Chief Scientist & Engineer

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18 November 2022

Ms Angela Stewart
Senior Planning Officer – Transport Assessments
Department of Planning & Environment
4 Parramatta Square, 12 Darcy Street,
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Dear Ms Angela Stewart,

Comments on of the air quality component of the EIS for the upgrade of the Great Western Highway between Blackheath and Little Hartley proposal (SSI-22004371)

The Department of Planning and Environment (DPE) invited scientific review on the Environmental Impact Statement (EIS) for the Great Western Highway between Blackheath and Little Hartley Upgrade project prior to exhibition.

In the same manner as for the Western Harbour Tunnel & Warringah Freeway Upgrade, the Advisory Committee on Tunnel Air Quality is submitting comments on the air quality aspects of the EIS, including air emissions modelling.

Due to conflicts of interest that several Committee members have in this matter, OCSE has taken the approach, as per previous reviews, of commissioning a review report by the expert non-conflicted member of the Committee, Dr Ian Longley from the National Institute of Water and Atmospheric Research (NIWA) in New Zealand, and another suitably qualified independent expert to work with Dr Longley, Dr Elizabeth Somervell. My office also commissioned Mr Åke Sjödin, from IVL Swedish Environmental Research Institute, Gothenburg, Sweden, to work on the report.

I have attached the report by Mr Sjödin, Dr Longley and Dr Somervell.

Should you have any questions, please contact Mr Edward Jansson, Senior Manager, Office of the Chief Scientist & Engineer, on 0422 009 452 or edward.jansson@chiefscientist.nsw.gov.au

Yours sincerely

H. Durrant-Whyte

Professor Hugh Durrant-Whyte
NSW Chief Scientist & Engineer

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18th November 2022

Prof Hugh Durrant-Whyte
NSW Chief Scientist & Engineer
Chair: Advisory Committee on Tunnel Air Quality

Dear Prof Durrant-Whyte

We received from you a request to review aspects of the EIS for the Blackheath to Little Hartley tunnel, on behalf of the Advisory Committee on Tunnel Air Quality. Please find below our review.

Yours sincerely

Dr Elizabeth Somervell
Air Quality Scientist
National Institute of Water & Atmospheric Research (NIWA) Ltd
Auckland
New Zealand

Åke Sjödin
Senior Project Manager
IVL Swedish Environmental Research Institute
Gothenburg
Sweden

Review of the Blackheath to Little Hartley EIS

Written by Elizabeth Somervell and Åke Sjödin on behalf of the Advisory Committee on Tunnel Air Quality

18th November 2022

The review is based on the documents: DRAFT: Great Western Highway Blackheath to Little Hartley Environmental Impact Statement (EIS) (October 2022) –Appendix E - Technical Report - Air Quality.

Background

Environmental Impact Statements (EIS) seek to describe the potential impacts to the environment and the public of upgrades or changes in infrastructure, such as roads. In doing so, the assessment of impacts relies on modelling future scenarios based on knowledge of current conditions, and future projections of changes to any pressures or state of the infrastructure or the receiving environment. To be adequate, a wide variety of data must be evaluated and used, including vehicle emissions, traffic patterns, topography, meteorological and landuse data, pollutant concentration data, construction techniques and tunnel operations.

This EIS seeks to assess the impact of constructing a tunnel for the A32 from Blackheath to Little Hartley and the consequent changes in local vehicle movements and air quality from its operation. This proposed section of tunnel differs from those previously assessed in two main ways. Firstly, that portal emissions (not just emissions from an elevated ventilation stack) will be permissible and secondly, that the surrounding environment is more rural and mountainous than previous sections.

Main findings of the review

Our overall conclusion of this assessment is that it has been undertaken thoroughly and to a high quality. It covers the major issues and areas that an EIS for a project of this scale should, including:

- the overall methodology,
- the assessment of and management plan for emissions during construction,
- the approach used to calculate the nature and concentration of emissions within the tunnel, and thus exiting the stack,
- the dispersion from the stack,
- changes to ambient air quality resulting from:
    - both stack emissions,
    - portal emissions,
    - changes to surface road traffic and emissions.

The information presented is of suitable detail and logical in order. The choices made regarding data used and methods followed have been logical and reasonable. It is our view that the EIS be accepted as is. Further work exploring alternative approaches or assessing other future scenarios, although potentially interesting, would provide little further value.

Specific issues

1. Modelling
    a. General comments on assessment methodology

We find that the assessment methodology is appropriate and represents best practice. All of the models and data used are appropriate and expertly used. We have found no significant errors nor important omissions.

Details of the model settings and input data are given in Annexure J (GRAMM / GRAL model data input analysis) and appear to be appropriately chosen, with due consideration given to the complexity of the terrain, the high resolution required due to the dynamic nature of emissions from the tunnel, both via the portals and the ventilation stacks, and the range of sensitive receptors used.

The predictions generated, a mixture of positive and negative minor changes, are reasonable and can be relied upon to be a likely representation of future air quality in the area.

    b. Emission modelling

The methodology used to estimate in-tunnel emissions to assess tunnel air quality and further being used as input to the dispersion modelling of pollutants emitted to the surroundings, is very well described in the ventilation assessment document for the Great Western Highway tunnel and the quality of the analytical work is generally high. The emission calculation methodology is very much the same as that used for the last Sydney tunnel EIS in 2020-2021 (the Beaches Link tunnel), i.e., using the new PIARC (World Road Association) approach for calculating vehicle emissions in tunnels published in 2019, and data published in the European Monitoring and Evaluation Programme (EMEP) / European Environment Agency (EEA) air pollutant emission inventory guidebook on primary emissions of NO_2 (NO_2/NO_X-ratios) from different vehicle categories of the various emission (Euro) standards.

In the review of the ventilation assessment document for the Beaches Link tunnel it was mentioned that there had been an update of the European Handbook Emissions Factors for Road Transport (HBEFA) emission model in 2019, when the HBEFA version 3.3 was replaced by the new version 4.1. The PIARC 2019 approach builds on HBEFA version 3.3, and in version 4.1 updates of the emission deterioration factors for both petrol and diesel light-duty vehicles were made. Although these updates tended to lead to a general increase in NO_X emissions, the review did not consider it likely that this would affect the estimated air concentrations of NO_2 in the tunnel that much, such that the adopted Air Quality Criteria for NO_2 of 0.5 ppm as an average along the tunnel would be exceeded in any of the tunnel traffic scenarios. This conclusion was partly due to the conservative assumption by the time the Beaches Link EIS was prepared, that the Euro 6 emission standard would not be introduced in Australia until 2027.

Now, in January 2022, there has been a further update of the HBEFA emission model (version 4.2) which considers, for the first time, not only the deterioration of diesel heavy goods vehicle (HGV)

NO_X emissions but also of NO_2/NO_X-ratios for diesel vehicles (both light- and heavy-duty)[1], see below tables.

Table 1. Deterioration functions for HGV NO_X emissions according to HBEFA version 4.2. (Source: Table 7 in in HBEFA 4.2 Documentation of updates 2022)

Mileage [km]	Traffic situation			
	Urban driving		Motorway driving	
	Rigid truck	Long-haul truck	Rigid truck	Long-haul truck
50’000	1.00	1.00	1.00	1.00
300’000	1.74	1.22	2.60	1.49
700’000	2.60	1.49	2.60	2.08
800’000	2.60	1.67	2.60	2.48

Table 2. Reduction rates of the NO_2/NO_X-ratio for light-duty diesel vehicles (PC and LDV) as function of the cumulated vehicle mileage according to HBEFA version 4.2. (Source: Table 10 in HBEFA 4.2 Documentation of updates 2022)

Mileage [km]	EU 3	EU 4	EU 5	EU 6 (a-c)	EU 6d-temp
0	100%	100%	100%	100%	100%
100’000	98%	87%	83%	66%	65%
200’000	74%	69%	52%	41%	41%
300’000	49%	48%	24%	15%	12%

Table 3. Reduction rates of the NO_2/NO_X-ratio for HGV as function of the cumulated vehicle mileage according to HBEFA version 4.2. (Source: Table 11 in HBEFA 4.2 Documentation of updates 2022)

Traffic situation	Mileage [km]	EU V EGR	EU V EGR (DPF)	EU V SCR	EU V SCR (DPF)	EU VI
Urban driving	50’000	100%	100%	100%	100%	100%
	800’000	90%	88%	86%	88%	29%
Rural driving	50’000	100%	100%	100%	100%	100%
	800’000	71%	72%	71%	72%	46%

Since the new findings of 1) deterioration of diesel vehicle NO_X emissions implying increased NO_X emissions and 2) NO_2/NO_X-ratios in diesel exhaust simultaneously being reduced with increasing mileage implying reduced NO_2 emissions, findings which have been incorporated in the HBEFA 4.2 version, this most likely means, taken together, that the conclusion in the ventilation assessment report (of the EIS) about the NO_2 levels in both tunnel tubes being significantly below the air quality criteria (0.5 ppm as an average over the full tunnel length) for both scenario years and for all traffic scenarios (normal operation, congestions and worst case operations) is still valid.

Table 5 (on page 20) of the HBEFA 4.2 documentation of updates (2022) has some misprints whereby the total figures for each vehicle category do not equal the sum of all Euro standard figures

c. Use and evaluation of meteorological and dispersion models (GRAMM, GRAL)

[1] HBEFA 4.2 Documentation of updates (2022)

Both Graz Lagrangian Model (GRAL) and its meteorological pre-processor Graz Mesoscale Model (GRAMM) have been extensively evaluated overseas and in Australia and found to be fit for purpose. In addition, a comparison of other potential meteorological pre-processors was made before choosing to go with GRAMM. Previous GRAL evaluations have focussed on stretches of open roadways where it performed conservatively.

Because of the elongated nature of the project, five independent domains were used to model along the highway corridor. GRAL was used in a mixture of “steady state” mode and “transient mode”, allowing the maximum detail to be used in modelling the portal and ventilation stack scenarios. The resolution used was fine enough scale, both horizontally and vertically.

d. The impact of meteorological measurements

The review of available meteorological data was comprehensive and found wide variation in patterns of recorded wind direction and wind speed. This to be expected in areas of complex terrain where a varied pattern of sheltering effects may be observed. The decision then, to use data from the closest station – Mount Boyce – as representing the entire length of the project is an appropriate compromise. The assessment notes that it is representative of winds at the top of the Blue Mountains as it is situated on top of a ridgeline, and that it exhibits a pattern of winds least like other surrounding meteorological sites. This is less than ideal as it is unlikely that the Mount Boyce site will capture the frequency and extent of any katabatic flows (drainage flows) further downhill that the study area may experience, or the potential for the development of inversion layers below the ridgeline height. Both of these conditions may lead to the accumulation of pollutants at ground level. However, both of these conditions are prevalent during cold nights and evenings when windspeeds are at a minimum. Predictive models struggle to adequately simulate these conditions in the best of cases and this is precisely why conservative assumptions are used throughout the modelling scenario to compensate. The assessment also notes “There is limited data available for the western portion of the project at the base of the Blue Mountains at Little Hartley” to evaluate the GRAMM output against and uses the Mount Boyce data throughout the domains modelled and that although meteorological monitoring is on-going within the study area, a full calendar year of data is not yet available.

In addition to the complex terrain, over half the modelled area is of urban, industrial or forested landuses, all of which have enhanced roughness lengths and introduce greater variance into the turbulent fluxes to be modelled.

When modelling complex scenarios, compromises will always be made when using wind data and modelling wind flows. The analysis of station data and validation of model output (in Annexure E of Appendix E of the EIS) demonstrates due consideration has been given to the impact of complex terrain and the meteorological data chosen is appropriate to the assessment. The use of GRAMM’s Match-to-Observations function is consistent with previous model evaluations for EIS. However, considering the extent to which Mount Boyce’s wind fields vary compared with other local sites, it would be interesting (though likely outside the scope of this assessment) to see the difference in wind fields generated without its use.

e. Air quality monitoring and treatment of background air quality

In brief, we find that while the assessment is sound, air quality monitoring could have been deployed and sited more effectively and efficiently, increasing the accuracy of the assessment. However, we also find that this would not have changed the main findings or outcomes of the EIS.

Background concentrations are a vital component in understanding the nature of the receiving environment and whether the predicted impacts of the project may be considered minor or significant in relation to that environment.

The assessment notes that there is no contemporaneous long-term monitoring and only four to eight months of data is currently available. A dataset has been created by extrapolating from data available for 2018 (this point is unfinished at the end of chapter six (page 6-73) of Appendix E, and described in detail in Annexure G (Unified data set derivation and analysis) of Appendix E. The analysis of existing data is thorough and the resulting dataset is fit for purpose, although as noted in reviews of previous assessments, commencing pre-project monitoring earlier to allow for a whole calendar year of data to be available, would be ideal.

An emission source which is potentially more important for this project than previous more urban projects are bushfires. These are not included in the modelling assessment, as they have been excluded before. They are difficult to include as they are intermittent and variable in terms duration and intensity. It is difficult to determine what would be a 'normal' wildfire smoke enhanced background scenario or a worst case scenario. Wildfires are predicted to become more common as a consequence of climate change but can be mitigated by controlled burning operations both locally and state-wide. Although wildfires represent a legitimate extra source of air pollution that could be considered, it is reasonable that they have not been.

f. Future background air quality

As in previous assessments, this EIS assumes that background pollutant concentrations in the future will remain constant and the values generated to use for the assessment year 2018 may be used for future scenarios. This is assumed to be conservative due to the general long-term downward trend in background air quality associated with general improvements in vehicle emissions over the last few decades.

g. Method to estimate NO_2 concentration

This EIS uses a standard empirical approach of estimating NO_2 concentrations using observational NO_2 and NO_x data which is appropriate. Consideration has been given to the receiving environment's photochemical potential differing from previous assessments, due to the rural location and high proportion of forested area surrounding the tunnel. There is little data to study this difference in detail but from the evaluation presented, we are satisfied that the impact on NOx conversion will be minor.