INDEPENDENT AIR QUALITY REVIEW
WESTCONNEX – M4-M5 LINK

NSW Department of Planning & Environment

28 February 2018

Job Number 16080598

Prepared by
Todoroski Air Sciences Pty Ltd
Suite 2B, 14 Glen Street
Eastwood, NSW 2122
Phone: (02) 9874 2123
Fax: (02) 9874 2125
Email: info@airsciences.com.au

Independent Air Quality Review WestConnex – M4-M5 Link

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 01	6/02/2018	A Todoroski	A Todoroski
DRAFT –02	8/02/2018	A Todoroski	DP&E reviewers
FINAL	28/02/2018	A Todoroski	

This report has been prepared in accordance with the scope of works between Todoroski Air Sciences Pty Ltd (TAS) and the client. TAS relies on and presumes accurate the information (or lack thereof) made available to it to conduct the work. If this is not the case, the findings of the report may change. TAS has applied the usual care and diligence of the profession prevailing at the time of preparing this report and commensurate with the information available. No other warranty or guarantee is implied in regard to the content and findings of the report. The report has been prepared exclusively for the use of the client, for the stated purpose and must be read in full. No responsibility is accepted for the use of the report or part thereof in any other context or by any third party.

TABLE OF CONTENTS

LIST OF FIGURES

1 SUMMARY

In general, the assessment is considered adequate. The air quality assessment for the WestConnex M4-M5 Link shows that the Project would mostly result in minor improvements to surface air quality along key surface roads, but there are also locations along these roads where minor increases in air pollutant levels would arise. Future such assessments could however be improved, as summarised below.

The modelling approach is adequate overall, however it is considered that the approach adopted uses the dispersion model in a less than ideal manner in terms of delivering the most accurate results at the most potentially affected locations. A simpler approach could have obtained results at least as accurate, with less effort and complexity. Various other approaches could also have been applied to overcome the model's limitations in representing potential pollutant dispersion over a large spatial area. Detailed modelling near to roads, per the model's potential strengths could have been used to obtain more accurate results at the most affected locations, and should be considered in future assessments.

The meteorological component of the model has poor spatial performance. Meteorological conditions will significantly affect air pollutant dispersion over a significant distance, but less so near the source. As the air pollution levels far from the affected roads would be low, any inaccuracy arising due to poor meteorological performance will also be small. However, it is not clear why modelling tens of thousands of generally distant, little affected locations is a key feature of the assessment approach.

The representation of apartments, offices (etc.) as a single receptor point increases uncertainty in the assessment as it has potential to underestimate the affected population and the pollutant impact. This is because many receptor points were selected in the centre of an apartment block or complex, rather than at the edge nearest the main road. A weighting for receptor type was used in the construction component of the assessment, (e.g. 1 receptor equalled 50 people in the high density zones), but this does not tackle potential uncertainty in the level of impact due to the central placement of receptors.

Background pollutant levels appear to be a key determinant of the absolute predicted levels. The interpolation method for determining background levels is not ideal as there are only a few monitoring points, with significant existing pollution sources between the monitoring sites. The interpolation used results in implausible changes in pollutant levels across the modelling domain, making the approach challenging to accept, and leading to significant potential errors in the absolute predicted levels.

An annual average $PM_{2.5}$ background level of 8µg/m^3, equal to the (non-applicable) NSW EPA criterion and NEPM standard has been applied. As $PM_{2.5}$ levels are not this high at all locations, the approach does not consider any potential cases of the Project emissions causing levels above a criterion value.

The issues identified in this review appear to primarily arise due to a lack of a suitable air quality impact assessment approach for major road projects in NSW. Developing such a guideline, or adapting one from other jurisdictions may resolve many of the issues. Future studies may also benefit from application of the GRAL model validation study conducted in parallel with this assessment.

It is important to note that regardless of such issues, the findings of the assessment are unlikely to change. This is because any well designed tunnel would have less impact than an equivalent surface road, and in-tunnel air quality can be managed through appropriate design of the ventilation systems and outlets. The model has been shown to perform adequately and consequently the assessment of impacts due to the project is considered to be adequate to support the conclusions reached.

2 INTRODUCTION

Todoroski Air Sciences has been engaged by the New South Wales (NSW) Department of Planning & Environment (DP&E) to review and provide independent advice in relation to air quality matters associated with the proposed WestConnex M4-M5 Link (hereafter referred to as the Project). The NSW Roads and Maritime Services (RMS) is the Proponent of the Project.

This report provides a review of the air quality assessment for the Project (**Pacific Environment, 2017a**). It also identifies potential areas where improvements in the air quality assessment can be made for future such projects.

3 PROJECT OVERVIEW

The Project involves the development of twin mainline motorway tunnels between the M4 East at Haberfield and the New M5 at St Peters. Each tunnel is approximately 7.5 kilometres (km) long and can accommodate up to four lanes of traffic in each direction.

The Project also includes a number of links and interchanges to allow for connections with other arterial roads and future proposed roadways, such as the Western Harbour Tunnel and Beaches Link.

Three new ventilation facilities are proposed as part of the Project with two located at Rozelle (the Rozelle and Iron Cove Link ventilation facilities) and one at St Peters (the Campbell Road ventilation facility).

Figure 3-1 presents and outline of the Project context and location.

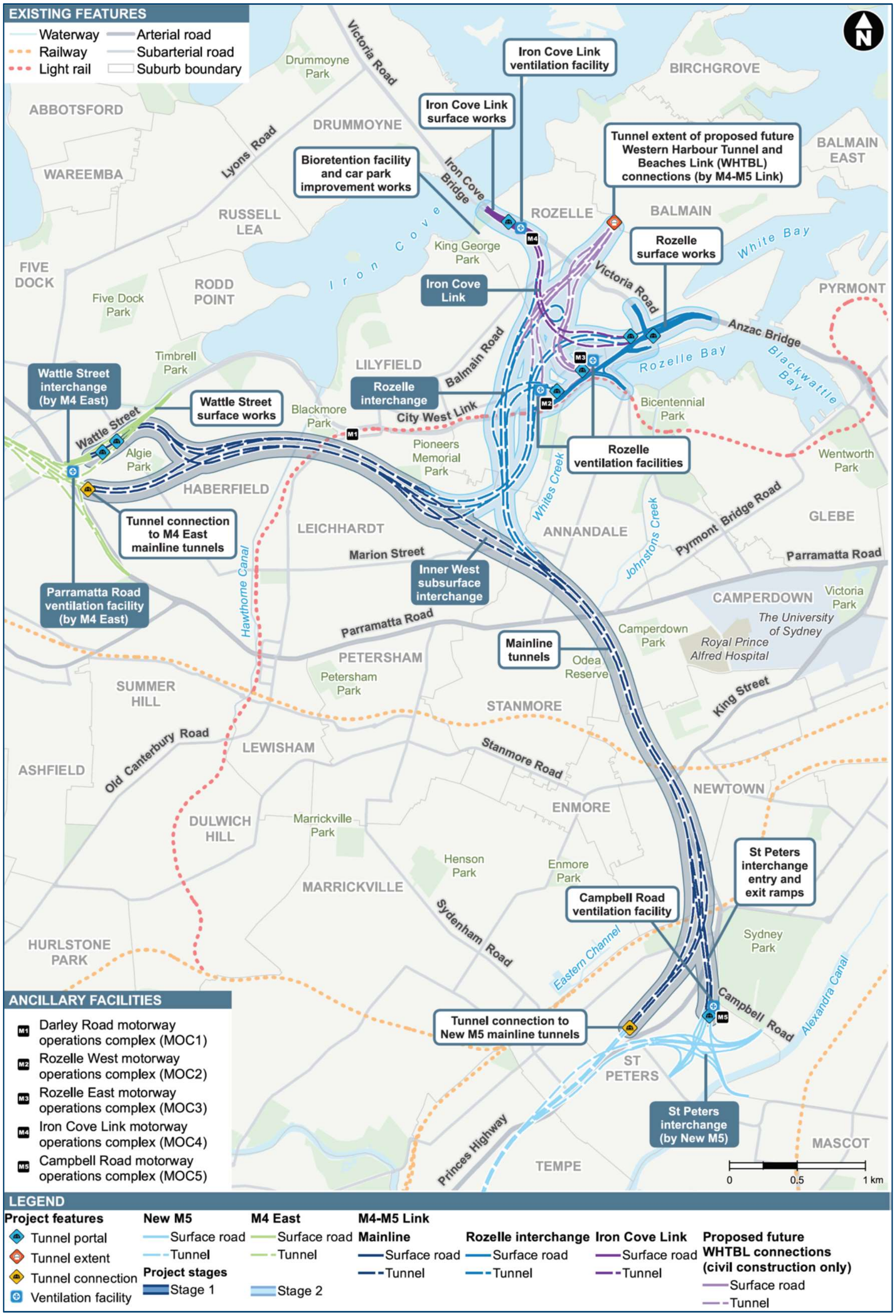

Figure 3-1: Project location and context

4 REVIEW OF THE AIR QUALITY ASSESSMENT

The review of the air quality assessment finds that overall, the assessment is adequate in that it clearly presents the expected situation; that a well-designed road tunnel, with well-designed ventilation and stack systems would mostly reduce traffic pollutant impacts by some degree at surface receptors.

The air quality assessment shows that the Project would overall result in minor improvements to surface air quality along most of the key main roads due to traffic travelling along the general route of the Project. By improving traffic flows, the quantity of traffic emissions can be reduced, and by dispersing the emissions from ventilation outlets into a larger volume of air than can occur for surface road emissions, the ambient ground level pollutant levels across the area can be improved overall.

It is noted that the assessment also identifies some areas where there would be increases in surface traffic and minor increases in air pollution mainly at intersections and along some surface roads associated with the Project.

A number of areas in which any future such air quality assessments could be improved are outlined in the following sections.

These less than ideal issues in this assessment primarily arise due to a lack of specific guidance on air quality impact assessments for major roads in NSW. Developing such guidelines, or in the interim adapting the general approach in the guidelines from another jurisdictions, may help to improve future projects. For example, the US, Europe and other jurisdictions and bodies such as the World Bank have long standing guidelines and legislation requiring a range of issues to be addressed when assessing the potential development of a major road or highway. Many of these aspects are not perhaps relevant in the context of this Project but many seemingly relevant aspects are not addressed in the air quality assessment. However, it is also unreasonable to expect that every possible issue in other jurisdictions be considered, which highlights the need to develop appropriate guidelines to apply in NSW.

4.1 Modelling approach

Similar to the air quality assessments for the WestConnex M4 East (**Pacific Environment, 2015a**) and New M5 (**Pacific Environment, 2015b**), the assessment used the GRAL model to predict operational impacts on ambient air quality. Modelling scenarios included the expected traffic scenarios and regulatory worst case scenarios (an artificially exaggerated case to assess compliance under all weather conditions for emissions at the permissible concentration limits for tunnel ventilation outlets at all times).

It is noted that no building wake effects were included due to time constraints, and to save time a large model grid resolution was used. A sensitivity analysis with buildings included was conducted and found an increase in concentrations by a factor of "around 1.3 to 1.5". It was however considered that the conclusions in the assessment would not change significantly with the inclusion of buildings. It is not clear if this consideration also considered that the selected receptor locations in general, tend to represent the centre of large buildings or building complexes and there may be higher levels at the sections of the buildings closer to the roadway.

The consultant's modelling strategy/ assessment approach with the selected model appears to be too computationally large and is not set up to deliver the most accurate results where most relevant. Consequently it appears that it was necessary to use the model in a less than ideal manner.

In the reviewer's opinion, it would have been preferable to have developed a more focussed, detailed model near to the major roadways (or at least those localities with changes in traffic volumes that are large) and to expend less effort on modelling receptors well removed from the roads. This would have made use of the model's known strengths in representing emissions near to roads and overcome its limitations in representing potential pollutant dispersion (affected by meteorological conditions) over a large spatial area.

It is noted that the *Optimisation of the application of GRAL in the Australia context* report **Pacific Environment, (2017b)** was prepared concurrently with the Project. This study indicates that the model does not provide superior performance to established models and that the meteorological component is poor at representing spatial variations in meteorology.

Overall, given that;

- there is no need to assess non-permissible portal emissions;
- other models perform as accurately as the chosen model but are much less complex or computationally demanding to operate;
- other models perform considerably better at representing the prevailing meteorology (which is relevant because the adopted approach features modelling of distant minor roads over a large spatial area); and,
- the "effort" required to conduct the chosen modelling approach would appear similar or greater than that needed to operate well established models that are able to conduct chemical transformation calculations, whereas significant additional work was necessary in this case to develop an empirical approach as the model cannot do such calculations;

it would seem that other models or approaches may have been used to overcome the difficulties encountered with the model per the assessment approach which was used.

Potentially, more accurate results could have been obtained with similar effort by changing the approach, the model that was used, or how the model was applied. Also, it is considered that results which are at least as accurate and sufficiently adequate could have been obtained with less effort, using a simplified approach and/or model.

Overall, the rationale for the consultant's modelling approach and selection of the model is unclear and unconvincing. However, for the reasons previously considered, this would not change the overall outcome, and the approach is considered adequate for assessing impacts due to the Project.

4.2 Meteorological modelling

Data from the BoM Canterbury Racecourse AWS during 2015 calendar year was chosen for use in the modelling as it was a recent year and broadly follows the same patterns as the 2014 data. Another reason outlined for selecting 2015 was to allow for the WestConnex monitoring station (St Lukes Park) to be included in the background concentrations.

Whilst is noted that the air quality assessments for the M4 East and New M5 projects used 2014 meteorological data., it is agreed that it is important to have used the 2015 data in this assessment, as it allows meaningful comparisons to be made with the air quality data recorded in 2015.

Technically, the meteorological data analysis in isolation does not provide any convincing or reasonable justification per the potentially applicable EPA methods, and does not clearly show whether the 2015 data used in the modelling are representative of the typical meteorological conditions. However, in the reviewer's opinion, the assessment has still applied the most suitable year of meteorological data in the modelling as the data year (2015) permits important verifications to be made with actual measured pollutant levels. These comparisons are considered to be more important, especially as the meteorological data do not appear to be a critical factor (see below).

However, the assessment should also evaluate the representativeness of the year chosen against other years, as would be expected in most other assessment situations in NSW in recent years. By doing this, any bias in 2015 relative to the overall trends in the weather data can be identified and considered when interpreting the assessment findings.

Overall, the model performance in regard to its representation of the spatially varying meteorological conditions is considered poor.

The poor spatial performance in the meteorological component of the model is primarily due to limitations inherent to the model used (GRAMM) and possibly due to the modelling approach and data quality control/ selection.

The meteorological model used is essentially unresponsive to the likely actual spatial (and temporal) variations in the meteorological conditions, and tends to apply very similar meteorological conditions at all points in the modelling domain as those in the meteorological input data.

The model set up classifies meteorological data into discrete categories according to wind speed etc. These weather parameter categories are generally related to atmospheric dispersion but do not incorporate all of the factors which actually affect the dispersion at any time. This limitation inherently prevents the model from considering the hour by hour atmospheric dispersion conditions which may be occurring differently in different spatially separated places in the modelling domain. The outcome is poor spatial and temporal meteorological performance, and by extension, poor capacity for the overall model to predict short term, place and time specific pollution levels at a distance from sources.

The critical question is whether or not these inherent limitations are significant for assessing the Project impacts.

In the reviewer's opinion, the limitations are not critical in this case. The fundamental reason is that for roads, the dominant effects occur within tens of metres from the road. Pollution from the road takes seconds or a few minutes to reach the nearest receptors which may experience the most significant effects. In this situation, there is insufficient opportunity for the weather (air dispersion) conditions to have a big effect so close to the source. From a receptor's point of view, the wind is either blowing the pollution from the road towards it, or not. If it is, the level of pollution arriving is mostly affected by the distance from the road and any intervening terrain or buildings, and less by the dispersion conditions.

For the ventilation outlets (stacks), the meteorological effects on the modelled dispersion pattern of emissions would be significant but are not important as the emissions from the stacks can only be released at relatively low pollutant levels, generally low enough for the safety of tunnel users breathing the air when in the tunnel. (It is noted that tunnel air pollution increases as one moves along the tunnel and hence the air vented from the stacks is at almost the worst/ highest in-tunnel pollutant concentrations, but the level of pollution ramping up within the tunnel is much less than the level of dispersion achieved with a stack once the air is released). In this regard the stacks can only have low impacts and any inaccuracy spatially due to the model limitations in already low levels would be insignificant.

Overall, whilst the poor spatial performance of the model is not critical, and would not change the conclusions reached, the use of the model set up in this case is incongruous with the level of detail adopted in the approach, particularly as a key feature of the assessment approach, is modelling potential impacts at tens of thousands of residential, workplace and recreational (RWR) receptors which are positioned well away from the road and which cannot be accurately represented using the model per the adopted set up.

4.3 Modelled receptors

The RWR receptors are defined as "discrete points in space - where people are likely to be present for some period of the day".

It is understood that the RWR receptors were identified on the basis of LIDAR derived “terrain” data. These data identified houses, sheds, water tanks, etc., to be higher than the surrounding terrain. It is understood that all such elevated features/ structures have been included as RWR receptors and hence it is likely that there may be more RWR receptors than actual dwellings, offices, etc.

Despite using essentially the same RWR receptor approach in several previous assessments, it remains unclear as to the actual technical or scientific purpose of the RWR receptors. For example, if the purpose is to assess every household within a certain area or distance from the affected roads, this is not achieved as the results at each location are not presented in the assessment, even if the location is shown.

Given that the Australian Bureau of Statistics (ABS) population data available at a fine spatial scale were used to quantify population exposure it is not clear what the purpose of the RWR approach is, especially as the RWR receptors appear to be at a much finer scale than the ABS data. It is not clear how the RWR approach, which seems to have some potential for underestimating the number of residences in an apartment block and overestimating the number in areas with detached dwellings, garages etc. was combined with the ABS data to produce an accurate population exposure value.

Given that an equally (or perhaps more) accurate assessment can be made with fewer representative receptors, it would seem that an assessment at fewer selected receptor locations may be more suitable and potentially more accurate and objective.

The “simpler statistical approach” used to assess the RWR is also not clear, and further clarification is requested in any future assessments on the approach for each assessed metric.

In the review of the earlier associated Projects, it was commented that the representation of high density dwellings such as apartments as a single receptor can underestimate the affected population. It is noted that a population weighting is applied in the construction risk assessment of the report (e.g. 1 RWR receptor is equivalent to 50 residents in an area zoned for high density) however it is unclear if this approach has been adopted in the other sections of the assessment such as the change in concentration at RWR receptor plots.

The geographical midpoint chosen to represent high density dwellings, particularly those along main roads, may also underestimate exposure for residents closest to the road and overestimate the exposure of those residents in the apartment complex with greater setback from the road. However as the reduction in pollutant level with distance away from a road is not linear, the numbers of more and less affected people more near the receptor point modelled do not balance out and the net effect is a potential underestimation of pollution impact and the number of people who may be more affected at that location.

Where results are presented as the change in concentration at RWR receptors, (without the application of population weighting), this increases uncertainty when assessing any net benefit or detriment. The outcome of these relative analyses is thus significantly influenced by the spatial extent of the receptors selected, with a more favourable balance being obtained when selecting greater numbers of more distant RWR receptors and a less favourable result where fewer RWR receptors nearer to the surface roads are considered. This is not to say there is any issue with the spatial extent of the RWR receptors chosen in this case, however it highlights the need for a pre-defined guideline to be established. Indeed it is noted that this issue is one of only four key air quality issues raised by **The World Bank (1997)** for consideration when assessing road projects in its Roads and the Environment Handbook.

It is suggested that in future assessments, a more demonstrably objective means of assessing the net project impact is to only consider all of the receptors where the effect due to the project (positive or negative) is above a pre-defined, tangible level of effect (e.g. > $\pm 0.5 \mu g/m^3$). This would obviate the present bias that arises from selecting a (too large or too small) spatial extent for the RWR receptors, and would make the evaluation of Project benefits more objective.

4.4 Tall buildings near ventilation outlets

The depiction of tall buildings near ventilation outlets, the potential wake effects associated with buildings and impacts on receptors within the building is considered below.

As outlined in Section 8.4.6 of the air quality assessment, building data were not included in the simulation due to issues associated with impractically long model run times. (As noted previously, there are numerous means to accommodate this, but the options do not appear to have been considered)

The air quality assessment comments "*there are only a small number of tall buildings in proximity to the proposed ventilation outlets, and therefore the effects of building downwash (refer to **Annexure B**) would probably have been rather limited*".

Annexure B acknowledges the effect of building induced turbulence and its effects on pollutant dispersion and how this is an important consideration for the design of tunnel ventilation outlets. However the assessment focuses on vehicle-induced turbulence as this is likely to be more significant than that caused by buildings.

The air quality assessment for the New M5 (**Pacific Environment, 2015b**) included a sensitivity test for buildings located near a tunnel ventilation outlet (Section 9.9.3). The closest commercial buildings to the ventilation outlet were included in the model test with locations and heights estimated from Google Earth.

The sensitivity test indicated that concentrations associated with the ventilation outlet on average increased by a factor of approximately 1.3. As the predicted impacts are low, it was determined that buildings effects are unlikely to represent a large source of uncertainty in the overall predictions.

Modelled concentrations for the Project effects on surface roads were predicted at two elevated receptor heights (10 metres (m) and 30m) for annual and 24-hour average $PM_{2.5}$. The results indicate the influence of surface roads reduced at 10m and was negligible at 30m, and that near the ventilation outlets pollutant levels from the outlets were greater at 30m height than at 10m.

Recommendations for building height restrictions in the vicinity of the Campbell Road ventilation facilities are made in the assessment. The development of suitable planning controls would likely need to be supported by detailed modelling addressing all relevant pollutants and averaging periods. In this regard, the model used in this Project (and indeed most commercial air dispersion models) is not suitable for detailed design evaluation of the interaction of ventilation stack plumes and any new, tall buildings and thus significantly more advanced approaches may be needed.

It is not part of the scope of this review to consider in-tunnel air quality in detail. In tunnel air quality is primarily affected by the predicted traffic/ vehicle numbers and the calculated emissions for the vehicles in the tunnel under various traffic flow and ventilation rate scenarios.

Whilst not a key focus of the review, it appears there may be some potential inconsistencies in heavy vehicles over time and that not all vehicle types appear to be considered. These issues would not likely have any significant effect in the overall findings, but more care should be exercised in future assessments where this may potentially be a concern. It is noted that ventilation outlet air quality would soon be independently regulated by NSW EPA, and in essence the actual measured data will drive the necessary rates of ventilation to ensure adequate in-tunnel air quality performance to meet contemporary health based criteria. As per previous assessment recommendations to allow, if necessary, the expedient and economical retrofitting of additional ventilation facilities (e.g. an additional mid-point stack), are recommended to be included as a condition for the tunnel design and construction aspects of this Project.

Therefore it is relevant to consider the environmental air quality effects of in-tunnel air pollutants released via the tunnel ventilation outlets. The assessment details in-tunnel air quality, indicating that if the ventilation system is well designed, the pollutant exposure for road users can be maintained within acceptable levels when they use the tunnels.

In this regard there would be minimal effect, noting that the in-tunnel air quality must be safe for road users in the tunnel, and it is dispersed and diluted via the ventilation outlets before reaching receptors. However, it is relevant to note that if the tunnel/ interchange design changes substantially from that which was assessed, some further form of assessment may be required to reconfirm the findings of the assessment. This may potentially range from a minor review for a relatively minor change, up to a significant re-assessment where ventilation outlet locations, heights, flow rates (and other such emission parameters) or pollutant levels change significantly.

4.5 Background data

The review of existing NSW Office of Environment and Heritage (OEH) monitoring data and selected RMS monitoring data for air quality is detailed and well presented.

Background concentrations applied in the assessment are developed from selected OEH and RMS monitoring sites. For short-term background pollutant concentrations a synthetic background file is developed based on the maximum level of the selected monitoring stations for each time period. This approach is considered to be conservative.

Monitoring data collected at WestConnex monitoring sites are summarised showing mean weekly values and monthly maximum, mean, 98^{th} percentiles and 75^{th} percentiles.

A spatially varying annual mean concentration for 2015 has been used for NO_2 and PM_{10} in an urban area.

It is noted that Figure F-35 in the air assessment is incorrect and the PM_{10} data it is meant to represent is not available for the review.

The background "grid" used for PM_{10} indicates low points at the RMS monitoring sites compared with OEH data at Liverpool, Prospect and Chullora, which does not appear to be likely to actually occur. It is not clear what data quality checks have been conducted on the road-side data.

Overall, the spatial interpolation of a few data points, some which are closely spaced and others well apart and the subsequent extrapolation of these data across an area with large expected variations in pollutant levels is challenging to accept as being realistic, especially as represented in Figure F-31 and Figure F-36. The figures show a diagonal graduation in NO_X levels and a very different graduation in PM_{10} levels across the modelling domain, neither of which is likely to actually occur in reality.

The interpolation approach is not considered to be the most appropriate approach to have taken in situations with limited information, as in this case, where the potential errors in the interpolated background levels may be as high as approximately 50% for NO_x and approximately 20% for PM_{10}, depending on how the data are applied in the assessment. These errors are significant in regard to the absolute accuracy of the assessment predictions, but would only matter if there were criteria applicable for compliance or assessment purposes (which there are not).

For $PM_{2.5}$, a background level of 8µg/m^3 which is equal to the NSW EPA impact assessment criterion and the NEPM standard, has been applied. This means that all predictions at all locations would exceed the criterion value, however this would not actually occur in practice. For example, the measurement data show lower pollutant levels in many places.

The approach taken does not allow scope to evaluate the possible issue of the Project potentially leading to levels above a criteria or standard in some specific locations. This is a moot point at present as the EPA criteria and NEPM standards do not apply to road projects. The issue may be relevant should any future road project assessment guideline set out an applicable criterion.

The basis for this approach is also unclear and is at odds with the level of effort and detail applied in the study overall including for other perhaps less significant pollutants being assessed. The approach would not most accurately represent the likely absolute cumulative impacts for $PM_{2.5}$, one of the key pollutants associated with motorway operations.

A contemporaneous assessment method for short-term impacts (per the NSW EPA Approved Methods **NSW EPA, 2017**), and also statistical method, is applied, but does not appear to be fully explained.

4.6 Other considerations

Irrespective of the assessment approach adopted to quantify impacts, it is unclear how the Project air pollutant effects relate to state or national air quality strategies, and there is no clear assessment provided to indicate that all best practice options to minimise impacts have been considered.

It is noted that unlike industrial emissions, where best practice design and operation principles have long applied to minimise emissions, roadway and road tunnel ventilation emissions are less directly attributable to the infrastructure operator. The emissions arise in the first instance from public use of the infrastructure and the capacity of the infrastructure operator to minimise these emissions is governed by two factors:

1. vehicles emissions, which are governed by national vehicle and fuel standards, state policies and state agency enforcement and regulation related to vehicle pollution control equipment (e.g. smoky vehicles, registration checks of vehicles etc.); and,
2. the design and operation of the proposed infrastructure (the subject of the EIS).

It is relevant to ensure that the design and potential operational controls for the Project set out in the EIS are adequate and can be applied by the body controlling the infrastructure to adequately control or minimise emissions.

4.7 Assessment of impacts

As the selected model cannot conduct chemical transformation calculations, an empirical method was used to evaluate NOx effects based on an analysis of selected ambient monitoring data. The approach appears to be conservative (unlikely to underestimate results) however it is not clear whether the empirical approach is applicable per the varying methods used for assessing cumulative levels.

It is also noted that an evaluation of model performance can only be conducted at locations with known (measured) levels of pollutants and these known pollutant levels (background data) are used as an input to the assessed (predicted) cumulative total pollutant levels (variously). However, there is inherent uncertainty in the background levels that may occur between locations with known pollutant levels, for example due to the interpolation approach applied (or for that matter other such approaches which could be used). In this case, it appears reasonable to seek that future assessments should outline any such inherent variability or uncertainty as far as it may affect the final results.

It is noted that the background data dominate the total level predicted in the assessment and it is thus relevant to consider the data in more detail when considering total cumulative pollutant levels at any location. However, as the background data are the key determinant of the predicted total cumulative pollutant levels, the assessment results in this case are governed by the simple interpolation of a limited data set and not by the modelling results.

As outlined previously, the simple interpolation used in the assessment to determine the background levels is unrealistic and appears to incorporate large anomalies, and these data govern the net levels predicted.

Regardless of the above, the key analysis that should be, and is generally well set out in the assessment, is the relative change which may result in road traffic (and ventilation outlet) emissions. The results in this case are governed by the modelling outputs at locations close to the roads. The model has been shown to perform adequately in such locations and consequently the assessment of impacts due to the Project is considered to be adequate.

5 RECOMMENDATIONS

The air quality assessment is adequate and indicates that no major air quality issues would arise if the Project is approved. The primary recommendation therefore is that the typical approval conditions applied to recent such projects be applied if the Project proceeds.

It is also recommended that any future assessment consider using an alternative modelling approach to address the issues identified in this review, or if the GRAL model is used, consider the following:

- Apply the building features of the model and use a finer scale resolution near to the roadways (to improve modelling precision where it is most relevant);
- Focus modelling near the roadways, and localities along the roadways where there is a tangible change in effects, for example a change in annual average $PM_{2.5}$ greater than ± 0.5µg/m^3 (to allow a more accurate and more clearly objective anysis of the net benefits to be made);
- Improve meteorological inputs (where a large modelling domain is used), for example by:
    - Pairing the model with a more reliable meteorological model than GRAM;
    - Use more meteorological categories;
    - Use more metrological station inputs with a correspondingly greater number of smaller modelling domain(s).
- Apply the findings of the GRAL validation study.

Irrespective of the modelling approach taken, it is also recommended to;

- Consider monitoring to collect key pollution concentration data at key roadside and background locations (i.e. locations nearby, but not greatly affected by roadway emissions), and use this to more accurately account for background pollution levels in the modelling domain(s);
- Ensure all key vehicle types are accounted for in the emissions inventory and that the trends in future emissions are sensible; and,
- Describe the Project design and operational features conducive to minimising air emissions as far as practicable. (This allows the key beneficial features of the Project to be evaluated in the context of the status quo or other alternatives).

Consideration by state authorities should also be given to developing a Major Road Infrastructure Air Assessment guideline, or in the interim, adapting a suitable guideline from another jurisdiction for application to future projects.

6 CONCLUSIONS

The air quality assessment shows that the Project overall would result in minor improvements in surface air quality along most of the key main roads. This occurs as it is expected that through traffic would travel along the Project tunnel roads, where vehicle emissions can be captured and dispersed up into the atmosphere from the ventilation outlets. By improving traffic flows, the quantity of emissions can be reduced, and by dispersing the emissions from ventilation outlets into a larger volume of air than can occur for surface road emissions, the ambient ground level pollutant levels across the area can be improved overall.

It is noted that the assessment also identifies that minor increases in traffic pollution can be expected alongside some sections of surface roads affected by the Project.

Overall, the assessment is adequate and clearly presents the expected situation; that a well-designed road tunnel, with well-designed ventilation and stack systems would overall reduce traffic pollutant impacts at surface receptors.

As outlined above there are a number of issues with the assessment that may potentially affect the calculated results, leading to somewhat higher or lower results. These issues primarily result due to a lack of a specific NSW guideline for assessing air quality for major road projects. Developing such a guideline, or in the interim adapting a guideline from another jurisdiction would ensure that all key issues are considered reasonably, and consistently which is likely to improve future assessments of such projects.

However, it is important to observe that regardless of these issues, the fundamental results shown in the assessment and its key conclusions are unlikely to change. This is because any well designed tunnel would have less impact than a surface road and in-tunnel air quality can be managed through appropriate design of the ventilation systems and outlets.

Overall, it is concluded that the assessment is adequate, however recommendations to potentially improve any future such assessments have been made for consideration.

Please feel free to contact me if you would like to discuss or clarify any aspect above.

Yours faithfully,

Todoroski Air Sciences

7 REFERENCES

Pacific Environment (2015a)
"WestConnex New M5 Air Quality Assessment Report", prepared by Pacific Environment for WestConnex Delivery Authority, November 2015.

Pacific Environment (2015b)
"WestConnex M4 East Air Quality Assessment Report", prepared by Pacific Environment for WestConnex Delivery Authority, September 2015.

Pacific Environment (2017a)
"WestConnex – M4-M5 Link Technical working paper: Air quality", prepared for Roads and Maritime Services by Pacific Environment, August 2017.

Pacific Environment (2017b)
"Optimisation of the application of GRAL in the Australian context", prepared for Roads and Maritime Services by Pacific Environment, August 2017.

NSW EPA (2017)
"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", NSW Environment Protection Authority, January 2017.

The World Bank (1997)
"Roads and the Environment: a Handbook". World Bank technical paper; no. WTP 376. Washington, D.C., Tsunokawa, Koji; Hoban, Christopher 1997.
http://documents.worldbank.org/curated/en/904041468766175280/Roads-and-the-environment-a-handbook