ArupTransport

Tyne and Wear Passenger Transport Authority

New Tyne Crossing

Proof of Evidence on Air Quality

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1. INTRODUCTION

Michael Andrew Bull will say:

1.1 I hold a BSc in Chemical Engineering from Exeter University and PhD in Public Health Engineering from Imperial College, London. I am a Chartered Engineer and am a corporate member of the Institution of Chemical Engineers. I am an Associate Director of Ove Arup & Partners International Ltd, and Team Leader of the Environmental Science Team and particularly responsible for managing the air quality assessments undertaken by Arup Environmental.

1.2 I have worked as a professional environmental scientist for approximately 19 years having previously conducted research in environmental science for three years. I have held posts both within industry and as a consulting scientist. I have been responsible for conducting environmental studies for major road improvement and construction schemes, power stations, mineral extraction sites and other major industrial complexes. I am one of the co-authors of the RTPI Good Practice Guide on Air Quality and Land Use Planning and recently contributed to the Mayor of London's Air Quality Strategy.

1.3 I have undertaken air quality assessments of numerous road tunnel schemes including the Dublin Port Tunnel, proposed tunnels on the North Circular Road London, the Hatfield Tunnel on the A1(M), the Holmesdale Tunnel on the M25 and the Heathrow approaches tunnel. In addition, I have undertaken air quality assessment of many road scheme proposals including the M25 and the A1(M) widening, construction of the M4 relief road, the M50 C-Ring in Dublin, and improvements on the M2, A13, A406, A23, M65, A40 and the A63 together with numerous smaller proposals.

1.4 In this instance I have been retained by the TWPTA to advise on air quality issues and this evidence has been prepared as required by the Statement of Matters to give details on the air quality effects of the proposals. I have been the project manager for the air quality assessment undertaken for the environmental statement and am familiar with the scheme. The scope of work for this assessment was as follows:

- a review of existing air quality in the area;
- a qualitative assessment of the impact of the construction activities on air quality;
- a quantitative assessment of the impact of the operation of the New Tyne Crossing on the local and global air quality; and
- a comparison of forecast air pollutant levels with current air quality criteria.

2. AIR QUALITY STANDARDS AND GUIDELINES

2.1 To undertake the assessment I have first considered the relevant standards and objectives for air quality. The Government's air quality strategy (AQS) forms the basis of air quality standards and objectives in the UK. In the AQS, the Government has set objectives for specified priority pollutants for the protection of human health placed into regulation by the Air Quality Regulations 2000 and the amendment Regulations 2002. These regulations prescribe air quality objectives to be achieved by target years for seven priority pollutants: benzene, 1,3-butadiene, carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), particulate matter (PM_{10}) and sulphur dioxide (SO_2).

2.2 Local authorities are required to assess whether the prescribed objectives are likely to be achieved by their target dates. Where prescribed objectives are unlikely to be achieved, local authorities are required to designate the area as an Air Quality Management Area (AQMA). Further assessments are then required and an action plan needs to be drawn up specifying the measures to be carried out and the time scale to bring air quality in the area back within prescribed limits.

2.3 Further standards have been introduced through European Regulation. The Framework Directive on Ambient Air Quality Assessment and Management (96/62/EC) and along with the First Daughter Directive (99/30/EC), set limit values for nitrogen dioxide; sulphur dioxide; PM10; and lead. In 2000, air quality limit values for carbon monoxide and benzene were set in the Second Daughter Directive (2000/69/EC). The Air Quality Framework Directive and first daughter Directive have been transposed into national legislation, through the Air Quality Limit Values Regulations 2001. These regulations place an obligation on the Secretary of State for the Environment to achieve the limit values by the due date, and therefore complement the existing air quality objectives. Draft regulations for the limit values of benzene and carbon monoxide were issued in 2002 and are likely to be adopted later this year.

2.4 The relevant standards and objectives are shown in Table 1.

TABLE 1	AIR QUALITY CRITERIA			
Pollutant	**Averaging Period**	**Limit Value/Objective**	**Year for Compliance**	**Reference**
Nitrogen Dioxide	1 hour mean	200 µg/m^3, not to be exceeded more than 18 times a year (99.8th percentile)	2005	AQS objective
			2010	UK limit value
	Annual mean	40 µg/m^3	2005	AQS objective
			2010	UK limit value
Carbon Monoxide	Running 8 hour mean	11.6 mg/m^3	2003	AQS objective
		10.mg/m^3	2010	Draft UK limit value
Benzene	Running annual mean	16.25 µg/m^3	2003	AQS objective
		5 µg/m^3	2010	Draft UK limit value
1,3 Butadiene	Running annual mean	2.25 µg/m^3	2003	AQS objective
Fine Particulates (PM_{10}) Measurement technique: Gravimetric	Daily mean	50 µg/m^3, not to be exceeded more than 35 times a year (90th percentile)	2004	AQS objective
			2005 (Stage I)	UK limit value
		50 µg/m^3, not to be exceeded more than 7 times a year (98th percentile)	2010 (Stage II)	UK limit value
	Annual mean	40 µg/m^3	2004	AQS objective
			2005 (Stage I)	UK limit value
		20 µg/m^3	2010 (Stage II)	UK limit value

3. EXISTING AIR QUALITY

3.1 The first part of my assessment has been to consider the existing air quality in the area, this allows predictions of future changes in air quality to be placed into context. Air quality monitoring information is available from several sources. DEFRA undertakes continuous monitoring of ambient pollutant concentrations at the automatic monitoring station adjacent to Newcastle Civic Centre. The station is classified as an Urban Centre site, where concentrations are likely to be higher than in the area of the New Tyne Crossing. Table A1 in Appendix A presents measured concentrations of pollutants relevant to traffic emissions at the monitoring station in Newcastle. The results show that measured concentrations of PM_{10}, carbon monoxide (CO) and nitrogen dioxide are within the limit values and objectives set in the Air Quality Regulations 2000 and Air Quality Limit Values Regulations 2001.

3.2 DEFRA also undertakes a national survey of nitrogen dioxide concentrations using diffusion tubes. The results of this survey are available on the UK National Air Quality Archive. Table A2 in Appendix A presents the concentrations recorded at background and intermediate sites in the vicinity of the New Tyne Crossing. The results show that background levels in the New Tyne Crossing area are in the range 17-23 $\mu g/m^3$. This is well within the 40 $\mu g/m^3$ air quality objective.

3.3 In the National Air Quality Archive, DEFRA has also produced background pollution maps for the UK in 1996, for several pollutants. The maps provide an estimate of the annual mean background concentration of each pollutant on a 1km grid across the UK. Reported concentrations of benzene, carbon monoxide, nitrogen dioxide and PM_{10} were used as background concentrations for part of this air quality assessment.

Newcastle City Council

3.4 Between January 2000 and April 2001, Arup worked with Newcastle City Council to carry out a monitoring programme in the area of the tunnel. The programme includes the measurement of benzene and nitrogen dioxide concentrations with diffusion tubes and the use of a mobile monitoring unit.

3.5 The mobile unit, containing real time CO, NO_2, PM_{10} and BTEX analysers, was placed at St Peter's Primary School in Jarrow, the New Tyne Crossing's South Portal entrance and the New Tyne Crossing Trading Estate for 4 month periods. The results for the main traffic related pollutants (PM_{10}, carbon monoxide, nitrogen dioxide and benzene) are presented in Table 2.

TABLE 2 – MOBILE AUTOMATIC MONITORING STATION					
		St Peters School, Jarrow	**South Portal Entrance**	**Tyne Tunnel Industrial Estate**	
Pollutant	**Statistic**	*01-01-00 to 30-04-00*	*16/05/00 to 14/09/00*	*1/10/00 to 31/1/01*	**Air Quality Objective**
Carbon Monoxide	Maximum 8hr mean (mg/m^3)	7.3	7.7	2.6	11.6 mg/m^3 to be achieved by 2003
NO_2	Mean ($\mu g/m^3$)	8	30	33	Annual mean of 40 $\mu g/m^3$, to be achieved by 2005
	No of hourly exceedences of 200 $\mu g/m^3$	3	2	55	18 exceedences in a year
Benzene	Average daily mean ($\mu g/m^3$)	1.6*	2.7**	1.5	Annual mean of 16.25 $\mu g/m^3$, to be achieved by 2003
PM_{10} #	Mean ($\mu g/m^3$)	11	11	13	Annual mean of 50 $\mu g/m^3$, to be achieved by 2004
	No of hourly exceedences of 50 $\mu g/m^3$	0	0	0	35 exceedences in a year

*16-02-00 to 11-05-00 **13-05-00 to 09-15-00

3.6 The concentrations were monitored for periods of 4 months. The average concentrations for this period were compared with the annual objectives in the air quality standards. However, it should be noted that these results are not for a full calendar year but give a broad indication of long term concentrations. The Quality of Urban Air Review Group (Appendix B) reported that a four month study would give an average concentration within approximately 15% of the recorded annual mean value.

3.7 These results show that two of the three sites meet the relevant air quality objectives. One site, (Tyne Tunnel Industrial Estate) showed 55 exceedances of the one hour nitrogen dioxide objective. However, there are two possible reasons for this. The operators of the mobile unit reported problems with leakage of the calibration gas during the monitoring that would result in high concentrations being recorded. In addition, the site is next to a heavy good vehicle park where movement of vehicles close to the monitor would result in high short term concentrations. The annual mean concentration at this site is below the objective level thus the short term exceedances must be as the result of a local source.

3.8 For the assessment a monitoring study was also undertaken using nitrogen dioxide and benzene diffusion tubes located at various locations near the north and south side of the proposed crossing for a period of 12 months. In total 45 diffusion tube locations were used for nitrogen dioxide and 10 for benzene. None of the sites recorded an exceedance of air quality objectives (detailed results are provided in Tables A3-A5 in Appendix A).

3.9 Therefore, in general, concentrations are within the relevant air quality standards or objectives with some local areas of exceedance.

4. CONSTRUCTION

Assessment Methodology (Construction)

4.1 My assessment of the impact of dust emissions on the local air quality has been based on a qualitative approach. I have examined the potential sources of dust emissions and any identified any nearby sensitive land uses. I then made an assessment of the impact during construction on these land uses and have proposed mitigation measures where necessary.

Identification Potential Sources of Dust

4.2 Dust emissions from construction activities depend on a combination of the potential for emission and the effectiveness of dust control measures.

4.3 In general, there are two sources of emissions that need to be controlled:

i. fugitive dust emissions from construction site activities; and

ii. exhaust emissions from construction plant, equipment and vehicles.

4.4 I shall therefore consider each of these two sources separately below.

Construction Activities

4.5 The construction activities that are the most significant sources of fugitive emissions are:

i. demolition activities, due to the breaking up and size reduction of concrete, stone and compacted aggregates;

ii. earth moving, due to excavation, handling, storage and disposal of soil and subsoil materials;

iii. construction aggregate usage, due to transport, unloading, storage and use of dry and dusty materials (such as cement powder and sand);

iv. movement of heavy site vehicles on dry untreated or hard surfaced areas; and

v. movement of vehicles over surfaces contaminated by muddy materials brought off the site - for example public roads.

4.6 Fugitive dust arising from such activities is generally of particle size greater than the PM_{10} fraction and therefore the impact of concern is that of nuisance caused by deposition onto surfaces.

Exhaust Emissions

4.7 The operation of vehicles and equipment powered by internal combustion engines results in the emission of waste exhaust gases containing the pollutants NO_X, fine particulates (which would also contribute to dust), VOCs, CO and CO_2. The quantities emitted would depend on factors such as engine type, service history, pattern of usage and composition of fuel. Although operation of site equipment, vehicles and machinery would result in the emission to atmosphere of unquantified levels of waste exhaust gases, such emissions are unlikely to be significant, particularly in comparison to levels of similar emissions from road traffic.

4.8 For example, detailed calculations for the Channel Tunnel Rail Link (CTRL) project for the section in London (Environmental Statement, CTRL Project) indicated that all site emissions over one working month were equivalent to one hour (rush hour period) of traffic emissions on an adjacent major road.

4.9 Given the likely magnitude of the emissions I do not consider that a detailed assessment is required and it is likely that their impact would be insignificant.

Identification of Sensitive Receptors

4.10 In order to assess the potential for dust nuisance I have examined the nearby dust sensitive land uses (receptors). A number of dust sensitive receptors were identified within 100m and 250m of the proposed construction (as shown in Table A8, Appendix A).

4.11 I have categorised the sensitivity of different land uses to dust from insensitive (e.g. parkland) to high (e.g. high-density residential properties) based on published information. These are summarised in Table A7 in Appendix A.

Assessment of Dust Impacts

4.12 Airborne dust has a limited ability to remain airborne and readily drops from suspension as a deposit. Research undertaken by the United States Environmental Protection Agency (reported in the DoE report on Dust from Mineral Workings, Appendix C) shows that in excess of 90% of total airborne dust has returned to rest within 100m of the emission source and over 98% within 250m. These distances are used to define 'risk zones' around emission sources within which dust deposition may be a problem for sensitive receptors. Within the innermost 100m zone, if strong dust emission sources are present on site, the risk of nuisance is high, unless a very high standard of dust control is achieved. Within the 100 - 250m zone, the risk of dust nuisance remains, but is less likely to result in adverse dust impacts. Beyond 250m, adverse dust impacts are unlikely.

4.13 The meteorological conditions for the region would not necessarily control dust dispersion within the 'stand off' distance of 250m of the site. This is because turbulence created by surrounding buildings would mean that dust may not travel with the prevailing wind, but in general the 250m distance remains a good indication of the extent of possible nuisance.

Assessment Results (Construction)

Potential Sources of Dust

4.14 Examining the proposed construction activities I consider that the main sources of dust would be as follows (for convenience I have broken the scheme into north and south sections)

North

4.15 Cut and cover excavation. The excavation would extend from the river bank to the new southbound A19, level with East Howdon and would be over 200m. The construction would last approximately 14 months.

4.16 The site compound at Howdon Landfill East site. The site would include a temporary stockpile for excavated material to be used as backfill.

Construction of new roads and toll plaza.

4.17 Associated haulage roads. Access from the site would be at the northernmost roundabout on East Howdon Bypass. The bypass would be used to remove material to the north.

South

4.18 Cut and cover and open cut excavation. The tunnel construction on the south side would extend for approximately 700m from Howard Street to the river and would last around 21 months.

4.19 Temporary stockpile, at the chemical storage area of Rohm and Haas, of excavated material to be reused as backfill.

4.20 Potential temporary stockpile of dredged material at the Former Mercantile Dock Yard, which would be required for 9 months.

4.21 Construction of the ventilation building. This would take approximately 4 months.

4.22 Demolition and reconstruction of the bridge at Howard Street.

4.23 Construction of new roads and structures for the approach roads to the south side.

4.24 Associated haulage roads. A haulage road would run to the east side of the tunnel route. This would join Chaytor Street for removal of spoil to the south along Priory Road and the A19.

Dust Impacts

4.25 The dust sensitive receptors within 250m of construction works are presented in Table A8 in Appendix A.

4.26 The only highly sensitive sites within 100m of the site are St Bede's and Dunn Street School. There would potentially be **substantial adverse** dust impacts at both schools from the cut and cover works. Although the complete cut and cover on the south side would take 21 months, the works would be split into 4 sections. Therefore excavation and backfilling work adjacent to the schools should take between 5-7 months. There would also be potential **substantial adverse** dust impacts at St Bede's school from the construction of the ventilation building.

4.27 Further potential **substantial adverse** dust impacts may also arise at the moderately sensitive sites within 100m of construction activities. The cut and cover works would affect properties, particularly along Brinkburn Terrace, and the Community Centre in East Howdon. Similarly, properties and retail facilities in Jarrow and the Community Centre would potentially be affected by the cut and cover works on the south side as described for the schools above.

4.28 **Potential substantial adverse** impacts may occur at properties at the corner of Priory Road and Chaytor Street adjacent to the potential temporary stockpile for dredged material at Mercantile Dock.

4.29 There are also moderately sensitive sites to the south of the South Portal. Potential **substantial adverse** impacts may occur within 100m of construction work at the approach roads and structures, at properties at Epinay Walk, Debussey Court and Regent Rd.

4.30 A number of dust sensitive properties were also identified within 100m and 250m of the proposed construction site. There is a risk of dust impacts occurring at these sites although it is less likely to result in adverse impacts.

4.31 The former uses in the area of the tunnel indicate that there may be slight contamination on site. Adverse impacts could occur from contamination in dust.

4.32 Emissions of vehicular pollutants arising from activities during the preparation and construction phases are unlikely to give rise to significant impacts on local air quality.

Mitigation Measures

4.33 Most of the dust emitting activities outlined above respond well to appropriate dust control/mitigation measures and adverse impacts can be greatly reduced or eliminated.

4.34 Effective dust mitigation measures prevent dust becoming airborne or contain dust-laden air within enclosures to prevent dispersion beyond the emission source. To control adverse dust effects a Code of Construction Practice would be agreed with the local authorities.

4.35 Due to the scale of the cut and cover excavations and associated haulage roads on the north and south side of the river, mitigation measures would be required. Stringent measures would be needed at the highly sensitive sites, within 100m of construction activities, at St Bede's School and Dunn Street School. Mitigation measures would also be required at residential areas identified in Table A9 in Appendix A in East Howdon and Jarrow.

4.36 The Code includes the measures presented in Table A9 in Appendix A. The effectiveness of the mitigation measures, as described in the DoE's (now DEFRA) Best Practice Guide for Dust Monitoring (see Appendix C), are also given in the table.

4.37 These measures would be applied as appropriate to protect sensitive areas. Many of these measures are known to be highly effective in reducing dust emissions from construction activities and the application of these measure would be expected to reduce the impact to **Minor Adverse**.

4.38 In addition, as there is some indication of slight contamination of the soils on site, a regular air monitoring programme would be instigated if there is evidence of hazardous materials. Upon confirmation of the type of material found adequate corrective measure would be immediately instigated.

4.39 The contractors would also be expected to work within all relevant health and safety legislation and comply with all relevant statutory air quality requirements such as the Clean Air Act, the Control of Substances Hazardous to Health Regulations and the Environmental Protection Act.

5. OPERATIONAL IMPACTS

Assessment Methodology (Operation)

5.1 To examine the changes in air quality as a result of the operation of the proposed New Tyne Crossing I have followed the guidelines outlined in Volume 11 (Environmental Assessment) of the Design Manual for Roads and Bridges, (referred to as the 'DMRB'), (DETR (now DfT), May 1999). My assessment has examined the potential air quality impacts of the tunnel considering both the local air quality and global emissions.

Impact on Local Air Quality

5.2 Following the DMRB guidelines I have undertaken four separate tasks.

Firstly, the use of a simple graphical screening assessment at several discrete receptors;

Secondly, detailed dispersion modelling in the area around the tunnel portals and at sites where the screening assessment indicated the potential for air quality standards to be exceeded;

Thirdly, a generalised graphical screening assessment that is intended to give an overall indication of the air quality impacts of the proposals; and

Finally, calculation of the global pollutant emissions from the scheme.

Graphical Screening – Discrete Receptors

5.3 The DMRB graphical screening method is designed to estimate air pollutant concentrations at discrete receptors in order to highlight any sites where there may be a potential air quality problem. The DMRB recommends that four key pollutants be examined as part of the screening method: nitrogen dioxide; carbon monoxide; benzene; and PM_{10}. The method takes into account any changes in traffic flows and speeds on the local network together with any difference in the number of heavy goods vehicles (HGVs).

5.4 The DMRB recommends that the results of the screening exercise are compared with the criteria presented in Table 3. These criteria are based on selected air quality standards in the UK. The screening method is not intended to be an exact indicator of pollutant concentrations, it designed to identify where a further assessment is required and provides a useful tool to compare various scenarios.

TABLE 3: CRITERIA FOR THE DMRB SCREENING METHOD	
Pollutant	**Criteria**
Carbon monoxide	10 ppm (annual max. running 8 hour mean) by 2003
Nitrogen dioxide	40 μg/m^3 (annual mean) by 2005
	200 μg/m^3 (annual 99.8th percentile of hourly means) by 2005
Benzene	5 ppb (annual mean) by 2003
1,3-Butadiene	1 ppb (annual mean) by 2003
Fine Particulate Matter (PM_{10})	40 μg/m^3 (annual mean) by 2004
	50 μg/m^3 (90th percentile of running 24-hour mean) by 2004

5.5 The receptors chosen for the graphical screening assessment are listed below. The selection of receptors was made to ensure that all areas near the scheme most affected by changes in traffic flows were represented. Because this method cannot take into account the impact of emissions from the tunnel, detailed dispersion modelling was used for any receptor close to the tunnel portals. I selected eight receptors for the DMRB analysis as shown below, these receptors have been selected so as to be representative of the potential impacts of the proposals, there are located close to the major roads and receptors further from the road would be expected to have a lower impact.

North Tyneside

Receptor	*Location*
GN1	48 Firtrees Avenue
GN2	2 Henley Gardens
GN3	19 Melrose Gardens

South Tyneside

Receptor	*Location*
GS1	28 Newlyn Drive
GS2	21 Bilton Hall Road
GS3	74 Salcombe Avenue
GS4	155 Lulworth Avenue
GS5	5 Regent Road

5.6 For each receptor I have calculated pollutant concentrations for:

- the base year of 2000;
- the proposed opening year of 2006 with and without scheme;
- the design year of 2021 with and without scheme.

Although it is expected that the scheme will now open later these years would represent worse case as pollutant emissions are predicted reduce in the future as a result of improved emission controls on the vehicle fleet.

Input Data and Assumptions

5.7 The DMRB graphical screening method requires information concerning traffic volumes and speeds, the distance of the receptor from the road and background pollution concentrations. Information on traffic flows, speeds and composition was obtained from Arup Transportation. I obtained the background concentrations for carbon monoxide and PM_{10} from the background pollution maps available in the UK National Air Quality Archive. For benzene and nitrogen dioxide I took values from the monitoring carried out by Newcastle City Council. I have adjusted all concentrations for future years using the procedures detailed in the DMRB. The values are shown in the Table 4 below.

TABLE 4: ANNUAL MEAN BACKGROUND POLLUTANT CONCENTRATIONS FROM UK NATIONAL AIR QUALITY ARCHIVE MAPS

Pollutant	2000		2006		2021	
	North	South	North	South	North	South
Carbon monoxide (ppm)	0.25	0.25	0.18	0.18	0.15	0.15
Oxides of nitrogen ($\mu g/m^3$)	24	24	18	18	15	14
Benzene (ppb)	0.6	0.6	0.4	0.4	0.3	0.3
PM_{10} ($\mu g/m^3$)	19	19	17	17	16	16

Detailed Modelling Methodology

5.8 To assess the air quality impacts around the tunnel portals I have used more detailed dispersion modelling techniques.

5.9 The model I have used for the detailed assessment is called Caline4. This model was developed in the USA and is an updated version of the Caline3 model – a preferred model of the United States Environmental Protection Agency (USEPA) for road scheme developments. Although developed in the USA the Caline4 model has been widely used in the UK and the results accepted by planning authorities, the Highways Agency and by Inspectors at public inquiry. In the DETR (now DEFRA) Guidance Document 'Selection and Use of Dispersion Models' (LAQM TG3(00), see Appendix D) the Caline4 model is classified as an 'Advanced Model', suitable for the most detailed assessments required by local authorities.

5.10 I have used the dispersion model ISC to model the emissions from the tunnel ventilation. The ISC model was developed by the United States Environmental Protection Agency (USEPA) and has been widely used for assessments worldwide. ISC represents a typical Gaussian dispersion model and uses a similar method to Caline4 to calculate dispersion.

5.11 I have used these models to calculate pollutant concentrations at the following receptors:

North Tyneside

Receptor	*Location*
DN1	2 Mitford Street
DN2	1 Meldon Street
DN3	47 Norman Terrace
DN4	111 Cumberland Street
DN5	48 Telford Street
DN6	2/4 Chatton Street

South Tyneside

Receptor	*Location*
DS1	40 Epinay Walk
DS2	46 Epinay Walk
DS3	45 Harold Street
DS4	3/5 Stothard Street
DS5	35/37 Stothard Street
DS6	67 Stothard Street
DS7	12 Raglan Street
DS8	55/57 Priory Road
DS9	45 Commercial Road
DS10	21 Ferry Street

5.12 I have calculated pollutant concentrations for:

i. the base year of 2000

ii. the opening year of 2006 with and without scheme

iii design year of 2021 with and without scheme

5.13 It has been found through the local authority review and assessment process that the objectives for NO2 and PM10 are the hardest to meet, no Air Quality Management Areas have been declared on the basis of an exceedance of the objectives for benzene or carbon monoxide from road traffic. Therefore, concentrations of these two pollutants were also forecast for 2010 for comparison with air quality limit value in that year.

Input Data and Assumptions

5.14 Inputs to the Caline4 and ISC models include traffic data, vehicle exhaust emission rates; details of ventilation systems for the existing and proposed tunnels, background pollution concentrations and meteorological data. Details of these inputs and any assumptions are given in the following sections.

5.15 For this study a separate network of links was developed for each of the areas that required detailed modelling. The network of links represents vehicle movements on the surrounding road system. Pollutant emission rates from vehicles on each of these links were calculated using emission data given in the DMRB. Emission rates were calculated for the existing year of 2000, 2006, 2010 and 2021. Emission rates are forecast to reduce with time due to improvements in vehicle emission control technologies and legislative requirements.

5.16 For modelling of the emissions from the stacks I have based the modelling on the design information for the ventilation stacks.

5.17 Under normal operation the new tunnel would take southbound traffic only. Therefore, I assumed that a ventilation stack would be required on the south side only. Modelling of potential locations for the ventilation building showed that a stack located by the South Portal produced the lowest forecast contribution to pollutant concentrations at properties in the area of the portal.

5.18 The stack was assumed to be 15m high with a diameter of 2.3m. The exhaust fans were assumed to operate with an exit velocity of 13.5m/s. I assumed that approximately 70% of the emissions between the North Portal and stack would vent through the stack and the remaining 30% and any emissions between the stack and South Portal would be emitted through the portal, these assumptions reflect the actual operation of the ventilation system.

5.19 Any emissions through the portals were treated as area sources in the ISC modelling.

5.20 The modelling procedure requires a value for background pollutant concentrations to take account of emissions from sources other than vehicles on the roads modelled in the assessment.

5.21 Background pollutant concentrations were taken as for the DMRB screening method.

5.22 The dispersion models require meteorological data comprising of hourly averages of wind speed and direction, temperature, mixing height and stability recorded at the Meteorological Office station at Newcastle Airport. Four years of data were obtained (1995-1998). I have forecast concentrations for the year showing the worst case levels at the selected receptors (1997).

5.23 Both Caline4 and ISC predict concentrations of oxides of nitrogen (NO_X) as a result of traffic emissions. I assumed that 20% of NO_X emissions from the ventilation stacks are converted to ambient nitrogen dioxide concentrations, such assumptions are consistent with research regarding the conversion to nitrogen dioxide in the plumes of industrial sources (see Appendix E). The Derwent Middleton correlation was used to estimate concentrations of nitrogen dioxide from the road network and background sources.

Graphical Screening - Generalised

5.24 The assessment guidelines in the DMRB outline a generalised screening appraisal that is used to indicate the overall impact of the road scheme on air quality along the corridor of the proposed scheme. This is the approach I have used for this aspect of the assessment. The impact is evaluated with reference to distance bands along the corridor and is undertaken for NO_2 and PM_{10}, these pollutants being of particular concern with respect to compliance with air quality standards.

5.25 I have used the same traffic data and background concentrations used as for the graphical screening assessment.

Impact on Global Air Quality

5.26 I have assessed the impact of the scheme on global air quality using the method described in the DMRB. Total emissions of carbon monoxide, oxides of nitrogen, hydrocarbons, PM_{10} and carbon dioxide were forecast for the area of the Tyne and Wear County Highways Model.

6. ASSESSMENT RESULTS (OPERATIONAL)

DMRB Graphical Screening – Discrete Receptors

6.1 The DMRB screening results are intended to provide a comparison of the air quality impacts with and without the New Tyne Crossing. It should be stressed that these results are not directly comparable with those from the detailed modelling since the DMRB method is intended to be conservative and hence it would be expected to over-predict concentrations. Where more detailed assessment is required, dispersion modelling was used to forecast the concentrations.

6.2 Despite forecast increases in traffic flow, predicted future concentrations, both with and without the scheme, are lower than those experienced at present at all receptors on the north side. This is due to expected improvements in background air quality and a reduction in pollution emissions from motor vehicles as newer cleaner vehicles enter the fleet..

6.3 Forecast concentrations generally remain the same or increase slightly with the scheme at all receptors on the north side but in all cases forecast concentrations are within the appropriate DMRB criteria. On the south side, forecast concentrations increase slightly at all receptors with the scheme, although one receptor (GS5) does not experience an increase until 2021. This is due to the increase in traffic flow along the A19. However, forecast concentrations are predicted to remain well within the DMRB criteria at all receptors, with and without the scheme Consequently, detailed modelling is not required for these receptors.

Detailing Modelling

6.4 I have carried out dispersion modelling using Caline 4 and ISC at receptors in the area of the tunnel portals only (further modelling was not required for the receptors covered by the graphical screening method as these did not show a potential for exceedance).

6.5 The results of the detailed modelling for carbon monoxide, nitrogen dioxide, benzene and PM_{10} are presented in Tables A12 and A13 in Appendix A.

6.6 The results show that predicted concentrations of benzene and carbon monoxide are well below the air quality objectives at all receptors and in all years, with and without the scheme in place. Furthermore, the results predict that concentrations of these pollutants stay unchanged with the scheme in place in 2006.

6.7 Predictions of the absolute PM_{10} concentrations are very complex since a wide variety of sources must be taken into account and these sources behave in different ways. However, local dispersion modelling is useful to predict the likely changes in future air quality and also the magnitude of such changes. With such modelling the most useful interpretation of the results is to compare two different schemes (i.e. with and without the proposed scheme).

6.8 Predicted results for the annual mean and 90^{th} percentile of daily means show that the scheme has only a very small impact on PM_{10} concentrations. Concentrations remain the same, or decrease very slightly, at all receptors. The forecast annual average concentrations of PM_{10} are well below the AQS of 40 $\mu g/m^3$ at all receptors in 2006 and 2021 with and without the scheme in place. Similarly, predicted 90^{th} percentile concentrations are within the objective of 50 $\mu g/m^3$ in all cases.

6.9 Concentrations of PM_{10} in 2006, 2010 and 2021 are forecast to be lower compared with the base year due to improvements in vehicle emission controls and a reduction in background concentrations.

6.10 The forecast 99.8th percentile of hourly nitrogen dioxide mean concentrations are well within the AQS objective of 200 $\mu g/m^3$ at all receptors and in all years, with and without the scheme.

6.11 Forecast annual mean concentrations of nitrogen dioxide are within the AQS objective of 40 $\mu g/m^3$ at all receptors with the scheme in 2006. The highest concentration forecast in 2006, with the scheme, is 35 $\mu g/m^3$ at Receptor DS6, which is on Stothard Street, adjacent to the South Portal. This is 1 $\mu g/m^3$ above the forecast concentration in 2006 without the scheme. Forecast concentrations remain within the limit value of 40 $\mu g/m^3$ at all receptors in 2010 and 2021. The highest concentration forecast with the scheme in 2010 is 35 $\mu g/m^3$ at Receptor DS6. The predicted concentrations show that the scheme reduces annual mean concentrations at all receptors when compared to the 'without scheme' scenario. The forecast reductions are greater at receptors nearer the Southern Portal as a result of the relief of traffic congestion from the proposed tunnel.

DMRB Graphical Screening - Generalised

6.12 The results of the generalised DMRB screening appraisal are given below in Table 5. This assessment provides an overall indication of the air quality impacts of the scheme. The assessment value takes into account the magnitude of the predicted change in pollutant concentrations and the number of properties affected. If the calculated assessment value is negative then the overall impact of the scheme is predicted to be an improvement in air quality. There is no further guidance in the DMRB on the significance of the assessment value. The results also present the number of properties showing an improvement and deterioration in air quality.

6.13 The results of the generalised assessment show an overall improvement in air quality along the route with an assessment value for PM_{10} of –259 and for nitrogen dioxide -1441. This is because several properties experience a substantial improvement in air quality, particularly those properties close to the existing tunnel portals. While the table shows that more properties experience a deterioration in air quality, this does not take into account the magnitude of the change. The results demonstrate that the properties that experience an increase in pollutant concentrations only experience a small change. Those properties that have a decrease in pollutant concentrations experience a larger improvement, hence resulting in an overall improvement in air quality using this method.

Results of Global Air Quality Assessment

6.14 The results of the global emissions calculations are given below in Table 5 and show the tonnes per year calculations for five scenarios. Table 6 indicates the net effects on global emissions as a result of the proposed tunnel for 2006 and 2021.

TABLE 5: RESULTS OF GLOBAL EMISSIONS CALCULATIONS (tonnes/year)						
Year	**Scenario**	**Carbon monoxide**	**Nitrogen oxides**	**Hydrocar bons**	**PM_{10}**	**Carbon dioxide**
2001	Existing	13308	8413	2288	303	1,032,260
2006	Do minimum	8354	5748	1096	179	1,135,581
2006	Do something	8119	5668	1064	176	1,119,514
2021	Do minimum	4830	4054	693	109	1,266,687
2021	Do something	4769	4030	684	109	1,258,676

TABLE 6: NET EFFECTS OF THE PROPOSED TUNNEL ON GLOBAL EMISSIONS						
Year	**Do something compared to Do minimum**	**Carbon monoxide**	**Nitrogen oxides**	**Hydrocarbons**	**PM_{10}**	**Carbon dioxide**
2006	Net effect (tonnes/year)	-235.58	-79.71	-31.54	-2.85	- 16067.83
2021	Net effect (tonnes/year)	-61.07	-23.94	-8.62	-0.70	-8011.27
2006	% change	-2.8%	-1.4%	-2.9%	-1.6%	-1.4%
2021	% change	-1.3%	-0.6%	-1.2%	-0.6%	-0.6%

6.15 The results show that there is little difference between the overall amount of pollutants emitted with and without the proposed tunnel. The scheme is forecast to produce a small net reduction in emissions as a result of a slight decrease in total vehicle kilometres.

Objections

6.16 A number of objections that include air quality have been received. These are summarised in Appendix F with a summary response.

7. SUMMARY AND CONCLUSIONS

7.1 I have carried out an assessment of the changes in local air quality that are likely to arise as a result of the proposed New Tyne Crossing. To undertake this study, I have collated the air quality monitoring information that is available for the area from Newcastle City Council's monitoring programme and from the National Air Quality Archive to assist in determining the current air quality conditions in the area. I have undertaken a qualitative assessment of the impact of construction activities on the local air quality. I have also undertaken an assessment of the impact on local and global air quality during operation using DMRB guidance and compared the forecast pollutant levels with appropriate air quality standards and objectives.

7.2 The UK Government and the European Commission have introduced a number of new air quality standards and objectives intended to result in nationwide improvements in air quality. The results of these new initiatives will be an improvement in air quality in the UK through a series of national and local measures to reduce the emission of air pollutants. The major changes will arise through the introduction of new emission controls on motor vehicles. Initiatives are already in place such as the introduction of catalytic converters, limitations on the benzene content of petrol and the removal of petrol with added lead.

7.3 At present, the roads approaching the existing tunnel are congested throughout the day, especially at peak hours. Emissions from the vehicles inside the existing tunnel are currently released through ventilation stacks on the north and south side. The existing air quality in the area complies with relevant air quality standards and objectives. This has been confirmed by a review of the local authorities' review and assessment and also supported by the results of the Newcastle City Council monitoring programme and supported by other monitoring data available for the area.

Construction

7.4 I have undertaken a qualitative assessment of the impact of construction activities on local air quality. I have identified the potential sources of dust emissions and the sensitive land uses and assessed the impact on air quality at these sites. I have also proposed mitigation measures where necessary and assessed their likely effectiveness.

7.5 If mitigation measures are applied as described in the proposed Code of Construction Practice, no residual effects are envisaged.

Operation

7.6 To predict the impact on local air quality from the operation of the tunnel, I have undertaken an assessment using the graphical screening assessment as outlined in the Design Manual for Roads and Bridges. The screening method is designed to over predict pollutant concentrations in order to highlight any sites where there may be a potential problem. If a problem is identified, further more detailed modelling would be required.

7.7 Around the tunnel portals, where DMRB graphical screening is not an appropriate method, I have used dispersion modelling. These are accepted models that have been widely used for similar assessments and are accepted in Government guidance as suitable for advanced air quality assessments.

7.8 The screening and dispersion modelling require as input information regarding traffic flows, pollutant emissions and background pollutant information. I have obtained traffic flows from Arup, pollutant emission data from Volume 11 of the DMRB, meteorological data from the Newcastle Airport site operated by the Meteorological Office and background pollutant information provided on the UK National Air Quality Archive and from Newcastle City Council monitoring.

7.9 I have calculated pollutant concentrations for the base year of 2000, for the opening year of 2006 with and without the proposals and for 2010 and 2021 with and without the proposals.

7.10 The results of the graphical screening and dispersion modelling show that in all cases predicted concentrations in the future would decrease as a result of improvements in vehicle emission controls and a reduction in background pollutant concentrations. In general, concentrations of these pollutants are forecast to remain the same or decrease slightly with the scheme in the area of the portals. The greatest decreases are forecast for annual mean nitrogen dioxide concentrations around the portals where traffic congestion is relieved with the scheme. At the northern and southern end of the scheme pollutant concentrations are forecast to remain the same or increase slightly with the scheme. This is due to predicted increases in traffic flow, although in all cases, concentrations of carbon monoxide, benzene, nitrogen dioxide and PM_{10} are forecast to remain within air quality objectives with the scheme in place.

7.11 The changes in traffic flow, with the proposed immersed tube tunnel, are forecast to produce a small net reduction in global emissions of all pollutants.