NSW GOVERNMENT | Chief Scientist & Engineer

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23 February 2021

Mr Glenn Snow
Director Transport Assessments
Department of Planning, Industry & Environment
Locked Bag 5022
Parramatta NSW 2124

By email: glenn.snow@planning.nsw.gov.au

Dear Mr Snow

Comments on the air quality aspects of the EIS of the Beaches Link and Gore Hill Freeway Connection (SI-8862)

I refer to the Department's public exhibition of the Environmental Impact Statement (EIS) for the Beaches Link and Gore Hill Freeway Connection project from 9 December 2020 to 1 March 2021.

In the same manner as for the Western Harbour Tunnel and Warringah Freeway Upgrade, F6 Stage 1 Extension, WestConnex M4-M5 Link, the M4 East and the New M5, the Advisory Committee on Tunnel Air Quality is submitting comments on the air quality aspects of the EIS, including air emissions modelling and construction impacts.

Because of the 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. My office commissioned Mr Åke Sjödin, from IVL Swedish Environmental Research Institute, Gothenburg, Sweden, to work on the report.

I attach the report by Dr Longley and Mr Sjödin.

Should you have any questions, please contact Dr Chris Armstrong, Deputy Chief Scientist & Engineer, Office of the Chief Scientist & Engineer, on 02 9338 6745 or chris.armstrong@chiefscientist.nsw.gov.au.

Yours sincerely

Hugh Durrant-Whyte FRS
NSW Chief Scientist and Engineer

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23rd February 2021

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 Beaches Link and Gore Hill Freeway Connection, on behalf of the Advisory Committee on Tunnel Air Quality. Please find below our review.

Yours sincerely

Dr Ian Longley

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Review of the Beaches Link EIS

Written by Ian Longley and Åke Sjödin on behalf of the Advisory Committee on Tunnel Air Quality

23rd February 2021

The review is based on the documents: Beaches Link and Gore Hill Freeway Connection Environmental Impact Statement (EIS) (December 2020) –Appendix H: *Beaches Link and Gore Hill Freeway Connection - Technical Working Paper: Air Quality*.

Background

Tunnel ventilation stacks work by moving the vehicle emissions from ground level to points higher in the atmosphere, which result in longer time and distance for emissions to disperse before reaching ground level. In Sydney, stacks are assisted by ventilation fans that are used to direct the emissions higher into the atmosphere. Dispersion is improved by winds that tend to become stronger higher up into the atmosphere, while wind and turbulence increase mixing of the emitted and background air resulting in dilution.

In developing Environmental Impact Statements for future infrastructure such as roads, proponents rely on modelling for future scenarios, both expected and worse case. Modelling for road tunnels draws on measurements of background air quality, projections of future vehicle emissions on roads, information on tunnel operations, and utilises meteorological and dispersion models. This results in estimations of the maximum concentrations of different pollutants at different locations, including in the vicinity of ventilation stacks and locations in the surrounding area. Therefore, key to a scientific review of a project's air emissions and impact on ambient air quality is consideration of the data used and modelling approach.

In considering the future air quality impacts of the project, a number of elements are assessed, 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, and finally the dispersion from the stack, as well as the changes to ambient air quality resulting from both stack emissions and changes to surface road traffic and emissions. These are discussed in the following sections.

Main findings of the review

Our overall conclusion of these documents is that they constitute a thorough review of high quality. They cover all of the major issues and areas that an EIS for a project of this scale should. 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 and it is our view that the benefit of exploring alternative approaches would be questionable or marginal.

Specific issues

1. Modelling
    a. General comments on assessment methodology

We find that the assessment methodology is sound 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.

b. Emission modelling

In-tunnel emissions

The methodology used to estimate in-tunnel emissions to assess in-tunnel air quality and further being used as input to the dispersion modelling of exhaust emitted through the tunnel ventilation stacks, is thoroughly and clearly described in the EIS. A major improvement in the emission modelling was made starting with the Western Harbour Tunnel (WHT) EIS in late 2019 by implementing the new PIARC approach for calculating vehicle emissions in tunnels, published in 2019. The new PIARC approach builds on the European Handbook Emission Factors for Road Transport (HBEFA), version 3.3, launched in 2017. HBEFA can be considered state-of-the-art in describing real-world emissions and is well suited for traffic conditions typical for tunnels. It may be worth noting here that a new version of HBEFA was launched in late 2019 (version 4.1[1,2]). Of particular interest for this review is the update of emission deterioration factors for both petrol and diesel light-duty vehicles (i.e. passenger cars and light-duty commercial vehicles). The main difference between the HBEFA 4.1 and HBEFA 3.3 mileage corrections for NO_X (and CO) is that the deterioration continues up to a mileage of 300,000 km, after which they remain constant (in HBEFA 3.3 no further deterioration of emissions was assumed to occur above 150,000 km). Further, for the first time, emission deterioration factors for NO_X are presented for Euro 5 and Euro 6 diesel and gasoline light-duty vehicles. See Figure 1.

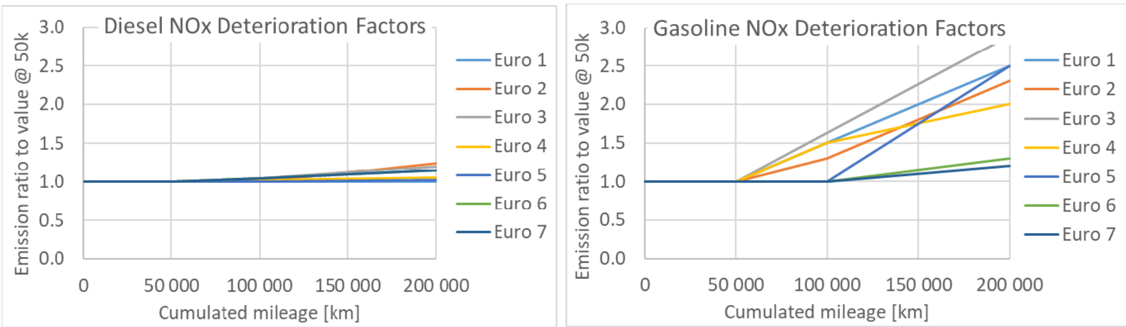

Figure 1: Emission deterioration factors for NO_X (hot emissions) for diesel and gasoline light-duty vehicles by Euro standard applied in the new HBEFA 4.1[1,2]. The deterioration factors are derived from remote emission sensing measurements made in Europe[3].

Since the PIARC-based approach applied to the Beaches Link tunnel does not consider emission deterioration as vehicles age beyond 150,000 km (see chapter 6.2.4.5 in the Ventilation Report –

[1] https://www.hbefa.net/e/documents/HBEFA41_Development_Report.pdf
[2] https://www.hbefa.net/e/documents/HBEFA41_Report_TUG_09092019.pdf
[3] https://www.ivl.se/download/18.34244ba71728fcb3f3fabb/1591706073882/C387.pdf

Appendix H Part 2), modelled in-tunnel NO_X emissions may be underestimated. However, it is not considered likely that the incorporation of deterioration factors in the emission modelling would affect the 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 scenarios. The rationale behind this assumption is that the NO_X emissions in the tunnel by year 2027 will be dominated by diesel vehicles, since the NO_X emissions from petrol vehicles on a g/km basis are much lower than for diesel vehicles up to and including Euro 5, and the deterioration of diesel NO_X emissions is very slow (Figure 1). Also, since the EIS assumes that the Euro 6 emission standard will not be introduced in Australia until after 2027, this yields a conservative estimate of the in-tunnel NO_X emissions (since it is considered likely that some Euro 6 vehicles will have penetrated the Australian fleet before 2027 anyway, regardless of the lack of Euro 6 legislation until then).

Another improvement already introduced in the WHT EIS, and used in this Beaches Link EIS, is the modelling of worst-case traffic operation scenarios, which comprise two types: one considering variable speed traffic operation for a range of average speeds ranging from 20 to 80 km/h, and another considering the emission situation during a breakdown or major incident in the tunnel. For all worst-case scenarios in-tunnel air concentrations of NO_2 were calculated to be well below the threshold of 0.5 ppm.

Emissions on surface roads

The methodology used to estimate emissions on surface roads is thoroughly and clearly described in the EIS. In general, the emission estimates for surface roads are conservative, which is particularly true for future years, since no further (stricter) emission legislation is assumed after Euro 5. This is because any Euro 6 emission legislation has not been adopted in Australia yet. Therefore, the emission levels calculated for the years 2027 and 2037 can generally be considered as “upper limits”, especially in regard to NO_X. This is particularly true also since the validation of the applied road surface emission model (the NSW EPA emission model) against measured emissions in the Lane Cove tunnel in 2013 showed an overprediction by the model for all the five criteria pollutants NO_X, NO_2, CO, PM_{10} and $PM_{2.5}$ by a factor between 1.7 and 3.3. However, it should be noted that the validated model version excludes the changes to the fuel splits for cars and LCVs following the Transport for NSW fleet model revision in 2016, which resulted in around a 10 percentage points higher share of diesel passenger cars and around 30 percentage points higher share of diesel light commercial vehicles in 2037 compared to 2012 than what is predicted by the NSW EPA emission model. A higher share of diesel vehicles is likely to increase the emissions of NO_X, NO_2 and $PM_{2.5}$, however not enough to offset the overprediction, since the emission increases would be a few percentage points maximum.

According to the EIS emission modelling exercise, the overall traffic emissions in the Beaches Link GRAL domain decreases by about 5% for all pollutants due to the project in 2027, whereas in 2037 the emissions of all pollutants remained unchanged compared to the ‘Do Minimum’ scenario, except for total hydrocarbons which decreased by 2.5%. These changes were small compared to the modelled changes in the overall traffic emissions during the time periods 2016-2027 and 2016-2037 in the range of -10% to -60% depending on pollutant (the lowest reduction for PM_{10}, the highest for total hydrocarbons). Although the emission calculations in the EIS are considered to be quite conservative, it would be of interest (and recommended) for future EIS involving the NSW EPA emission model applied to surface roads and the PIARC methodology (emission factors) applied to in-tunnel emissions, to compare the two to look for potential inconsistencies between the two models and as a means of conducting a sensitivity analysis of the emission modelling of the Sydney/Australian vehicle fleet, especially since the NSW EPA model was developed already ten years ago and the HBEFA 3.3 emission factors contained in the PIARC approach reflects the conditions "post-dieselgate" (after 2015).

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

The EIS has given careful attention to the implications for meteorological modelling of the location of the project which may be impacted by the coast and harbour. Coastal locations are likely to experience higher wind speeds than inland locations and potentially different wind directions due to local land-sea breezes. We find that the approach used to address this using the 'Match-to Observations' function in GRAMM (as recommended in the recent evaluation study of the GRAMM-GRAL package[4]) is highly appropriate in this situation and are comfortable that this is likely to provide the most representative results whilst retaining slight conservatism.

The study area also contains some complex terrain, including specifically the shallow valley or basin through which the Warringah Freeway passes. Such basins are known to lead to the accumulation of some air pollutants in some specific meteorological conditions due to the combination of sheltering from winds, down-slope "drainage" flows and inversions. These conditions are only really significant on colder winter evenings or early mornings. We are satisfied that the way the GRAMM-GRAL modelling suite has been used is sufficient to capture these potential effects, but also to note that they are likely to be of minimal significance for this project. To provide additional confidence an additional modelling task could be undertaken. If dispersion modelling were undertaken for the year 2018 the results could be compared with measurements undertaken at the project monitoring stations. If the modelling was failing to capture this phenomenon it would show up as a relative under-prediction of concentrations at station WHTBL:03 on calm and cold winter evenings and/or mornings.

In general, the GRAMM-GRAL dispersion modelling suite has been used appropriately and appears to be giving credible results. The evaluation of the models provided in the EIS (Appendix H) relates to the model's ability to capture dispersion from open roadways. The model's apparent success in doing this (albeit with some conservatism) may be used to infer that they will perform similarly well in predicting dispersion from a ventilation stack. It is currently not possible to directly verify this observationally. This is because a recent analysis of currently available air quality measurement data from monitoring stations situated near road tunnel ventilation stacks has shown that these stacks have negligible or zero impact on the measurements, with measured concentrations being driven by surface road emissions and other sources (Hibberd, 2019). Since that analysis, data has become available from monitoring around the ventilation stacks of the M4 East tunnel. Dr Longley has seen data for 18 months prior to opening and 6 months post-opening as part of his role on the M4 East Air Quality Community Consultative Committee. I confirm that, to date, no impact of stack emissions has

[4] See CSE webpage - ACTAQ Research on GRAL and GRAL optimisation study final report

been detected. A better opportunity to re-evaluate the model (albeit one that probably lies outside the scope of this EIS) now arises due to the large amount of additional observational data available.

d. Air quality monitoring and assessment 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.

In common with previous F6 Extension, West Connex and North Connex projects, considerable funds have been spent on air quality monitoring, putting Beaches Link in the enviable position of having a far richer observational dataset available than most, if not all, comparable projects. Annexure D Table D-1 (within Appendix H) lists 38 air monitoring stations (including 9 long-term DPIE stations and 29 RMS/SMC stations associated with road tunnel projects) and how data from them has been used to meet 6 different objectives.

Of the 29 project monitoring stations, 12 are classed as “background” stations, and 8 are listed as having been used to assess background air quality for this project, although we find that only 2 (M4E: 05 and NewM5:01) have been used in any substantive way. This does not include the station specifically established for this purpose (WHTBL: 01 in Bantry Bay). However, this is slightly misleading, as discussed below.

Background air quality is assessed in two ways. For “Community Receptors” – locations such as schools, child care centres and hospitals that are subject to a more detailed assessment – a time series of background air quality data is required for each hour in a year. These values are then added to the predicted impact of the project (from the dispersion model) for each hour based on real representative meteorological data from a given assessment year. Best practice is that this data is taken from on-site measurements, but the need to combine it with dispersion modelling results introduces the restriction that the background data must be derived from the project assessment year. In the case of this project the assessment year was chosen to be 2016. The project background air monitoring did not begin until October 2017 preventing it from being used directly for the assessment. This is a persistent problem which has impacted all of the West Connex projects, F6 Extension and Western Harbour Tunnel projects. **It is recommended that relevant agencies across Australia consider approaches to resolve the persistent problem of monitoring being commissioned too late for the purpose for which it is intended for future projects.**

However, it is incorrect to assume that data from the project background station WHTBL:01 has not been used to inform background. Data from other stations are used in the EIS to infer that background air quality varies across the project domain by using a geostatistical interpolation (“background map”), which is also used to provide summary background data for residential, workplace and recreational RWR receptors. Crucially, data from WHTBL:01 is used to validate the background map for long-term mean concentrations at that site. Although this is not clearly expressed in the EIS, the agreement is very good. (The interpolation was conducted for 2016 only, although this seems to be an artificial and unnecessary restriction – greater confidence can be derived from conducting multiple interpolations for multiple years.)

In the absence of directly usable background time series data the EIS takes the approach of building a 'synthetic' time series combining fragments of data from other stations that were operating in 2016. This is a suitable approach. However, rather than try to create different synthetic background time series for different parts of the domain, the EIS takes the approach of creating a single time series representing the **maximum** likely background concentrations across the domain (using data from the southern and western edges of the domain), making it increasingly conservative towards the north-east of the project. This limitation is clearly acknowledged in the EIS. It does not impact the outcome of the assessment but is a situation which could be improved.

A potentially more significant gap in the assessment is the lack of background data from the heavily-trafficked area of North Sydney (south-west end of the project). The background maps (Appendix D, figures D-24, D-25 and D-26) indicate a gradual and smooth transition in concentrations of NO_x, PM_{10} and $PM_{2.5}$ from higher concentrations in inner west Sydney (where data is relatively abundant) decreasing to lower concentrations in the north-eastern coast, whereas in reality a (currently unobserved and unmodelled) increase in concentrations in North Sydney is plausible. This could have been investigated using screening monitoring (e.g. passive diffusion tubes) at relatively low cost when the project monitoring sites were being established, and such a campaign may still be worth it now. An alternative source of information on background concentrations in North Sydney can be derived from the project 'roadside' monitoring site WHTBL:03 in Naremburn. This site is immediately to the north-east of the Gore Hill Freeway, meaning it effectively functions as an urban background site in north, north-east and easterly winds.

Inclusion of summary data from sites M4E:05 and NewM5:01 (for example in the trends tables in Appendix D) would have made review and checking of the data easier, given they are used in the assessment of background data.

e. Future background air quality

This EIS assumes, as is common practice, that background air quality in the future will be the same as in the assessment year 2016. This is assumed to be conservative due to the general long-term downward trend in background air pollutant levels associated with general improvements in vehicle emissions over the last few decades. However, analysis of long-term monitoring data in Appendix D appears to contradict this assumption with trends in many observations becoming more steady or upwards in recent years (e.g. Appendix D Figures D-6, D-7, D-9, D-11, D-12 and D-13). It is understood that this is partly due to the particularly severe impact of bushfires in 2019, which temporarily and substantially increased PM (but not NOx or NO2) concentrations, now complicated by temporary reductions in concentrations due to reduced traffic (mainly NO2 and NOx) caused by COVID-19 in 2020. However, section D5.6 also shows downward trends in emissions (seen in Figures D-13 and D-14 around 2016/2017 – 2018) reversing for some pollutants in the timeframe of this EIS (i.e. 2018 – 2019).

f. Method to estimate NO_2 concentration

The method used has limitations, which the EIS appropriately acknowledges. However, we find the empirical approach of estimating NO_2 concentrations using observational NO_2 and NO_x data to be sound, appropriate and the approach most suited to the purposes of the EIS.

g. Treatment of elevated receptors:

This project contains a number of elevated receptors, i.e. taller buildings and locations where ground level is higher than at the base of the stacks. We find that this has been well-considered in the EIS with the explicit modelling of such receptors handled thoroughly and appropriately.

2. Assessment and management of construction impacts

The procedure for the assessment of construction impacts in the Beaches Link project EIS is the same as the one used for the previous recent Sydney tunnel construction projects, based on the *Guidance on the assessment of dust from demolition and construction* published by the UK Institute of Air Quality Management (IAQM) in 2014. The IAQM guidance has been adapted for use in Sydney accounting for factors such as the assessment criteria for ambient PM_{10} concentrations. The stepwise semi-quantitative risk assessment method is considered sound and is systematically and thoroughly conducted in the EIS.

The risk assessment showed that three of the five assessed construction zones were classified as high risk zones with regard to dust impacts on all the three impact categories of dust soiling, human health and ecological receptors, and for all the four activity types (demolition, earthworks, construction and track-out) in all cases, except for demolition, which was classified as a medium risk in six cases. For the remaining two zones risks were classified as medium, low or negligible.

In the EIS, the risk assessment is inevitably associated with identifying potential mitigation measures that could, and should, be applied whenever needed, to minimise the risk of all types of dust impacts for each of the four activity types. The list of proposed measures in the EIS to mitigate dust impacts is comprehensive and highly valid, not least the proposed monitoring and adjustment or management of dust generating activities during unfavourable weather conditions.

In the Beaches Link EIS, also management of odour impacts has been considered, since some risks are associated with odorous gases from an old landfill at the Flat Rock Drive construction support site. The proposed site investigations, including to carry out odour monitoring during relevant site activities and adjust mitigation and management measures to minimise potential off-site impacts, are acknowledged and appropriate.

3. Assessment conclusions and equity issues

Overall, the project (as assessed) seems to deliver a small improvement in ambient air quality at a slight majority of receptors, and a slight worsening in air quality at a slight minority of receptors. This is broadly in response to the anticipated redistribution in surface road traffic. This conclusion is dependent on the validity of the modelled changes in traffic flows. The largest improvements in air quality appear to be associated with predicted reduction in traffic volumes along the Warringah Freeway. As this central area is amongst the most polluted in Sydney at present, the project could be seen as making a positive contribution to tackling an air pollution hot-spot. However, this is only true if the predicted traffic reductions actually occur. The Beaches Link project adds substantial new road capacity to Sydney in an area of high demand. It is reasonable to expect a high degree of additional demand induced by the project, and the additional economic growth it is likely to enable. Whereas the EIS indicates that such induced traffic growth is included in the traffic modelling, the EIS does not explicitly indicate the sensitivity of the air quality impacts of the project on that induced demand, nor the magnitude of the potential error in predictions of traffic.