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Dear Mr Crinnion

NorthConnex M1-M2 project (SSI 13_6136)

Thank you for the opportunity to comment on the Environmental Impact Statement (EIS) for the NorthConnex M1-M2 project (SSI 13_6136). NSW Health makes the following submission for your consideration. The appendix to this letter provides more detailed comments on the matters raised.

NSW Health has reviewed the EIS with emphasis on the technical adequacy of Human Health Risk Assessment (HHRA). NSW Health is satisfied that the HHRA has been generally undertaken in an appropriate manner. The HHRA relies on data from air modelling and the comments provided in this letter are contingent upon the EPA's confirmation that the modelling approach is consistent with their *Approved Methods*. It should be noted that the modelling is dependent on a number of assumptions, for example, future traffic flows.

Exposure to traffic related air pollution has been shown in epidemiological and clinical studies to be associated with a range of cardiovascular and respiratory health outcomes. Importantly, there is little evidence of any threshold below which exposure to components of traffic related air pollution are not associated with adverse health effects.

Consistent with this, the National Health and Medical Research Council (NHMRC) 2008 report *Air quality in and around traffic tunnels* concludes that it is good practice to limit exposure and to strengthen measures to ensure in-tunnel and external air quality impacts are continually minimised. NSW Health supports this position and recommends that all reasonable measures are taken to minimise exposure to air pollution both inside and outside the tunnel.

External air quality

NSW Health notes that portal emissions are not included in the proposal. This is in keeping with good design and consistent with the NHMRC (2008) observation that "In urban locations, it is often felt that portal emissions are not acceptable because of the localised effect of such a powerful point source of air pollutants."

The EIS predicts an overall reduction in $PM_{2.5}$ exposure in the area around the Pennant Hills Road corridor in 2019 and 2029. There are, however, limited areas of increased $PM_{2.5}$ exposure adjacent to the ventilation stacks. The HHRA predicts a very small increased risk of hospitalization and mortality (to a maximum of 10^{-5} to 10^{-6} per annum) for residents who experience an increase in $PM_{2.5}$ exposure. Based on this assessment, it is recommended

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that there is further exploration of all feasible and reasonable measures to reduce ground level concentrations in those areas currently predicted to experience an increase.

The EPA has advised NSW Health that predicted ground level concentrations due to emissions from the NorthConnex stacks could be reduced by improving the dispersion of emissions. Typical options for improving the dispersion of stack emissions include increasing stack height, decreasing stack diameter and/or increasing stack exit velocity, although each one of these would need to be evaluated for its practicability. A reduction in the concentration of emissions from the stacks would also reduce predicted ground level concentrations. This could be achieved by increasing ventilation flow rate to further dilute vehicle emissions, prior to discharging through the stacks.

In-tunnel air quality

The NHMRC has stated that concentrations of NO_2 in Australian tunnels present cause for concern as brief intense exposures to NO_2 and PM may aggravate asthma. Modelling presented in the EIS suggests that, $PM_{2.5}$ and NO_2 levels in the NorthConnex tunnel could – if World Road Association (PIARC) emissions factors are used – be equal to or higher than other tunnels in operation in Australia and overseas. Predicted concentrations are lower when NSW EPA emissions factors are used. Given the sensitivity of the results to underlying assumptions, it is important that all assumptions are described and that an assessment is made of the probability of exceeding the modelled concentrations.

In 2008, the NHMRC reported that a study of in-tunnel exposure to air pollution “showed a significantly increased allergenic response in asthmatics after exposure for 30 minutes to NO_2 at levels >300 µg/m^3”. It is noted that the models presented in the EIS suggest NO_2 concentrations in the NorthConnex will regularly exceed 300 µg/m^3. The NHMRC has also stated that “motorists start to experience adverse health effects when particles exceed 500 µg/m^3”, a level predicted to be reached at the end of the north bound tunnel when PIARC assumptions are used.

In-tunnel air quality predictions made by the EIS have been based upon the “most likely” traffic forecasts. It is recommended that a more conservative scenario with higher traffic flows be presented to provide greater surety in the assessment. In addition the NSW Environment Protection Authority (EPA) has advised NSW Health that using the assumptions in the EIS, NO2 emission factors used in the assessment are approximately 25-35% lower than those predicted using the 2021 EPA emission factor.

Given these issues, it is recommended that further consideration is given to ventilation designs, especially for scenarios with higher traffic congestion than that currently modelled, to better inform whether the proposed tunnel design is optimal and considers all reasonable actions to minimise in-tunnel exposure.

Thank you for considering NSW Health comments on the NorthConnex M1-M2 project (SSI 13_6136) EIS. Should you wish to discuss our submission further, please contact NSW Health Environmental Health Branch on 9424 5918.

Yours sincerely

Dr Kerry Chant
Chief Health Officer and Deputy Secretary
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APPENDIX

Air quality

Detailed comments on the Environmental Impact Statement (EIS) for the NorthConnex M1-M2 project (SSI 13_6136).

The Human Health Risk Assessment (HHRA) has been based primarily on a scenario where estimated expected traffic flows have been assumed. Given the expected growth in traffic for the corridor (as predicted by Scenario B (2029) and that the tunnels have been designed to have three traffic lanes in both directions) it would be prudent to consider scenarios with higher than predicted traffic flows. This has been done to some extent for external air quality (see Appendix E of HHRA) but no similar assessment has been done for in-tunnel air quality.

The World Road Association (PIARC) emission factors have been used to assess external air quality and both PIARC and NSW EPA emissions factors have been used to assess in-tunnel air quality. Given that the PIARC factors have been specifically published for use with tunnels and provide Australian specific values it is appropriate to use these as the primary source in calculating exposures for the HHRA.

A key predictor of emissions is traffic speed and it is unclear what assumptions have been made by the model to produce exposure estimates upon which the HHRA is based. This should be made explicit and a sensitivity analysis done to provide a firmer base for the HHRA.

There are some discrepancies and internal inconsistencies within the Technical Working Paper - Air Quality that raise concerns about the robustness of the exposure inputs into the HHRA. An example is the tunnel outlet emission tables in Appendix H of the Technical Working Paper: Air Quality.

In-tunnel air quality

NSW Health has assessed the predicted in-tunnel air quality against the design criteria for the project, international air quality guidelines for tunnels where they exist, in-tunnel air quality achieved by other tunnels, and health specific guidelines.

1. *Design criteria*

Carbon monoxide (CO) and nitrogen dioxide (NO_2) ventilation system design criteria levels are described on pages 475 and 476 and in table 7-95 of the EIS. The criteria are based on the recommendations of PIARC (2012). It should be noted that PIARC is not a health authority and the PIARC recommended level is not necessarily completely protective of human health.

Pollutant concentration increase along the length of the tunnel and it would be useful to clarify the location within the tunnel where the project design criteria are to be applied (e.g. the mid-point, where there would be average concentrations or the distal end, where concentrations would be at their maximum).

Modelled in-tunnel air quality is summarized in Table 7-101 (p. 516). Paragraph 3 of page 514 states the figures presented are based on an assumption of free flowing traffic at 80 km/h, although this is not clear from the table. It would be useful to clarify the assumed traffic speed and to confirm the averaging period for the concentrations presented in the table.

If it is assumed that the maximum concentrations (ie the concentrations at the 9km mark) presented in table 7-101 are directly comparable to the design criteria presented in table 7-95, the NO_2 concentration at peak hour in the northbound tunnel is very close to the design criterion in 2029 (0.932 mg/m^3 *cf*. 0.94 mg/m^3). If traffic has been assumed to be travelling at 80 km/h (as stated on p. 514) then there is a likelihood that the design criteria might feasibly be exceeded should traffic speeds be lower or if traffic forecasts underestimate the volume that actually occurs.

It would assist assessment of in-tunnel air quality if results were presented for traffic moving at the range of speeds for which design criteria have been established (ie 20, 40, 60 and 80 km/h).

Page 515 of the EIS states: "A preliminary ventilation design analysis for the project indicates that the in-tunnel air quality design criteria may be approached in the case of significant congestion within the main alignment tunnels". Significant congestion such as a breakdown scenario is described on page 503. Considering as part of this scenario there is the potential for motorists to be inside the tunnel for a significant period of time (up to 55 minutes), it would be prudent to model in-tunnel air quality under the breakdown scenario too.

2. *International In tunnel Air Quality Guidelines.*

Several jurisdictions have established CO and NO_2 guidelines for in-tunnel air quality and these have been summarised in the NHMRC 2008 report on page 104. Comparing the modelled levels for the project (table 7-101, page 516 of the EIS) with international guidelines indicates that the NorthConnex tunnel would meet the French, Norwegian and Belgian guidelines for NO_2. However, it should be noted that these guidelines are not necessarily health based (ie they may not be completely protective of health) and it is unclear what assumptions concerning speed of vehicles has been made to arrive at the values in Table 7-101. If a relatively high speed of 80 km/h has been assumed and lower average speeds are encountered during peak hour then compliance with these guidelines may not be achieved.

The Swedish NO_2 guideline is substantially lower than other jurisdictions (0.2 ppm or 410µg/m^3 averaged over 1 hour) and based on modelled in-tunnel air quality, NorthConnex is likely to exceed this guideline in the northern tunnel.

3. *Air Quality in other tunnels*

The NHMRC (2008) reports that most concentrations of in-tunnel NO_2 are in the range 50–150 ppb with high emissions or congestion raising concentrations towards 300 ppb. The levels predicted for the NorthConnex are in excess of 300 µg/m^3 (approximately 150 ppb) for more than half of the northbound tunnel of the NorthConnex.

The NHMRC (2008) have described mean $PM_{2.5}$ (particulate matter with a diameter of 2.5 micrometres or less) levels for a range of tunnels (figure 4.6, page 32 and figure 4.13, page 42 respectively). NHMRC reported levels for $PM_{2.5}$ ranged from 32 to 388µg/m^3 although the highest figure was thought to be an overestimate with the level being more likely to be around 200 µg/m^3.

The predicted range of $PM_{2.5}$ levels for the northern tunnel of the NorthConnex in 2029 (6pm) is from 0.037 to 0.553 mg/m^3 with a level of 0.305mg/m^3 (or 305 µg/m^3) predicted for the mid-tunnel (table 7-101, p 516 of the EIS) . As described on page 51, appendix G of the EIS these estimates are derived using internationally recognised PIARC emissions factors which provide Australian-specific emissions based on fleet distribution data and emissions standards relevant to Australia. The EIS reports that estimates derived using PIARC factors are likely to be conservative, based on an additional analysis using NSW EPA emissions factors. The EIS Figure 7-31 (page 523 in the EIS) compares predicted $PM_{2.5}$ levels to those measured in other Sydney tunnels using both PIARC and the alternative NSW EPA emissions factors. Using PIARC emissions factors, in-tunnel $PM_{2.5}$ concentrations are predicted to exceed those measured in the M5 East tunnel and other tunnels described in the NHMRC report. Predicted levels are lower when NSW EPA factors are used.

Given the sensitivity of the results to the underlying assumptions, and the NHMRC statement that "it is a common observation that motorists start to experience adverse health effects when particle levels exceed 500 µg/m^3", it is recommended that detailed information is provided about the assumptions and uncertainties underlying each model (e.g. vehicle number, vehicle speed, fleet segmentation, fuel and engine standards) and that an assessment is provided of the probability of exceeding design criteria and predicted $PM_{2.5}$ concentrations.

4. *Health based Guidelines and studies.*

There are well established health based CO guidelines for in-tunnel air quality and the NorthConnex tunnel is predicted to meet these. In contrast there are no in-tunnel health based air quality guidelines established for NO_2. There are ambient health based air quality guidelines established by the WHO but the averaging period is relatively long at 1 hour with a value of 200 µg/m^3.

The NHMRC (2008) has highlighted that "concentrations of NO_2 which do or could arise in Australian tunnels present cause for concern" (page 120) based upon a key tunnel exposure study of Svartengren et al 2000 "that showed a significantly increased allergenic response in asthmatics after exposure for 30 minutes to NO_2 at levels >300µg/m^3". In making this statement NHMRC noted that transits in tunnels are likely to be less than 30 minutes but argued that a 15 minute or 30 minute exposure limit was appropriate given that "tunnel pollutants are trapped inside vehicles if the windows are closed, extending exposure times well beyond tunnel transit times".

Predicted exposures in the both tunnels of the NorthConnex project are greater than 300µg/m^3 (from 5km onwards for the northbound tunnel in 2029 and at the end of the southbound tunnel in 2029, table 7-101) and hence there is the potential for sensitive individuals to experience adverse effects during transit.

The NHMRC has stated that compared to $NO_{2,}$ the issue of protecting users from the effects of PM is more controversial. It has concluded that there is insufficient evidence to define exposure limits but remarks that "it is a common observation that motorists start to experience adverse health effects when particle levels exceed 500 µg/m^3." (page 120). Predicted levels of $PM_{2.5}$ approach and exceed this level at the end of the northern tunnel of NorthConnex and consequently adverse health effects cannot be discounted for users of the tunnel.

Summary – in-tunnel air quality

Based upon the above comparisons, the air quality predicted could – if PIARC emissions factors are correct – be equal to or poorer than other tunnels described in the NHMRC report. Based on information documented in the NHMRC 2008 report, it is possible that sensitive users of the tunnel could experience adverse health effects following transit. It is recommended that additional information is provided about the modelling assumptions and that further consideration is given to ventilation capacity, especially for scenarios with higher traffic congestion than that currently modelled.

<u>External Air Quality</u>

In relation to the impacts of a tunnel upon a local community, NHMRC stated that:

> Road tunnels convert a line source (the road) into one or a few point sources (portals, stacks). This represents a redistribution of pollutants, generally reducing concentrations over a large area while increasing concentrations in a small area around the point sources. In the hypothetical case of an even population distribution (and an immobile population) over the district, a road tunnel asks a few people to bear a greater health burden on behalf of the majority who benefit from better air quality. This may seem unacceptable, especially if those living near the point sources do not gain as much from the transport benefits of the tunnel. However, this is not the case if the point sources (and their "impact zones") can be located in areas of reduced or zero population density, or dispersion can be designed in such a way that the increased burden is negligibly small. This should be the goal of good tunnel design. (NHMRC 2008, page 127)

In order to assess whether the NorthConnex proposal has achieved the above goal it would be necessary to evaluate the design options considered. Portal emissions are not included in the current proposal and this is in keeping with good design and consistent with the NHMRC observation that "In urban locations, it is often felt that portal emissions are not acceptable because of the localised effect of such a powerful point source of air pollutants" (page 117). Although stack location, stack height, stack volumetric flow rates, stack outlet diameter and outlet velocity flow rates are presented for the proposal, there is no presentation of how modifying these variables might decrease the impact emissions will have on the local external air quality around the stacks.

Several pollutants (e.g. NO_2) have a safe threshold described in health based air quality guidelines and the project does not appear to result in an exceedance of these values. However, other pollutants (e.g. PM, benzene) do not have a threshold and the impact of the project must be assessed by quantifying the incremental risk resulting from increased exposure to these pollutants.

Particulate matter impacts for Scenario A and Design Criteria A

The HHRA appropriately quantifies the incremental risk for local residents resulting from the predicted increased PM exposure around both the Northern and Southern stacks (summarised in Table 1). It should be emphasised that the exposure estimates used to undertake this assessment have been taken at face value.

Table 1: Risk from $PM_{2.5}$ – annual incremental exposure – primary outcomes of interest

	Northern Stack			**Southern Stack**		
	Mortality (>30yrs)	CVD Admissions (>65 yrs)	Resp Admissions (>65 yrs)	Mortality (>30yrs)	CVD Admissions (>65 yrs)	Resp Admissions (>65 yrs)
Scenario A (2019)	5×10^{-6}	2×10^{-5}	3×10^{-6}	7×10^{-6}	2×10^{-5}	4×10^{-5}
Scenario B (2029)	7×10^{-6}	2×10^{-5}	4×10^{-6}	8×10^{-6}	2×10^{-5}	5×10^{-5}
Design Analysis A	1×10^{-5}	3×10^{-5}	6×10^{-6}	1.6×10^{-5}	5×10^{-5}	9×10^{-6}

The above table demonstrates that there is a theoretical increase in the risk of the primary health outcomes of interest (mortality and admissions to hospital). This is to be expected for a pollutant with no threshold of effect. According to the framework outlined in the HHRA, the predicted levels described would not normally be considered to be negligible and might fall within the acceptable or tolerable risk category. As such an investigation should be made into all reasonable and feasible measures to minimise this risk and in the context of a tunnel these measures should be focussed at maximising dispersion. Measures that should be considered include the number of stacks, heights of stacks, outlet velocity flow of emissions from stacks and the location of stacks. The EIS as it currently stands does not provide detail about how these issues were explored and the effect that alterations to the current design might have.

Summary – external air quality

The HHRA of the external air quality impact for residents around the Northern and Southern Stacks demonstrates a non-negligible risk in terms of long term health impacts. The level of risk is such that all feasible and practical measures to improve dispersion of the emissions from the stacks need to be explored to minimise the risk. The current EIS does not explore this process in sufficient detail.