\text{g}/\text{m}^3$. This is below the insignificance threshold of 10% of the AQS objective and, therefore, short-term carbon monoxide concentrations can be classed as insignificant. The PEC to the maximum running 8 hourly mean of carbon monoxide concentrations is a maximum of 7% of the AQS objective showing that even with background concentrations the short-term carbon monoxide concentration can be classed as insignificant.

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APPENDIX A - Existing (Baseline) Air Quality

1 INTRODUCTION

E.ON UK has discovered significant cracks in the auxiliary boiler at Connah's Quay power station resulting in its consequent failure and removal from service. Without the auxiliary boiler the power station is unable to produce the steam supplies required to start the combined cycle gas turbines (CCGT) at the station and, therefore, are unable to generate electricity. E.ON UK has installed two temporary boilers at the site as a substitute whilst the auxiliary boiler is being repaired.

The Environment Agency has requested that an assessment is carried out of the potential impact the temporary boilers may have on the local air quality. Initially a H1 assessment was carried out which concluded that air dispersion modelling was required to predict more accurately the impact of the two temporary boilers. This study assesses the emissions of nitrogen oxides (NO_x) and carbon monoxide (CO) from the two temporary boilers.

2 AIR QUALITY STANDARDS

The Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland sets out air quality objectives for nitrogen dioxide and carbon monoxide. The Strategy was first published in 1997 with subsequent revisions in 2000, 2003 and the most recent in 2007 (Defra, 2007). Current values of the objectives applicable in the area surrounding Connah's Quay power station have been adopted in this study and are shown in Table 1. Additionally, the Environment Agency's H1 Guidance Note Annex F (Environment Agency, 2011) lists Environmental Assessment Levels (EALs) for the protection of human health to be adopted within environmental permitting applications. H1 provides EALs for a wide range of species not included in the AQS and it also provides EALs for species included in the AQS but on different time scales, such as an annual average EAL for carbon monoxide which is utilised in this assessment.

Table 1: Air quality standards for the protection of human health

Substance	Objective	
	Concentration (µg/m ³)	Measured as
Nitrogen dioxide	40	Annual mean
	200	1 hour mean not to be exceeded more than 18 times a year (99.79 th percentile)
Carbon monoxide	350 ¹	Annual mean
	10,000	Not to be exceeded when expressed as an 8 hour running mean

¹ This EAL has been taken from a previous H1 guidance note (Environment Agency, 2008) as the current H1 guidance note does not include an EAL for this pollutant.

3 ASSESSMENT METHODOLOGY

An atmospheric dispersion model has been used to calculate the contribution of the temporary boilers at Connah's Quay power station to ground level concentrations of the released substances.

3.1 Model

The atmospheric dispersion model ADMS (Air Dispersion Modelling System) version 4.2 has been used. ADMS is used extensively by power station operators and the Environment Agency and also by many other industries and consultancies. ADMS was developed by CERC (Cambridge Environmental Research Consultants) and has been verified extensively against measurements.

3.2 Emission Characteristics

The temporary boilers at Connah's Quay power station have been installed to produce steam for starting up the Combined Cycle Gas Turbines (CCGTs) at the site. Therefore, the temporary boilers will only operate at baseload for approximately 3 hours per day to allow the CCGTs to start-up. When the temporary boilers are not operating at baseload to produce steam for the CCGT's they will either be shut-down or banking. Banking is when the boilers are operating at low load to keep the boilers in hot standby mode by intermittent firing of the burner to replace ambient heat losses. The emission parameters for the temporary boilers whilst banking are much lower than for baseload operation. Therefore, the modelling study has assumed that both boilers are operating at baseload all year which is a worst case assumption.

Modelling has not been carried out with the CCGT units operating at the same time as the temporary boilers are operating as the temporary boilers will not operate once the station has started up. Additionally, the CCGT stacks are significantly taller than the temporary boiler stacks and, therefore, the maximum impact point from the CCGT units will be in a different location than that from the temporary boilers.

The emission characteristics for the temporary boilers operating at baseload are shown in Table 2.

Table 2: Emission characteristics

Parameter	Temporary boilers
Stack grid references	327860, 371137 327850, 371120
Stack height (m)	14.2
Stack diameter (m)	0.9
Exit temperature (°C)	210
Actual oxygen content (% by volume, dry)	3
Actual water content (% by volume)	16.5
Reference oxygen content (% by volume, dry)	3
Volume flow rate (normalised) (Nm ³ /s)	3.1
Volume flow rate (actual) (m ³ /s)	6.5
Efflux velocity (m/s)	10.3
NO _x (as NO ₂) emission concentration (mg/Nm ³)	127
NO _x (as NO ₂) emission rate (g/s)	0.39
CO emission concentration (mg/Nm ³)	35
CO emission concentration (g/s)	0.11

Emission concentrations for NO_x and CO are taken from actual operation of the boilers at baseload. All other parameters are taken from the boiler manufacturer's specification for the boilers.

Approximately 10% of the emitted NO_x will be in the form of NO_2 , the remainder being NO . Therefore, it has been assumed that 10% is in the form of NO_2 for the purposes of this study.

3.3 Meteorological Data

Meteorological data for the dispersion modelling study was obtained from the Meteorological Office. Data from Hawarden Airport were used together with cloud cover from Crosby. Five years of sequential data recorded during 2007 to 2011 inclusive were used. Hawarden Airport is located approximately 9km south-east of the power station.

3.4 Grids

Ground level concentrations have been calculated on a regular grid of 61 by 61 points extending 600m north, south, east and west. The spacing between points was 20m. Modelling of Connah's Quay power station is normally carried out on a larger grid with a grid spacing of 125m. Small grid spacing has been used for this assessment to ensure that the highest impact point was determined due to the short stack heights for the temporary boilers compared to the CCGT stacks.

3.5 Surface Roughness

Surface roughness length is a measure of the influence of surface features on dispersion. A value of 0.4m has been used. The land use in the study area is a mixture of residential, industrial, agricultural land and the Dee Estuary. A value of 0.4m is appropriate for this mix of land use.

3.6 Buildings

The dispersion of substances released from an elevated point source such as the temporary boiler stacks can be influenced by the presence of buildings close to the source. The buildings can interrupt the wind flows and give higher ground level concentrations close to the source than would arise in the absence of the buildings.

Buildings will have a significant effect on dispersion if they are significantly taller than approximately one third of the stack height. The dimensions of the buildings which have been included in the model are detailed in Table 3. The main boiler house has been used as the main building within the model as it is the taller of the two buildings.

Table 3: Building dimensions

	Main boiler house	Auxiliary boiler house
Coordinates of building centre (m)	327946, 371113	327920, 371140
Height (m)	36.5	12
Length (m)	128	3
Width (m)	34	15.5
Building orientation (angle between building length and north) (°)	214.5	214.5

3.7 NO_x Chemistry

The Air Quality Strategy objectives for the protection of human health relate to the concentrations of nitrogen dioxide component of nitrogen oxides. Approximately 10% of the NO_x at the stack exit will be in the form of nitrogen dioxide, with the remaining 90% in the form

of nitric oxide (NO). Once released, NO can be converted to NO₂ by reaction with low level ozone in the atmosphere. The process is also reversible in sunlight and the net rate of conversion of NO to NO₂ in the plume is, therefore, a function of the rate of dilution of the plume by ambient air, trace gas concentrations in the air and meteorology.

ADMS contains a NO_x chemistry module which models these processes and can be used to predict ground level NO₂ concentrations. This module has been tested and has shown to function satisfactorily (Hunter, 2003) and is likely to give a more robust assessment of power station contributions to NO₂ concentrations than simpler methods such as the use of conversion factors. Hence this module has been used to assess the impact of the station on local NO₂ concentrations.

The input to the NO_x chemistry module comprises:

- The NO_x as NO₂ emission rate
- The percentage of NO_x as NO₂ by volume in the emitted flue gas
- Hourly varying background concentrations of NO_x, NO₂ and O₃ over the same period as the meteorological data.

The emission rate and percentage of NO_x present as NO₂ used for each stack is detailed in Section 3.2. The hourly background data for NO_x, NO₂ and O₃ was taken from the Wirral Tranmere monitoring site.

The simple NO_x chemistry module in ADMS models the oxidation of NO by ozone and in the presence of sunlight, the photolytic decomposition of nitrogen dioxide, as shown in Equations 1 and 2, with reaction coefficients k₁ and k₂ respectively (the reaction coefficient k₂ depends on cloud cover and solar inclination).



These equations proceed quickly so that photostationary equilibrium is reached within a few minutes with the following equation:

$$[NO_2] = \left(\frac{k_1}{k_2} \right) [NO] [O_3] \quad (\text{Eq 3})$$

At each receptor the NO_x may have originated from more than one source. The mean age of each pollutant is calculated and at each receptor the minimum non-zero mean age of the calculated pollutants is used as the calculation time in the chemistry scheme. Concentrations of NO_x, NO₂ and O₃ are calculated over the time period using an adaptive time stepping scheme.

ADMS uses cloud cover in the meteorological input file together with the time of day and time of year to calculate the reaction coefficient k₂, and hence the photostationary state. This estimate of photostationary conditions should be broadly similar to that implicit in the user supplied input ambient NO_x and NO₂ information. However, as the meteorological data is spot cloud cover estimates, the photostationary estimates implicit in the ambient concentrations differ slightly from the ADMS estimates. Hence, ADMS adjusts the NO_x balance of the ambient input conditions before proceeding with its calculations.

4 BASELINE CONDITIONS

Consideration has been given to existing background concentrations arising from sources other than Connah's Quay power station to take account of the potential adverse effects arising from total exposure to pollutant concentrations. Measurements of existing air quality in the vicinity of Connah's Quay are summarised in Appendix A. Based on measurements presented, values to represent background annual mean concentrations for the study area have been estimated and are presented in Table 4. Note that background concentrations of nitrogen dioxide are incorporated directly in the model.

Table 4: Estimated background annual mean concentrations

Substance	Estimated background annual mean concentration ($\mu\text{g}/\text{m}^3$)
Nitrogen dioxide	Hourly values incorporated directly in the model
Carbon monoxide	252

5 RESULTS

Table 5 shows the predicted ground level concentrations of nitrogen dioxide and carbon monoxide for the temporary boilers operating continuously throughout the year at baseload. Concentrations shown are the values at the maximum impact location at ground level. Concentrations at other locations, including air sensitive receptors will be lower than the values presented. Concentrations presented are the maximum that result using any of the five years of meteorological data. For each substance and concentrations statistic, the tables show:

- The AQS objective or Environmental Assessment Level (EAL) that concentrations are compared against
- Typical background annual mean concentrations in the study area
- The contribution of the temporary boilers to ground level concentrations, the Process Contribution (PC)
- The PC expressed as a percentage of the EAL
- The Predicted Environmental Concentration (PEC), the combination of the process contribution and background concentrations
- The PEC expressed as a percentage of the EAL.

For carbon monoxide, the predicted process contribution is provided directly by the model. The predicted environmental concentration for annual mean carbon monoxide is the sum of the process contribution and background annual mean concentration. The Environment Agency's H1 guidance (Environment Agency, 2011) suggests that twice the annual mean background concentration should be added to all pollutants for short-term PEC's. Background CO concentrations will primarily be from ground level sources such as traffic emissions. Therefore, it is unlikely that high background concentrations at ground level will coincide with high process contributions from an elevated source such as a power station. However, due to the relatively short stacks for the temporary boilers at Connah's Quay power station, Table 5 shows the predicted environmental concentration for short-term CO concentrations calculated using both one times and twice the annual mean background CO concentration as a precautionary approach.

For nitrogen dioxide, the predicted environmental concentration has been predicted directly by the model using emissions data from the temporary boilers at Connah's Quay power station and incorporating hourly background concentrations from the Wirral Tranmere monitoring site. To estimate the process contribution for nitrogen dioxide it is necessary to undertake a further model run in which emission from the temporary boilers are set to zero. The predicted environmental concentration from the zero emissions run gives the background concentration. The process contribution to the 99.79th percentile hourly mean NO₂ concentration is the difference between the 99.79th percentile predicted environmental concentration from the model run including emissions from the temporary boilers and the 99.79th percentile concentration predicted from the model with zero emissions. Both model runs use the same meteorological data. Annual average NO₂ process contributions are calculated in a similar way. It is possible that the process contribution could be higher than those presented in Table 5, as discussed in Section 5.1.1.

Table 5: Predicted process contribution (PC) and predicted environmental concentration (PEC) when the temporary boilers are operating continuously at baseload

Substance	Statistic	AQS objective or EAL (µg/m ³)	Background concentration (µg/m ³)	PC (µg/m ³)	PC/EAL (%)	PEC (µg/m ³)	PEC/EAL (%)
Nitrogen dioxide	Annual mean	40	30.0	14.0	35%	44.0	110%
	99.79 th %ile of hourly mean concentrations	200	116.8	42.8	21%	159.6	80%
Carbon monoxide	Annual mean	350	252	34.4	10%	286.4	82%
	Maximum running 8 hour mean	10,000		211.6	2%	463.6	5%
	Maximum running 8 hour mean	10,000	504	211.6	2%	715.6	7%

The results for each pollutant are discussed below:

5.1 Predicted Nitrogen Dioxide Concentrations

The predicted environmental concentration for the annual mean nitrogen dioxide concentration is a maximum of 44 µg/m³ which is above the AQS objective of 40 µg/m³. The process contribution is 14µg/m³. However, the modelling study assumes that the temporary boilers operate all year at baseload. In reality, the temporary boilers will only operate at baseload for approximately three hours every day that the main station is required to operate. This will be a maximum of three hours per day throughout the year which would significantly reduce the process contribution.

It is worth noting that even under this unrealistic operating scenario the process contribution from the temporary boilers is only 48% of background concentrations and, therefore, the majority of the predicted environmental concentration is due to background concentrations which comprise 75% of the AQS objective.

The maximum predicted environmental concentration occurs during 2011. For all other meteorological years modelled the predicted environmental concentration is below the AQS objective.

The predicted environmental concentration of the 99.79th percentile of hourly mean concentrations is 80% of the AQS objective of 200 $\mu\text{g}/\text{m}^3$ demonstrating that the AQS objective is easily met. The predicted process contribution to the 99.79th percentile of hourly mean concentrations is 21% of the AQS objective.

Table 5 shows the highest predicted environmental concentrations for nitrogen dioxide and the process contribution that occurs during that year for consistency. Higher process contributions can, however, arise in individual years which do not correspond to the year with the maximum predicted environmental concentration.

The highest process contribution to the annual mean nitrogen dioxide concentration corresponds to the year with the highest predicted environmental concentration. Hence the maximum process contribution predicted using any of the five years of meteorological data for annual mean concentrations is that quoted in Table 5.

The highest process contribution to the 99.79th percentile hourly mean nitrogen dioxide concentration is higher than that quoted in Table 5. The highest process contribution to the 99.79th percentile hourly mean nitrogen dioxide concentration across all five years is 56.4 $\mu\text{g}/\text{m}^3$ which is 28% of the AQS objective of 200 $\mu\text{g}/\text{m}^3$. It is worth noting that the predicted environmental concentration (i.e. the combined power station and background contribution) for the year where the highest process contribution occurred is lower than the values quoted in Table 5.

Predicted environmental concentrations from the model for nitrogen dioxide when using the NO_x chemistry module are dominated by background concentrations and, therefore, contour plots when using the NO_x chemistry module do not show the likely impact areas of the power station clearly. The maximum impact locations for all meteorological years and all statistics modelled are within 120m of the temporary boiler stacks.

5.2 Predicted Carbon Monoxide Concentrations

The maximum predicted process contribution to the annual mean carbon monoxide concentration is 10% of the EAL of 350 $\mu\text{g}/\text{m}^3$. The predicted environmental concentration (i.e. the process contribution and background concentrations) is a maximum of 82% of the EAL of 350 $\mu\text{g}/\text{m}^3$. Background concentrations contribute 72% of the EAL. However, even with background concentrations included, the EAL is easily met.

The predicted process contribution to the maximum running 8 hourly mean of carbon monoxide concentrations is 2% of the AQS objective of 10,000 $\mu\text{g}/\text{m}^3$. This is below the insignificance threshold of 10% of the AQS objective and, therefore, short-term carbon monoxide concentrations can be classed as insignificant. The PEC to the maximum running 8 hourly mean of carbon monoxide concentrations is a maximum of 7% of the AQS objective assuming a precautionary approach of adding twice the annual mean background concentration to the process contribution. This shows that even with background concentrations the short-term carbon monoxide concentration can be classed as insignificant.

6 CONCLUSIONS

E.ON UK has discovered significant cracks in the auxiliary boiler at Connah's Quay power station resulting in its consequent failure and removal from service. Without the auxiliary boiler the power station is unable to produce the steam supplies required to start the combined cycle gas turbines (CCGT) at the station and, therefore, are unable to generate electricity. E.ON UK

has installed two temporary boilers at the site as a substitute whilst the auxiliary boiler is being repaired.

The Environment Agency has requested that an assessment is carried out of the potential impact the temporary boilers may have on the local air quality. Initially a H1 assessment was carried out which concluded that air dispersion modelling was required to predict more accurately the impact of the two temporary boilers. This study has assessed the emissions of nitrogen oxides (NO_x) and carbon monoxide (CO) from the two temporary boilers.

The predicted ground level annual mean nitrogen dioxide concentrations are a maximum of $44 \mu\text{g}/\text{m}^3$ including background concentrations which is above the AQS objective of $40 \mu\text{g}/\text{m}^3$. The process contribution is $14 \mu\text{g}/\text{m}^3$. However, the modelling study assumes that the temporary boilers operate all year at baseload. In reality, the temporary boilers will only operate at baseload for approximately three hours every day that the main station is required to operate. This will be a maximum of three hours per day throughout the year which would significantly reduce the process contribution.

It is worth noting that even under this unrealistic operating scenario the process contribution from the temporary boilers is only 48% of background concentrations and, therefore, the majority of the predicted environmental concentration is due to background concentrations which comprise 75% of the AQS objective.

The maximum predicted environmental concentration occurs during 2011. For all other meteorological years modelled the predicted environmental concentration is below the AQS objective.

The predicted environmental concentration of the 99.79th percentile of hourly mean concentrations is 80% of the AQS objective of $200 \mu\text{g}/\text{m}^3$ demonstrating that the AQS objective is easily met. The predicted process contribution to the 99.79th percentile of hourly mean concentrations is 21% of the AQS objective.

The maximum predicted process contribution to the annual mean carbon monoxide concentration is 10% of the EAL of $350 \mu\text{g}/\text{m}^3$. The predicted environmental concentration (i.e. the process contribution and background concentrations) is a maximum of 82% of the EAL of $350 \mu\text{g}/\text{m}^3$. Background concentrations contribute 72% of the EAL. However, even with background concentrations included, the EAL is easily met.

The predicted process contribution to the maximum running 8 hourly mean of carbon monoxide concentrations is 2% of the AQS objective of $10,000 \mu\text{g}/\text{m}^3$. This is below the insignificance threshold of 10% of the AQS objective and, therefore, short-term carbon monoxide concentrations can be classed as insignificant. The PEC to the maximum running 8 hourly mean of carbon monoxide concentrations is a maximum of 7% of the AQS objective showing that even with background concentrations the short-term carbon monoxide concentration can be classed as insignificant.

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APPENDIX A

Existing (Baseline) Air Quality

Measurements of air quality in the vicinity of Connah's Quay have been collated. Based on the measurements, estimates of annual mean concentrations on nitrogen dioxide, nitrogen oxides and carbon monoxide have been derived. The background concentrations are added to modelled plant contribution to determine that overall concentrations are compliant with air quality standards.

The DEFRA automatic monitoring sites that have been used in this assessment are listed in Table A1.

Table A1: Monitoring sites

Monitoring Site	Type	Location	Approximate distance from power station (km)
Wirral Tranmere	Urban background	332054, 386711	16
Liverpool Speke	Urban background	343887, 383603	20
Mold	Suburban background	323551, 363410	9
Wrexham	Urban traffic	332865, 349909	22
Salford Eccles	Urban industrial	377925, 398729	57

Table A1 shows that the Mold monitoring site would be the most appropriate monitoring site to use as it is the closest monitoring site to the power station and is also classed as a suburban background monitoring site which is most applicable to the location of the power station i.e. in a largely built-up area but not continuously built-up and a background monitoring site which is not heavily influenced by one source. However, the Mold monitoring site has only been operational from late 2009 to present day and during 2010 had very low data capture. Therefore, there are not enough full years of background data to be used in the modelling assessment. Additionally the Mold site does not measure carbon monoxide concentrations.

A1 Nitrogen Dioxide

Background concentrations of nitrogen oxides are combined with process contributions directly within ADMS using the NO_x chemistry module. Hourly concentrations measured at Wirral Tranmere have been used within the model. Table A2 shows annual mean concentrations measured at the Wirral Tranmere monitoring site for 2007 to 2011 together with concentrations recorded from other nearby sites to allow measurements used to be viewed in context of other nearby sites.

Table A2 shows that annual mean concentrations used in the model show good agreement with those recorded at other nearby monitoring sites. The data illustrates that all measurements comply with the Air Quality Strategy objectives for annual mean nitrogen dioxide concentrations of 40 µg/m³. The Wirral Tranmere concentrations are likely to be an over-estimate of concentrations around Connah's Quay power station, as the Wirral Tranmere monitor is located in a larger urban area than the power station.

Table A2: Baseline (annual mean) concentrations of nitrogen dioxide

Site	Year	Annual mean concentrations ($\mu\text{g}/\text{m}^3$)	Data capture
Wirral Tranmere	2007	19.3	97%
	2008	18.9	98%
	2009	19.0	94%
	2010	30.6	94%
	2011	32.7	96%
Liverpool Speke	2007	23.8	96%
	2008	21.6	95%
	2009	22.2	94%
	2010	29.8	94%
	2011	23.8	97%
Mold	2010	17.3	31%
	2011	11.1	92%

Short term concentrations of nitrogen dioxide at the three monitoring sites are shown in Table A3. The table shows that the Air Quality Strategy objective of $200 \mu\text{g}/\text{m}^3$ as a 99.79th percentile of hourly mean concentrations is currently met by a significant margin.

Table A3: 99.79th percentile of hourly mean concentrations of nitrogen dioxide

Site	Year	99.79 th ile of hourly mean concentrations ($\mu\text{g}/\text{m}^3$)	Data capture
Wirral Tranmere	2007	96	97%
	2008	96	98%
	2009	89	94%
	2010	129	94%
	2011	117	96%
Liverpool Speke	2007	96	96%
	2008	86	95%
	2009	100	94%
	2010	111	94%
	2011	99	97%
Mold	2010	77	31%
	2011	71	92%

A2 Nitrogen Oxides

Background concentrations of nitrogen oxides in the vicinity of Connah's Quay power station are shown in Table A4.

Table A4: Baseline (annual mean) concentrations of nitrogen oxides (NO_x as NO₂)

Site	Year	Annual mean concentrations (µg/m ³)	Data capture
Wirral Tranmere	2007	28.2	97%
	2008	26.6	98%
	2009	26.0	94%
	2010	40.3	94%
	2011	37.4	96%
Liverpool Speke	2007	38.1	96%
	2008	33.3	95%
	2009	34.3	94%
	2010	48.5	94%
	2011	34.1	97%
Mold	2010	31.4	31%
	2011	15.2	92%

A3 Carbon Monoxide

Background annual mean concentrations of carbon monoxide are shown in Table A5.

Table A5: Baseline (annual mean) concentrations of carbon monoxide

Site	Year	Annual mean concentration (µg/m ³)	Data capture
Wirral Tranmere	2007	237	68%
Liverpool Speke	2007	172	70%
	2008	145	94%
	2009	192	97%
	2010	252	98%
	2011	207	99%
Wrexham	2007	348	71%
Salford Eccles	2007	142	95%
	2008	139	90%
	2009	136	98%
	2010	177	98%
	2011	147	95%
Estimated background in the vicinity of Connah's Quay		252	

Traffic is the dominant source of carbon monoxide, accounting for around 70% of the UK's emissions (DETR, 2000). This is reflected in the higher concentrations recorded at the urban traffic monitoring site (Wrexham) compared to the urban background and industrial sites (Wirral Tranmere, Liverpool Speke and Salford Eccles). The Wrexham monitoring site is located in a town centre approximately 5m from a road. Concentrations are, therefore, likely to be considerably higher than those present in the study area.

Liverpool Speke and Wirral Tranmere have also recorded high concentrations over the five years due to their proximity to roads. Liverpool Speke and Wirral Tranmere monitoring sites are approximately 10m and 50m respectively from the nearest road. The highest concentration recorded at the urban background sites has been used as a conservative estimate of background concentrations in the vicinity of Connah's Quay power station.