Analytical assurance statement

Analytical Assurance Statement for transport and air quality modelling.

1. Limitations of the Analysis
   - Has the Analysis been constrained by time or cost, meaning further proportionate analysis has not been undertaken?
   - Could the further analysis that could be done lead to different conclusions?
   - Does the analysis rely on appropriate sources of evidence?
   - How reliable are the underpinning assumptions?
2. Risk of Error / Robustness of the Analysis
   - Has there been sufficient time and space for proportionate levels of quality assurance to be undertaken?
   - Have sufficient checks been made on the analysis to ensure absence of errors in calculations?
   - Have sufficiently skilled staff been responsible for producing the analysis?
3. Uncertainty
   - What is the level of residual uncertainty (the level of uncertainty remaining at the end of the analysis)?

4. Use of analysis

   - Does the evidence provided support the business case?
   - Is there evidence the agreed target will be achieved?

1. Limitations of the Analysis

- *Has the Analysis been constrained by time or cost, meaning further proportionate analysis has not been undertaken?*

  The analysis has been constrained by time and cost to some degree. The city-wide modelling of transport and air quality of a range of options is complex and time consuming, and the project is working to a time and cost budget. However, we have made every effort to ensure that the analysis provided is as robust as possible within these constraints. This has included:

  - Thorough review of all the analysis by both the consultancy team and Derby City Council Officers;
  - Additional checks on both traffic and air quality outputs, specifically in relation to the traffic management scheme, to fully understand traffic diversionary affects;
  - Sensitivity tests to assess the robustness of the outcomes
  - Taking into account JAQU guidance and seeking input from JAQU in determining the methodology throughout the development of the project, This has included agreeing further analysis and necessary actions with JAQU to address issues raised by the Technical Independent Review Panel (T-IRP).

  Therefore, we do not believe further proportionate analysis could usefully be carried out in the time available, especially when taking into account the legal directions that have been issued determining the submission dates for T-IRP, OBC and FBC

For example, feedback from the December T-IRP queried whether microsimulation was carried out for the traffic management scheme.

We have not carried out microsimulation because the DATM highway model fully simulates all the junctions within the city including those within the traffic management scheme and can therefore fully represent the impacts of the traffic management scheme. In addition, the measures have a wide impact on the highway network throughout the city of Derby by rerouting traffic away from Stafford Street to other main road routes. The use of microsimulation modelling to assess only the local impacts of these measures is not appropriate as it could not estimate these wider rerouting impacts and could not be undertaken within the timescales or costs of this stage of the appraisal as no model currently exists for the area. The DATM model is the primary tool to provide flows on the relevant links to enable air quality modelling and understand the effectiveness and implications of the scheme and this has been prioritised. Further detailed junction and signals work is ongoing as part of scheme detailed design outside the modelling exercise, this is however, unlikely to use microsimulation modelling as junction modelling tools such as LINSIG are more appropriate for deriving signal specifications for input into the final scheme designs. LINSIG outputs to date have been used to refine detailed design alongside the transport modelling and are in broad agreement with DATM modelling outputs, increasing the confidence in the effects of the scheme in reality. Additional microsimulation would not have added significant value to the evidence base for the required time or cost and, given the level of analysis, thorough and incremental approach to testing, we do not believe that it would have altered conclusions or influenced scheme design.

- *Could the further analysis that could be done lead to different conclusions?*

  Given the level of review and the sensitivity tests that have been carried out we do not believe that further analysis would lead to different conclusions.

- *Does the analysis rely on appropriate sources of evidence?*

  The work has aimed to use the best available data sources that could be collected within the time and budget available. The key data sources comprise:

  - Traffic flows have been provided by the existing Derby Area Transport Model (DATM) which has been re-validated to 2016. SYSTRA have prepared a transport model review note for DATM entitled 'Stage 2a Transport Model Review Document v5.1'. The Transport Models accuracy has been assessed against the standard DfT WebTAG criteria which has shown a good correlation between modelled and observed flows throughout the Derby highway network. This note has been assessed by JAQU/DfT and DATM has been approved as being 'Fit for Purpose' to assess the traffic impacts of the benchmark charging CAZ and other air quality proposals.
  - Local fleet composition data was derived from an analysis of ANPR data from sites across the city across a 2-day period. This has been used to provide both compliant/non-compliant split in the traffic model and the detailed fleet split in terms of Euro standards in the air quality emissions model. We would note that this data is a little limited in both coverage being only sites on or within the inner ring road, and of a duration covering only 2 days. Ideally at least a full week of data should have been collected and wider set of sites covering more areas of the city. However, it was targeted at the key areas of concern and was limited by time and budget.
  - Speed data has been taken from the national traffic master data set for the road links in Derby. This is considered to be the most robust speed data set available.
  - Vehicle emission data is based on COPERT V as specified by the JAQU guidance and again is consider the best available data for this scale of modelling. However, the project has collected 2 weeks of real world emissions data using a remote sensing system. This data focused on the two areas of concern at Stafford Street and Traffic Street. Initial analysis suggests that the real-world emissions are higher in these locations than the standard COPERT v emission factors suggest.
  - Ratified diffusion data for 2016 has been used to validate the air quality model and was available at some 70 sites across the city. Although it is recognised that there can be up to 25% error on diffusion tube results this is the best data available given

that there were no automatic air quality monitoring sites available. Also the number of sites available gives good coverage and robust statistics across the whole modelled area.

- *How reliable are the underpinning assumptions?*

  There are a wide range of assumptions used in the transport and air quality modelling and economic assessment work. In general, the study has used the assumptions as provided by JAQU guidance for carrying out the feasibility study. However, there are a number of areas where local assumptions have needed to be made and the evidence for these assumptions varies.

  The key assumptions considered that are likely to have the most impact on the analysis are summarised as follows:

  - Transport modelling – the Derby Area Transport Model has been used to determine the traffic impacts of the various schemes tested during this appraisal. DATM is a multi-modal transport model and incorporates a Saturn Highway Model, a TRIPs public transport model and a demand model that includes all the demand responses required by the DfT's WebTAG guidance. The model also utilises a DELTA land use model. A detailed assessment of the validation of the DATM highway model has been undertaken for this assessment and this has shown that the model exceeds WebTAG calibration targets in both the AM and PM peaks and narrowly misses these targets in the Interpeak period. Therefore, the model is considered as 'Fit for purpose' for assessing the various schemes under this appraisal. All modelling parameters used in this modelling including Values of Time and Fuel costs have been taken from WebTAG guidance.
  - Fleet projection – it has been necessary to project the 2016 ANPR fleet data forward to the target year. This has been done with a fleet projection tool developed by Ricardo. This takes as its basis that the local trends in fleet turnover will be the same as the national data in the NAEI, but from a different starting point. This is clearly a simplification and there are likely to be some differences locally. However, given no local projections exist, this was viewed to be the best approach and in line with JAQU guidance.
  - Vehicle emission data – the road transport emissions data is taken from COPERT 5 as per the guidance provided by JAQU. This data is based on average speed relationships and it is known that detailed real-world performance can significantly deviate from these emissions data. Remote sensing emissions monitoring of road vehicle NOx has been carried out on Stafford Street and Traffic Street in Derby. This indicated that emissions of Euro 4 and Euro 5 diesel cars and vans were some 50% higher than the COPERT data. For Euro 6 vehicles the measured emissions were higher than COPERT, but the difference was much less. This variation helps explain some of the upward adjustment of Road NOx required in the model verification process. Further exploration of the limitation of the emission data is carried out with sensitivity testing on Euro 6 emissions and fNO2 as per JAQU guidance.
  - Behavioural assumptions – in terms of how vehicle owners respond to the different options will be important and varies from each of the options assessed:
    - Traffic management scheme – the traffic management scheme on Stafford Street and wider associated network management have been subject to a significant degree of analysis to understand the behavioural response and resultant air quality implications. The results of this work are reported in T4 and associated appendices (T5). This included testing a series of incremental traffic management options to reduce roadside NO_2 levels on Stafford Street followed by testing of associated mitigation to address any identified adverse effects resulting from re-assignment of traffic in the wider area.
    - The Class D charging CAZ scheme – the key assumption used here is the upgrade behaviour of drivers in relation to the charge. The standard behavioural response provided by JAQU, based on TfL data, have been used. It is recognised that in practice this response may be different in Derby but adopting the JAQU assumptions was felt to be a proportionate approach

for a benchmark scheme to compare against the traffic management option given the time available. Where further work has been done around the charge-response relationship (e.g. for Leeds), insufficient evidence was available with which to depict a local charge-response relationship and no evidence found suggested that the relationship could be confidently assumed to be different in the local context. In addition a sensitivity test is being carried out on this upgrade assumption.

- Impact extrapolation – to provide the economic assessment over a 5-year period an estimate of the benefits and costs over 5 years had to be made. Generic guidance has been provided by JAQU on this topic and we have taken this into account in developing the approach for this study. The key impact that needs to be extrapolated is the emission benefit and how this will reduce in future years. Without modelling further future years at this stage it was felt to be proportionate to model the reduction in emission benefit of the scheme using the PCM trends from 2020 to 2025 for the Derby baseline PCM results. We recognise that this does not account for a number of local factors, not least future developments and highway/network management schemes. However, as explained further in E1, this approach was deemed appropriate and most proportionate given:
  - Further resource would be needed to develop an adequate model to depict changes in emissions over the future period, akin to an emissions model extrapolated annually to 2025 (which wasn't appropriate purely to apply to the economics case)
  - Even then, it is questionable how different the results between such a local model and national trends would be. Given lack of local-specific projection parameters, such a model would instead use national parameters anyway
  - Also it is questionable whether one could have confidence in any difference produced from a local relative to national modelling. There is always inherent uncertainty associated with projecting parameters forward. Hence the results attained from such a local fleet projection model, and those represented by the extrapolation factors derived from the national plans (in particular given the overlap in inputs used), are deemed likely to fall within the range of uncertainty around this exercise.

In summary there are limitations and uncertainties in the assumptions made but we feel what has been done is proportionate for the time and budget available in order to inform the choice of the preferred option and in its refinement. In addition, sensitivity testing has been carried out to assess the robustness of the outcomes given changes to the modelling assumptions.

2. Risk of Error / Robustness of the Analysis

- *Has there been sufficient time and space for proportionate levels of quality assurance to be undertaken?*

Quality management for all Ricardo and SYSTRA projects (and all deliverables produced) is delivered in accordance to the requirements of the International Standard ISO 9001:2008. Principles of quality assurance (QA) are integrated in all our activities and at all levels through established and implemented procedures according to the international standard. The formally appointed Project Manager and Project Director lead in ensuring the project is undertaken in accordance with the current Ricardo and SYSTRA Quality Assurance processes and that the system is effective.

As noted above the citywide modelling of the options is both complex and time consuming, whilst being carried out under tight delivery times scales. However, all analysis (transport, air quality and economic) for the Derby options has been developed in accordance with these over-arching Ricardo and SYSTRA QA policies and procedures to ensure high quality and accuracy of deliverables. Specifically, this includes:

- Use of the core principles from our modelling QA group in the design of analysis spreadsheets (Ricardo only);

- Technical oversight of methodological modelling issues from our modelling knowledge leaders;
- Day-to-day oversight of the modelling work by the lead modeller;
- Checks of assumptions, input data, calculation sheets and output results
- Overall review and sign off by the project director.

All Transport modelling has been undertaken using WebTAG guidance. All inputs and outputs of the models are thoroughly checked by our project team to ensure that they meet/exceed our high quality standards. The team employed on this project have been involved in the development and application of DATM since 2005 and have developed an excellent understanding of the model and also the transport networks within Derby. This experience has been utilised together with our QA procedures to ensure that the transport model outputs are providing robust appraisals of Derby's transport networks. The project has been managed by the Council as per the details set out in the management case of the business case.

All Air Quality models have been developed in accordance with 'best practice' modelling guidance for the construction of workbooks and tools. This includes having separate sheets for data import, manipulation and results. In addition, the model has been developed with strict version control procedures (to avoid version error) and with assigned governance and responsibilities (i.e. the PM holds overall responsibility for the quality of the model, with analysts holding joint responsibility for the elements they developed).

In some cases, some data transformations have been carried out in MS Excel prior to import to the economic model. Each of those transformation workbooks has been identified and also subject to scrutiny.

All data sources used in the model are appropriately referenced and clearly marked where data is inputted into the model. All assumptions and data sources have been logged, in particular as part of the Air Quality and Economic Methodology Reports.

In addition, for this specific work additional QA checks have been performed with the input of SCC and the wider consultancy team. For example, where data and assumptions have been drawn from external models, we have discussed directly our interpretation of the data received, and its planned use in the economics model to sense check our approach (e.g. air quality emissions outputs, and transport modelling outputs).

In accordance with Ricardo's and SYSTRA's QA processes, all deliverables and outputs have been signed off by both the Project Manager and/or Project Director before release. Also, where time has allowed we will issue draft results to Derby to allow the city to review and scrutinise results prior to finalising.

- *Have sufficient checks been made on the analysis to ensure absence of errors in calculations?*

  Checks on modelling work are carried out as part of our quality assurance process. Again, with complex models across several thousand road-links there is a large amount of data and calculations to check. With this amount of data it is not possible to check everything. Our approach has been as follows:

  - Review and check all methods being used in the model set up and calculations;
  - Review model input data for consistency, this has focused on samples of data and key locations;
  - Check calculations in all spreadsheets, again using a sampling approach to check calculation steps;
  - Sense check results using the experience of the lead modeller, knowledge leader and project direct to ensure that they seem reasonable.

  Where any anomalies in results have been identified in the checking process these have then been explored for errors in data or calculations.

Finally as part of the model validation process for the base year Air Quality model the results are compared with monitoring data. Where there is a significant difference with the modelling data, + or – 30% checks are carried out to explore why these differences occur.

We believe this level of check is proportionate for the time and resources we have available, and has identified a number of issues that have had to be corrected. However, it is not an absolute guarantee that there are not errors, but it is sufficient to ensure that all results are reasonable and consistent.

We have responded to queries raised by JAQU during the target determination process and other review processes and reviewed the information, taken any appropriate action and feedback to JAQU through appropriate channels.

- *Have sufficiently skilled staff been responsible for producing the analysis?*

The air quality modelling team at Ricardo have significant experience of developing, assessing and recommending measures to reduce emissions and improve air quality at the city scale, including extensive expertise in air pollution modelling from the development of inventories and baselines to modelling the future impacts of abatement scenarios.

The Transport modelling team at SYSTRA have significant experience in the modelling of transport networks in general and specifically providing outputs that feed in to Air Quality models for other consultants. SYSTRA staff have been developing and applying the Derby Area Transport Model for over 15 years and therefore have an excellent understanding of the model and also the local Derby transport networks.

The team is led by a Project Director who holds over 20 years of experience of working on transport and emissions reduction projects. His key areas of expertise include vehicle emissions modelling, low emission vehicle technologies, sustainable transport measures and local air quality management and policy and he has worked on a number of LES, LEZ and CAZ projects in the UK including in Southampton, Derby, Nottingham, Oxford, London, Leicester and South Oxfordshire.

The day-to-day modelling work is led by an experienced atmospheric scientist with a strong focus on modelling transport and industrial emissions and characterising their effects on ambient air quality who is an advanced user of ADMS, ADMS-Roads, ADMS-Urban, AERMOD, CALPUFF, Envi-Met CFD, ArcGIS, QGIS and other air dispersion modelling tools as well as meteorological modelling software such as WRF, and has also developed Ricardo's in-house dispersion modelling suite (RapidAir).

The modelling lead is supported by our modelling knowledge leader, who developed our RapidAir and PyCOPERT models, to explore and resolve any methodological issues. In addition a team of experienced consultants specialising in air quality impact assessment and atmospheric dispersion modelling are carry out aspects of the modelling work, guided by the modelling lead.

All staff have had specific training on all the modelling tools being used for this work.

3. Uncertainty

- *What is the level of residual uncertainty (the level of uncertainty remaining at the end of the analysis)?*

SYSTRA have prepared a transport model review note for DATM entitled 'T2 - Local plan Transport Model Validation Report v5.5 Jan 19, which discusses this in detail. The Transport Models accuracy has been assessed against the standard DfT WebTAG criteria, which has shown a good correlation between modelled and observed flows throughout the Derby highway network. This note has been assessed by JAQU/DfT and DATM has been approved as being 'Fit for Purpose' to assess the highway impacts of the benchmark chargeable CAZ and other possible proposals to address the air quality issues.

A direct assessment of uncertainty in the air quality results is only carried out for the baseline model as part of the validation process against monitored air quality data and is effectively a combination of the overall uncertainty in the full modelling chain. In this process model performance and uncertainty is assessed using the Root Mean Square Error (RMSE) for the observed vs predicted NO_2 annual mean concentrations, as detailed in Technical Guidance LAQM.TG(16).

Some clear outliers were apparent during the model verification process, whereby we were unable to refine the model inputs sufficiently to achieve good model performance at these locations. There are a number of reasons why this could be the case, including:

- A site located next to a large car park, bus stop, boiler flue, or taxi rank that has not been explicitly modelled due to unknown activity data.
- Sites located underneath trees or vegetation (i.e. unsuitable locations for diffusion tubes to measure NO_2 concentrations effectively).
- Uncertainties in the traffic model outputs (please refer to the traffic model validation report for further information on this).
- Uncertainties in the background maps. At some locations in the model domain the mapped background NOx concentrations look very high compared to the surrounding area; even after discounting all road source sectors from the background maps, the NOx/NO_2 calculator was indicating that a negative road NOx concentration would be required to match the measured NO_2 concentration. This could indicate that the mapped NOx background has been overestimated at these locations. However, it could also indicate uncertainties with the measured NO_2 concentrations.
- Uncertainties introduced by modelling background concentrations at 1km resolution over such a wide area. In this case we have attempted to address this by interpolating the 1km background maps to a finer 1m resolution. This aims to smooth out the sudden changes in background concentrations at the edges of the 1km square background maps. We found that using the interpolated/smoothed background map produced better model performance overall.

The outcome of the verification process was an RMSE of 4.9 $\mu g.m^{-3}$. This can then be used as a measure of error on forecast results for future years. This error metric has been used when considering the results by identifying locations over 35 $\mu g.m^{-3}$ as being at risk of exceedance. Therefore, the reduction in the number links greater over 35 $\mu g.m^{-3}$ has also been used to compare options.

However, when assessing options in future years there will also be uncertainty related to the assumptions we have made in modelling these options. The reliability of the assumptions used in the modelling has been discussed above and has been tested through sensitivity tests. The key outcome of these tests is as follows:

- The traffic management will generate compliance whether or not the existing Clean Bus Technology Fund is taken up by local bus operators.
- If there is no upgrade response in relation to the charging scheme, then this scheme will not achieve compliance.
- With Euro 6 light duty vehicles only performing to stage 6a one new exceedance would be generated in the ‘do minimum’ scenario on the A38 and one location under the traffic management scheme would come up to, but not over, the limit value. However, both locations do not have significant relevant exposure.
- Analysis of heavy-duty emissions at low speed also indicates that emissions could increase but not sufficiently to cause non-compliance with the traffic management scheme.

This indicates that the preferred traffic management option is robust under the sensitivity tests carried out, in terms of its ability to achieve compliance, although poor real-world performance of vehicle emissions would increase the risk of the scheme not producing full compliance.

The robustness of the CBA analysis was also assessed with further sensitivity tests, including the behavioural response tests for the scheme options, and is reported in E1. This noted that there were some clear uncertainties in assumptions used to assess the options, particularly around behavioural responses. However, the tests carried out showed that although the final NPV for the options was sensitive to these assumptions, flexing these assumptions did not influence the ranking of the options in NPV terms.

4. Use of analysis

- *Does the evidence provided support the business case?*

Evidence in relation to the primary success factor has been provided from the analysis in terms of NO_2 concentration results for each of the national model road links in Derby, for the baseline and each of the tested options in 2020. This is complemented by a cost benefit analysis and distributional analysis for each of the tested options.

This analysis indicates that the key compliance issue that remains to be solved in 2020 under both baseline and 'do minimum' scenarios is on Stafford Street. Two mitigation options have been assessed that solve this compliance issue:

- *A traffic management scheme* – this scheme is focused on Stafford Street, but is complemented by a wider set of network management measures. The assessment indicates a significant improvement of NO_2 concentrations on Stafford Street which then comfortably achieves compliance. As a result of the scheme traffic is redistributed on roads around the city but the analysis has not indicated that this will not cause any further exceedance problems.
- *The Class D CAZ chargeable access restriction* – this has been modelled as a benchmark charging scheme to compare with the traffic management scheme. This option is also modelled to achieve compliance at Stafford Street. In addition, it provides wider reductions in NO_2 concentration across the city when compared with the traffic management scheme.

The sensitivity analysis carried out on the transport and air quality models indicated that the traffic management scheme was robust in achieving compliance even when the underlying assumptions were flexed. The greatest risk to non-compliance was from poor real-world performance of vehicle emissions though the tests carried out did not show an exceedance. In comparison if there was a very low level of vehicle upgrades in response to the CAZ D scheme this risked not achieving compliance on Stafford Street.

Value for money assessment of the options through the cost benefit analysis showed that the traffic management scheme had a positive NPV of £18.7 million compared to the CAZ D charging scheme with a negative NPV of -£90.1 million. Sensitivity testing of this analysis indicated that although the NPV of the options was sensitive to the assumptions made none of the tests carried out changed the outcome and the traffic management scheme maintained a much greater NPV than the charging scheme.

Finally, the distributional analysis showed that although the traffic management scheme did not generate wider air quality benefits it did produce positive travel time savings for most areas of the city, with low income areas benefiting most. There were some localised disbenefits on a road-by-road basis from displaced traffic, but these did not affect any one social group more than

another, so did not generate any wider distributional impacts. In contrast the charging scheme produced broad air quality benefits across the city and some accident reduction benefits within the charging zone. These benefits are greatest for lower income groups. However, this is balanced with much greater costs to businesses and households in terms of the direct and indirect impact of the charges. These costs will also fall disproportionately on smaller local businesses and low-income households.

Overall the evidence suggests that the traffic management scheme be taken forward as the preferred option because:

- It achieves compliance and is robust under the sensitivity tests carried out.
- It has the greatest NPV and so demonstrates better value for money than the charging scheme, and again this is robust under the sensitivity tests carried out.
- It has few distributional impacts on households or businesses, with the exception of a localised area which experiences increases in traffic flows and emissions through rerouting. This localised impact supports the requirement for the proposed CAF schemes for mitigation. This is compared to a charging scheme that will place much more significant costs on households and business, with low income households and small local business most affected.

- Is there evidence the agreed target will be achieved?

Yes, the modelling suggests that both the traffic management scheme and the Class D CAZ charging scheme have the potential to achieve compliance with the air quality limits.