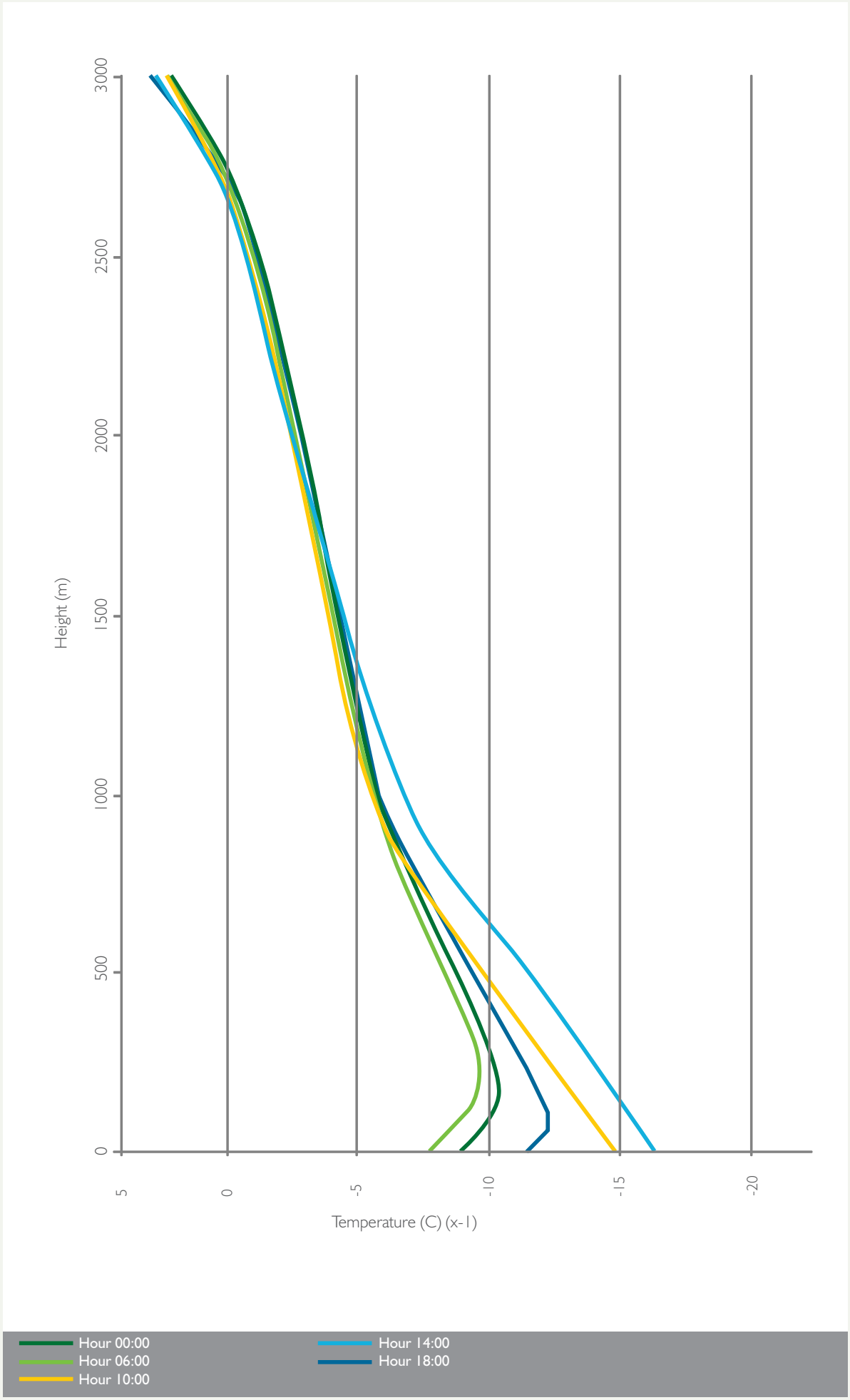

Figure 7-11 Temperature profiles at the northern ventilation outlet in winter

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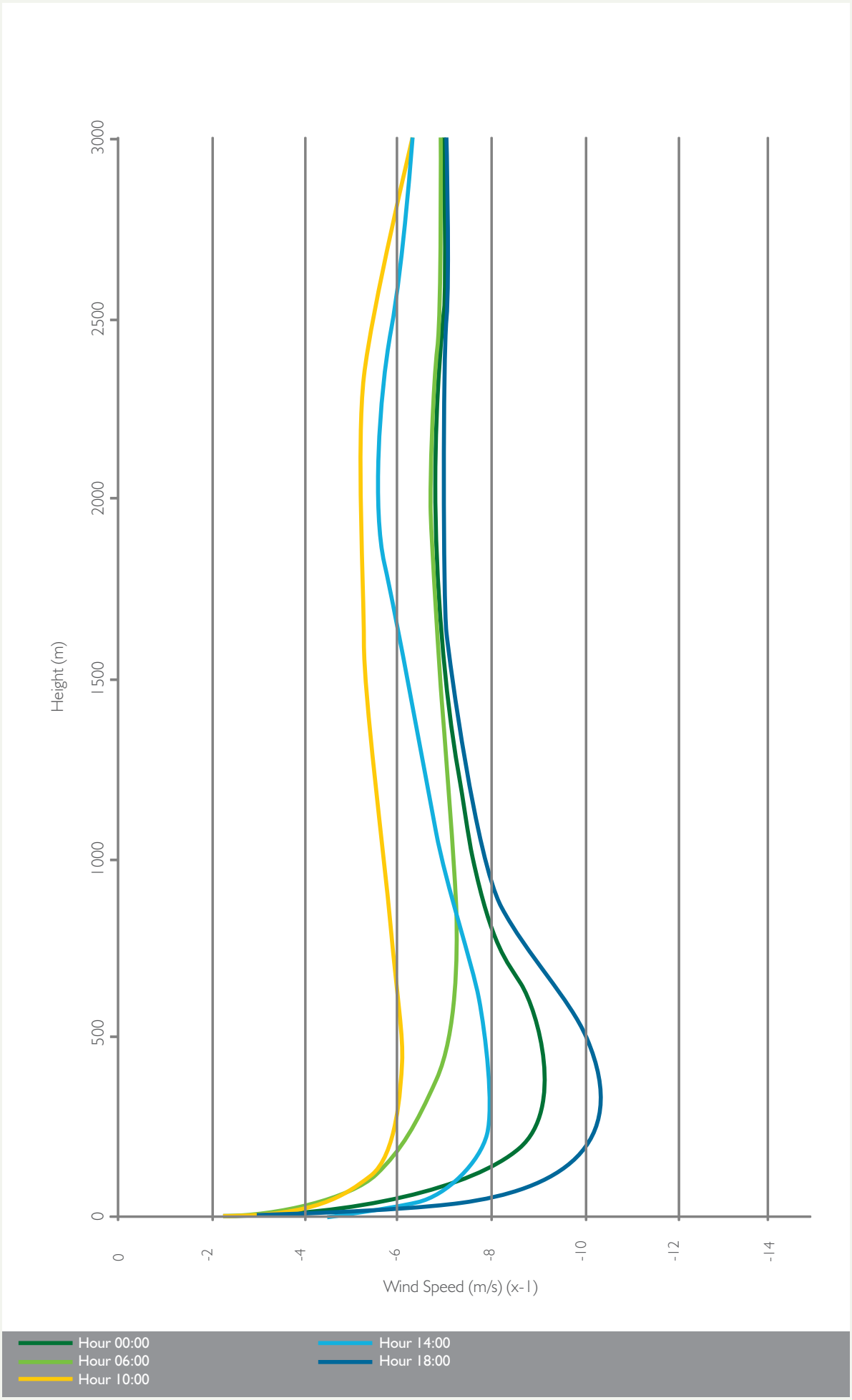

Figure 7-12 Vertical wind profile at the southern ventilation outlet in summer

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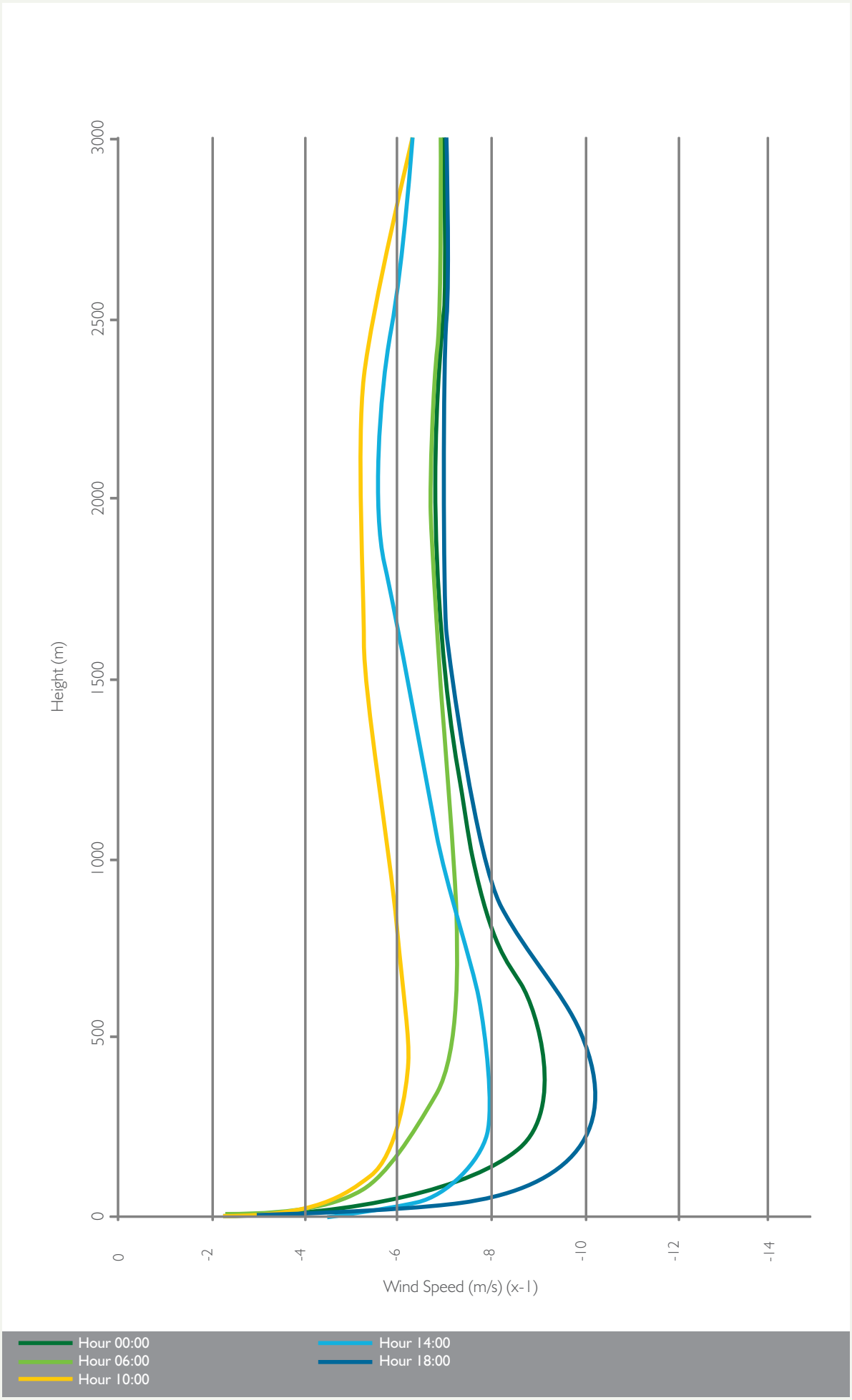

Figure 7-13 Vertical wind profile at the southern ventilation outlet in summer

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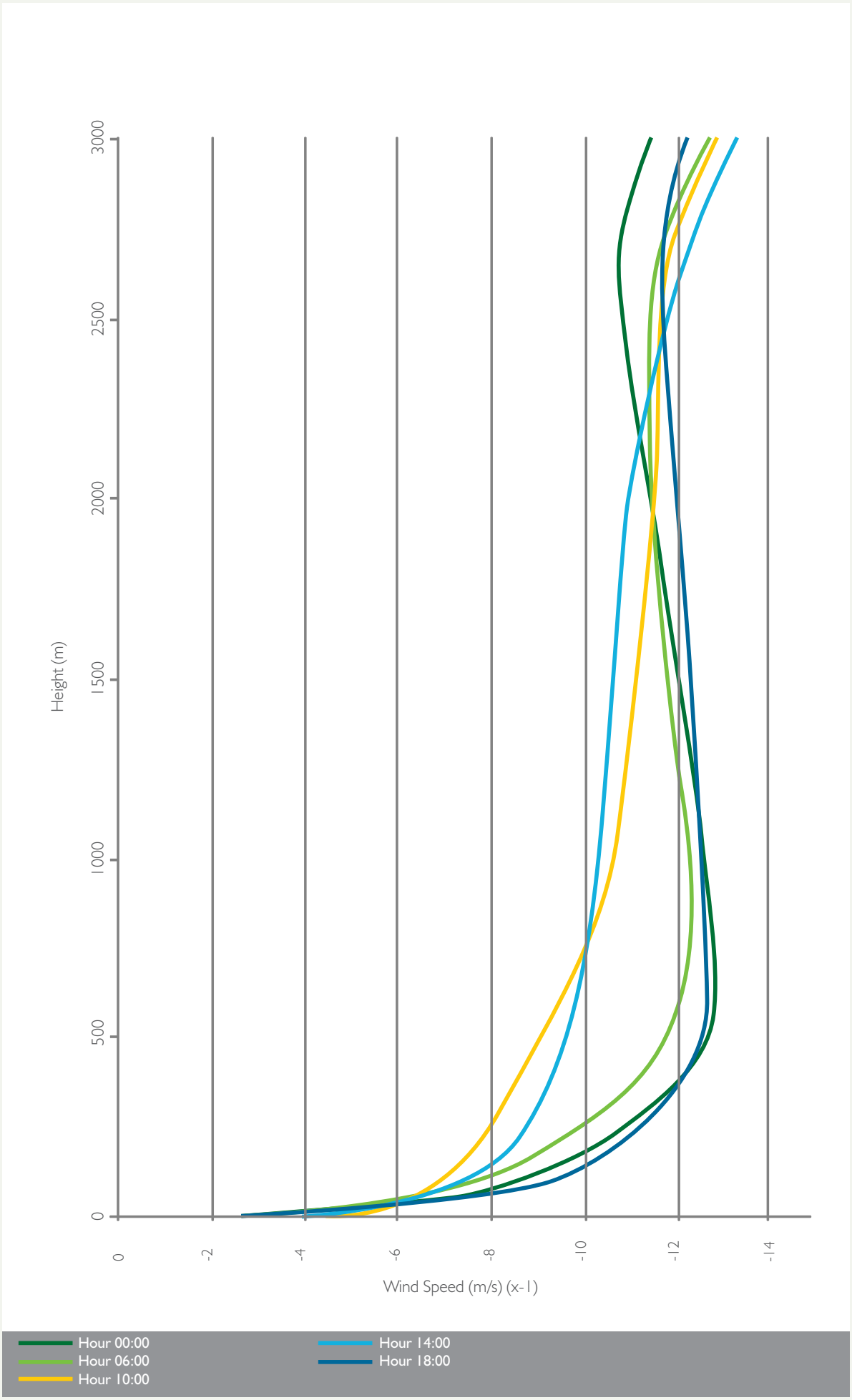

Figure 7-14 Vertical wind profile at the southern ventilation outlet in winter

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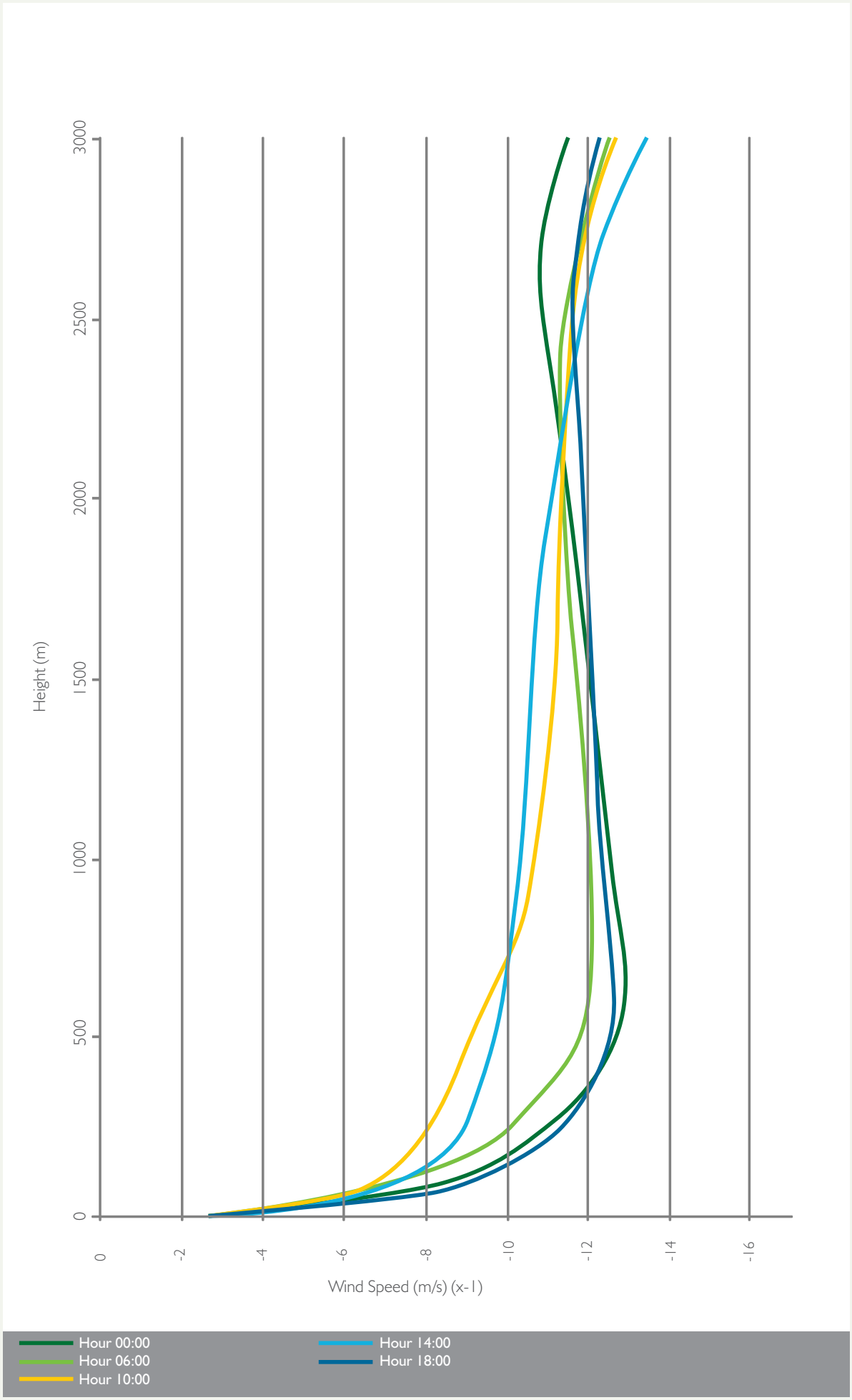

Figure 7-15 Vertical wind profile at the northern ventilation outlet in winter

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Following from the analysis of local inversion and wind speed conditions near the southern and ventilation outlets, the behaviour of the emission plume from the ventilation outlets has been modelled to assess likely behaviour under various meteorological conditions. In particular, the effect of wind speed and atmospheric stability have been targeted to assess the potential for emissions to become 'trapped' near ground level.

The plume modelling has considered two boundary conditions:

- Maximum plume rise conditions:
  - A ventilation outlet height of 15 metres.
  - A ventilation outlet diameter of 4.65 metres.
  - A ventilation outlet velocity of 19.86 m/s.
  - A ventilation outlet temperature of 314 Kelvin (41 ^{o}C).
  - Wind speed of 1.9 m/s and 7.1 m/s.
  - Stability class A and F.

- Minimum plum rise conditions:
  - A ventilation outlet height of 15 metres.
  - A ventilation outlet diameter of 7.65 metres.
  - A ventilation outlet velocity of 14.39 m/s.
  - A ventilation outlet temperature of 282 Kelvin (9 ^{o}C).
  - Wind speed of 1.9 m/s and 7.1 m/s.
  - Stability class A and F.

Note that these scenarios been constructed to analyse plume behaviour and meteorological conditions. Minor changes in ventilation outlet height (such as an increase of five metres, as is proposed for the project (refer to **Section 9.2**)) will not affect the observations made from this analysis).

Select results from the plume modelling for these scenarios are presented in **Table 7-29**.

Table 7-29 Plume settling height and downwind distance for a range of meteorological conditions at the southern and northern ventilation outlets

Wind Speed	Stability	Distance from outlet to final plume rise (m)	Effect plume height (m)	Plume rise above outlet (m)
Maximum plume rise conditions				
7.0	4	808	111	96
1.9	6	111	117	102
1.6	2	905	360	345
Minimum plume rise conditions				
7.0	4	402	61.5	40
1.9	6	111	103	88
1.6	2	793	360	345

The results in **Table 7-29** show the maximum and minimum plume rise heights that would occur for the northern and southern ventilation outlets under a range of meteorological conditions.

The final plume rise would be highest under light wind speed conditions when the atmosphere is unstable. Under these conditions, the plume would reach its final settling height of 345 metres at almost one kilometre down wind. Unstable conditions would occur during the daylight hours, usually between sunrise and sunset, and dispersion is expected to be at its best under these conditions.

Under neutral conditions, the final plume rise would be lower, but dispersion would usually good in a neutral atmosphere as the wind speed is usually moderate (ie greater than 3 m/s).

The worst dispersion conditions are likely to be stable light wind conditions. Under these conditions, plumes emitted from the ventilation outlets are likely to reach a maximum height of between 61 metres and 117 metres. This is the level where the elevated inversions are most dominant (ie between 30 metres and 120 metres), but these elevated inversions only occur during the night time when emissions from the project would be low (based on lower traffic volumes at night). The inversions are mostly broken up around 10 am, even during the middle of winter. During the summer the elevated inversions either do not occur or are very weak.

There could be some plume trapping in the middle of winter during peak hours between 8 am and 10 am, under light wind conditions when the atmosphere is still weakly stable. Plumes emitted into these conditions are likely to travel horizontally for a distance and may come to ground with morning inversion break up fumigation, but, due to low overnight emissions from the project, the plume would not be concentrated aloft.

Emissions from road level would cause a much greater build-up of pollutants under light wind inversion conditions than emissions from the project's ventilation outlets.

Issue description

The environmental impact statement (page 467) presents a discussion of project/ air quality monitoring. It is stated that monitoring stations along the project were commissioned in late 2013. Such a short monitoring period, till the current time, is not adequate as the variability in climate through time has not been assessed in any way. It is clear that there has been no modelling of the cumulative effects of these pollutants through time and their effect on the environment and the local community.

Council believes that this cumulative effect through time needs to be understood and added to the current environmental impact statement.

Response

Further information on background air quality data used in the air quality impact assessment for the project is provided in **Section 2.11** of this report.

Issue description

Section 7.3.3 of the environmental impact statement (page 477) states that the most recent New South Wales State of the Environment report states that transport emissions are the most important human related source of air pollution in Sydney. In 2008, motor vehicles were the largest source of emissions of oxides of nitrogen (63 per cent of total emissions) and the second largest source of volatile organic compounds (24 per cent of total emissions) in the Sydney region.

Council believes that this information further supports the need to address air quality issues associated with establishing this project.

Response

The NorthConnex project would not produce new emissions or new pollution. The project would collect vehicle emissions that are currently released in an uncontrolled manner at ground level, adjacent to residential and other sensitive receivers, and effectively disperse those emissions in a controlled manner high in the atmosphere. The net effect would be a reduction in the concentration of vehicle pollution at ground level where it may affect the local community.

The data presented in Section 7.3.3 of the environmental impact statement supports the need for ongoing programs targeting air quality improvements across the Sydney region. These actions, in which Roads and Maritime is an active participant with the Environment Protection Authority, are identified in Action for Air (EPA, 1998) and the most recent update of that strategy (DECCW, 2009).

7.2.1.2 Water quality

Issue description

In general the environmental impact statement does not provide enough information to determine the potential impact from the project on surface water or if mitigation measures will be adequate.

Council requests that the Department of Planning and Environment satisfy itself that the section of the environmental impact statement referring to the stated likely impacts of waste water quality reflects current best practice.

The surface water section outlines a number of strategies by which water pollution will be avoided. Little detail is however supplied as to how this will happen. For example, while the need for a Sediment and Erosion Control Plan is acknowledged, no such plan exists.

Council requests that this plan, when completed, is supplied to Council for comment.

Response

The assessment of potential surface water impacts provided in Section 7.9 of the environmental impact statement meets the requirements of the Director-General's environmental assessment requirements. The assessment identifies the potential sources of impacts during both construction and operation, and provides mitigation measures to appropriately manage these impacts. This includes collection and treatment of groundwater and the development of erosion and sediment control plans in accordance with Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Managing Urban Stormwater: Soils and Construction Volume 2D, Main Road Construction (DECC, 2008). These plans would be developed and updated progressively throughout the construction of the project to respond to site specific conditions and the changes to the construction works. As such, it is not considered practical to provide these plans to stakeholder such as Council

for comments. However, Roads and Maritime and the construction contractor would be pleased to consult with Council during the initial preparation of the erosion and sediment control plans to ensure that Council's concerns are adequately addressed.

The project would also be required to obtain an environment protection licence from the Environment Protection Authority which is likely to regulate water pollution and include specific water discharge quality limits.

Issue description

The environmental impact statement (page 848) states that water quality within the Berowra Creek sub catchment is generally poor and references are given. The most up-to-date reference is the Water Quality Report Card 2012 (Hornsby Shire Council, 2012), which highlights that the majority of sites in the Berowra catchment are currently rated at either good or fair.

Council requests that this statement and reference be updated and corrected.

Response

Council's comments regarding water quality are noted. References to existing water quality are provided for an understanding of the existing environment only.

Council's Water Quality Report Card (2012) indicates that the industrial monitoring point (site 10) in Thornleigh and the urban monitoring point (site 4) nearest the project in Berowra Creek Catchment have very poor and poor site health grades, respectively.

The consideration of poor water quality for receiving watercourses does not change the outcomes of the assessment in terms of potential impacts or mitigation measures required to be implemented. Existing poor water quality is not a justification to discharge poor water quality and each point source of potential pollution should implement measures to improve the overall water quality of the system. Hence, the project has adopted a discharge water quality which is expected to be significantly better than currently exists in the receiving watercourses.

Issue description

The environmental impact statement (page 851) attempts to make the case that the environment is already polluted so a relatively small amount of pollution emanating from the current project does not need to be seriously addressed.

Council asks the Department of Planning and Environment to be satisfied that the cumulative effect of multiple pollution points on the receiving watercourse/ waterbody are adequately considered.

Response

Council's comments regarding water quality are noted. References to existing water quality are provided for an understanding of the existing environment only. This does not change the outcomes of the assessment in terms of potential impacts or mitigation measures required to be implemented.

The assessment of potential surface water impacts provided in Section 7.9 of the environmental impact statement meets the requirements of the Director-General's environmental assessment requirements.

The consideration of poor water quality for receiving watercourses does not change the outcomes of the assessment in terms of potential impacts or mitigation measures required to be implemented. Existing poor water quality is not a justification to discharge poor water quality and each point source of potential pollution should implement measures to improve the overall water quality of the system. Hence, the project has adopted a discharge water quality which is expected to be significantly better than currently exists in the receiving watercourses.

Issue description

The environmental impact statement (on page 861) states that the quality of the discharge water from the project will be better than the receiving water quality. Council believes that this does not address the need or otherwise to clean up pollution from a designated point source.

The process of water quality treatment through time, once the project is operational, seems adequate. However, details of how the water quality treatment process will be designed and constructed are not presented. Council requests that it be consulted once such designs and operational strategies are completed.

The potential impacts to downstream flooding, and erosion/disturbance of downstream systems, needs to be designed and implemented in a satisfactory manner. Council believes that such information should be added to the environmental impact statement as the potential impacts on flooding and downstream erosion/ecological impacts could be significant and far reaching.

Response

The environmental impact statement identifies that water discharges during construction from the construction water treatment plants is likely to be higher quality than the existing water quality based on the watercourses being influenced by highly urbanised catchments. It is recognised and accepted that water discharges need to be of an appropriate quality to ensure environment protection, and that historical degradation of surface water quality is no justification for not adequately treating and managing construction water discharges.

The actual construction water quality discharge requirements will be subject to the limits set by the Environment Protection Authority through an environment protection licence for the project.

The environmental impact statement identifies that the operational water treatment plant has been designed to achieve a maximum water discharge quality equivalent to the 95 per cent protection level specified for freshwater eco-systems in accordance with ANZECC guidelines (ANZECC and ARMCANZ, 2000). The discharge water quality levels would be determined in consultation with the Environment Protection Authority during the detailed design phase taking into account the sensitivity of the receiving environment.

The environmental impact statement also notes that this discharge has the potential to result in downstream impacts such as erosion, and localised flooding. The environmental impact statement commits the project to further investigations into the exact location of discharge to Blue Gum Creek or Darling Mills Creek. Additional mitigation measures such as stream bed and bank stabilisation, or re-sizing of existing drainage infrastructure would be determined at this stage based on the location of discharge. Detailed design of the discharge and identification of an appropriate location for the discharge would take into account potential geomorphic, property and ecological impacts. Roads and Maritime and the construction contractor would be pleased to consult with Council during the development of the water treatment process design, to identify and respond to Council's specific concerns.

Further, the potential ecological impacts from altered hydrology are assessment in Section 7.6.3 of the environmental impact statement.

Issue description

The summary of mitigation and management measures in Table 7-179 of the environmental impact statement states that the project has been designed to achieve a maximum water discharge quality equivalent to the 95% protection level specified for freshwater ecosystems in accordance with ANZECC guidelines (mitigation measure OpSW3). No mention is made of a minimum discharge water quality.

Council requests that the Department of Planning and Environment consider whether the 95% protection level should be the minimum discharge quality and that with the application of reverse osmosis technology the ultimate goal should be a no net increase in pollutant loads to local waterways.

Response

Mitigation measure OpSW3 states that the project has been designed to achieve a maximum water discharge quality equivalent to the 95% protection level specified for freshwater ecosystems in accordance with ANZECC guidelines (ANZECC & ARMCANZ, 2000). This mitigation measure also commits to determining the actual discharge water quality levels in consultation with the Environment Protection Authority during the detailed design phase taking into account the sensitivity of the receiving environment. This level is considered to be significantly higher quality than the current water quality of the receiving water course. As such, it is anticipated that the project would result in an improvement to the water quality in Blue Gum Creek.

5.2.1.3 Spoil sites

Issue description

Council notes that Section 8.8 of the environmental impact statement suggests that the Hornsby Quarry site is one of six potential options for the delivery of spoil from the NorthConnex tunnels. Council is supportive of consideration being given to such a proposal and the benefits it might bring to the Hornsby Shire, subject to the outcomes of a detailed assessment which outlines the details of such a proposal and addresses any potential impacts.

The disposal of fill into the quarry, if adopted, would require waste classification and liaison with the relevant Hornsby Council officer managing the site.

Response

The environmental impact statement identifies that Hornsby Quarry, along with a number of other potential sites, may provide the necessary capacity to receive the spoil generated by the project. At this time, work is ongoing to determine the final disposal site(s).

In the event that Hornsby Quarry is pursued as a spoil disposal site for the project, an appropriate environmental assessment would be undertaken in accordance with the *Environmental Planning and Assessment Act 1979*.

If the Hornsby Quarry option is pursued further in the future, Council would be consulted, including with relevant staff involved in the management of the site.

7.2.1.4 Demolition

Issue description

Section 10.4 of the environmental impact statement refers to possible asbestos/hazardous materials (lead paint) in older properties. Council asks the Department of Planning and Environment to condition the development to ensure the materials are appropriately removed and disposed of.

Response

Section 8.3.1 of the environmental impact statement identified the potential for asbestos and other hazardous waste to be generated from activities such as building demolition.

In relation to asbestos waste, the environmental impact statement identifies that management and disposal of asbestos containing material would be undertaken in accordance with:

- *Work Health and Safety Act 2011*.
- Code of Practice for the Safe Removal of Asbestos 2nd Edition (NOHSC, 2005a).
- Code of Practice for the Management and Control of Asbestos in Workplaces (NOHSC, 2005b).
- Protection of the Environment Operations (Waste) Regulation 2005 – clause 42 special requirements relating to asbestos waste.
- AS2601:2001 Demolition of Structures.

Removal of asbestos containing material would generally involve the following:

- Development of a site specific asbestos removal control plan.
- Establishing asbestos removal boundaries with appropriate security signage and barriers.
- Preparation of the work area.
- Use of the wet removal method where feasible and reasonable.
- Removal of asbestos containing material in sections and placement in suitably labelled and properly sealed asbestos waste containers.
- Decontamination of the workplace, tools and personal protective equipment.
- Disposal of asbestos waste at an appropriately licensed facility.

7.2.1.5 Noise and vibration

Issue description

Section 7.2 and Volume 2 Appendix F present the noise impact assessment for the project. At this stage, Council has no issues with these assessments, however asks that further details be forwarded for review upon receipt of the detailed Environmental Management Plan.

Response

Council's comments are noted. Council would be consulted during the preparation of environmental management plans to ensure that its interests are identified and addressed.

7.2.1.6 Non-Aboriginal heritage

Issue description

Section 7.10 of the environmental impact statement indicates that the proposal would impact on 53 heritage listed items, including four archaeological items and three heritage conservation areas within the Hornsby Shire local government areas. However, it is understood that only five items would be directly impacted.

The project would involve the acquisition and demolition of parts of the heritage listed former Maltworks site in Thornleigh. This site is of local significance under the provisions of Schedule 5 (Environmental Heritage) of the *Hornsby Local Environmental Plan 2013*. Although the original germination building would be retained, the connection of the structure to the rest of the site would be lost. Archival recording of this site should be undertaken and submitted to Council's Local Studies Library catalogue prior to the commencement of any demolition or construction work.

Property No. 1 Pacific Highway, Wahroonga is proposed to be acquired for the northern interchange. The subject site is listed as a heritage item (Garden) of local significance under the provisions of Schedule 5 of the *Hornsby Local Environmental Plan 2013*. The garden contains "Landmark palm trees and other remnants of an earlier garden with local historical and aesthetic significance derived from their species and horticultural qualities". Two locally listed Canary Island Palm Trees would be removed during construction. Options for relocating the Canary Island Palms should be investigated during the detailed design phase for Council's review. Similarly, any heritage trees likely to be affected in the road reserve should be included in the investigation.

The proposal also involves works in the Beecroft-Cheltenham and Wahroonga North Heritage Conservation Areas. These works should be localised to specific areas already associated with major transport network infrastructure to minimise impacts on the heritage values of the areas.

Furthermore, it is understood that two heritage listed properties in Wahroonga (St Pauls Church - Pearce's Corner and "Cherrygarth" and garden) have been identified for acoustic treatment due to the potential for exceeding applicable noise criteria. If it is determined at the detailed design stage that acoustic treatment is required, Council requests that the proposed works should be discussed with landowners and a heritage architect to limit the potential impacts to heritage values.

Response

Table 7-186 of the environmental impact statement identifies non-Aboriginal heritage mitigation measures which would be implemented by the project.

In relation to the Maltworks site, mitigation measure NAH8 includes a commitment to undertake the following:

- A structural assessment of the germination structure would be conducted to ascertain the possible impact of the demolition of adjacent structures and to identify suitable mitigation methods to ensure the germination structure remains intact. Additional measures would be identified and implemented, if required, to treat the newly exposed surfaces of the germination structure to protect it from the elements as a result of the demolition of adjacent structures.
- An archival recording of the industrial site would be undertaken to record the connection of the original structures to the modern upgraded structures.
- An archaeological test excavation program would be undertaken to assess the archaeological potential of identifying evidence of the early malting industry in this area, and the relationship of the industrial to the urban site and evidence of the occupation of the Manager's house by the Chilvers family.

A copy of the abovementioned archival recording would be provided to Council's Local Studies Library catalogue.

In relation to the Canary Island Palms mitigation measure NAH3 includes the following commitment:

> *Feasible and reasonable options for the relocation of the two mature Canary Island Palms (I762) would be investigated. If the trees cannot be relocated:*
>
> - *Archival samples would be collected in accordance with NSW Royal Botanic Gardens collection procedures.*
> - *Options would be investigated to collect seed samples for later propagation.*
> - *Oral histories (if relevant) would be obtained.*

Council would be consulted with respect to options for relocating the Canary Island Palms.

The removal of other heritage listed street trees is considered to be a minor localised impact. Generally, these trees are mature species. Relocation is unlikely to be a feasible mitigation option. The project is committed to investigating options to avoid direct impacts to these trees. Where avoidance is not possible, the project would revegetate the street frontage is consultation with the relevant local council and would incorporate plantings that are representative of the heritage listed street trees.

In relation to the potential impacts to the Beecroft-Cheltenham and Wahroonga North Heritage Conservation Areas, the environmental impact statement identifies that the project infrastructure in these area has been designed so that potential impacts are localised to specific areas already associated with major transport network infrastructure. Further, mitigation measure NAH6 identifies that landscaping of ancillary infrastructure sites would be undertaken with consideration of the heritage values of the Wahroonga North heritage conservation area and the Beecroft Cheltenham heritage conservation area.

The environmental impact statement identifies three heritage listed properties as eligible for consideration of at-property acoustic treatment. Two of these, being St Pauls Church – Pearces Corner and Cherrygarth, are located within Hornsby local government area. The third, Hindfell, is located in Ku-ring-gai local government area.

The need for acoustic treatment at each property would be confirmed during detailed design, in consultation with landowners, and with consideration of potential impacts to heritage values. Should at-property acoustic treatment be required for the above listed heritage items, this may result in impacts to the fabric of these items. Treatment would be sympathetic to the heritage values of each item and would be undertaken in accordance with the Burra Charter, which stipulates that changes which reduce cultural significance should be reversible.

7.2.1.7 Property acquisition

Issue description

The proposal will require land acquisitions and land use change for temporarily affected land, as outlines in section 8.1 of the environmental impact statement.

Council requests that the future use of residual land for parks, recreational areas or redevelopment sites should be investigated in consultation with Council. Council should also be consulted when considering future local embellishments including recreational facilities, cycling infrastructure, and public transport initiatives.

Response

Section 8.1 of the environmental impact statement identifies that, on completion of the project, Roads and Maritime would investigate options for the use of residual land. This is likely to involve selling land for redevelopment in accordance with the relevant existing land use zonings. This would involve consultation with Hornsby Shire Council.

This section of the environmental impact statement also notes that the project would facilitate future consideration of local embellishments including recreational facilities, cycling infrastructure, and public transport initiatives by the relevant authorities and infrastructure providers. These future opportunities, driven by improved amenity, do not form part of the NorthConnex project and would be subject to separate consideration by the relevant parties as appropriate. Any consultation with Council would be the responsibility of the relevant party considering these embellishments in the future.

7.2.1.8 Property identification

Issue description

Council believes that no mechanism exists under section 149(2) of the *Environmental Planning and Assessment Act 1979* for Council to identify the location of the tunnel in relation to affected land. This is required to ensure that future owners of land impacted by the proposal are appropriately informed.

If not done so already, Council requests that the Department of Planning and Environment to initiate an amendment of *Environmental Planning and Assessment Regulation 2000* to address this issue.

Response

Council's comments are noted. Roads and Maritime will work with Council and the Department of Planning and Environment to ensure that an appropriate mechanism for reflecting the presence of the NorthConnex project is implemented. This will include measures to ensure that the presence of the project is taken into account in future land use planning and development proposals.

7.2.1.9 Construction traffic

Issue description

Council notes that most of the suggested construction traffic routes are subject to further development however Council believes these matters require particular consideration:

a) How heavy vehicle access can be managed at the Wilson Road compound (C6), the Trelawney Street compound (C7) and the Pioneer Avenue compound (C8).

b) The geometry of the existing roundabout at the intersection of Phyllis Avenue/ Central Avenue is sufficient to safely accommodate heavy vehicles from the Trelawney Street compound (C7) and northern interchange compound (C9).

c) How access can be managed after hours from Trelawney Street compound (C7).

d) Capacity of local roads and operation of intersections used to access the Pioneer Avenue compound (C8) given the daily volumes will exceed 600 vehicles per day. Queues in Duffy Avenue regularly form past Pioneer Avenue, and traffic turning right out of Lymoore Avenue will obstruct traffic trying to turn left out of Lymoore Avenue, and traffic turning into Lymoore Avenue due to the narrow road width. Sefton Road and its intersections are also affected by traffic generated by Thornleigh Public School.

e) How workers will be encourage to park and ride from the Pioneer Avenue compound (C8).

f) For local roads that will be used by haulage and construction vehicles, dilapidation surveys will be required and commitment provided for remediation of road pavement if required.

g) Details of localised traffic impacts that would arise from providing access for building works at the Bareena Avenue compound (C10) from Woonona Avenue North are documented. Council and local residents should be consulted and advised of proposed mitigation measures.

h) Given the existing delays incurred at a number of intersections, including Pennant Hills Road/ Phyllis Avenue and Pennant Hills Road/ Duffy Avenue, the impacts of additional construction and workers vehicles will have on Pennant Hills Road and local roads is properly assessed and quantified.

i) Vehicle location monitoring devices are used to ensure heavy vehicles are not deviating from approved routes.

Council requests that the Department of Planning and Environment satisfy itself that the construction traffic management plans will provide enough detail to give confidence that construction traffic will be managed safely and efficiently with minimal impacts on other road users, residents and businesses.

Response

As identified in the environmental impact statement, haul routes would be subject to further development through consultation between the construction contractor, Roads and Maritime and the Transport Management Centre in order to identify appropriate solutions to reduce impacts on the surrounding road network and the local community.

Responses to specific issues raised by Council are provided below:

a) Heavy vehicle use at the Pioneer Avenue compound (C8) would occur during the site establishment and site demobilisation phases only. These heavy vehicles are expected to access the site through the existing Pioneer Avenue access point.

   Heavy vehicles at the Wilson Road compound (C6) would access and egress the site to and from Pennant Hills Road. More detailed access and management arrangements would be developed during detailed design and would be detailed as part of Traffic Management Plans and Traffic Control Plans.

   Following feedback from the community and stakeholder relating to concerns regarding the haulage route from the Trelawney Street compound (C7), haulage routes at the Trelawney Street site have been revised and are detailed in **Section 9.4** of this report.

b) Following feedback from the community and stakeholder relating to concerns regarding the haulage routes, haulage routes at the Trelawney Street compound (C7) and northern interchange compound (C9) have been revised and are detailed in **Section 9.4** of this report. These revised haulage routes do not use the roundabout at the intersection of Phyllis Avenue/ Central Avenue.

c) As identified in the environmental impact statement, heavy vehicle access to and from the Trelawney Street compound (C7) outside of standard construction hours would be directly to and from Pennant Hills Road. This is likely to involve a left in, left out option only. Further details of revised haulage routes to and from the Trelawney Street compound are provided in **Section 9.4** of this report.

d) The environmental impact statement acknowledges that the majority of the intersections around the Pioneer Avenue compound are currently operating at or above design capacity during both the AM and PM peak periods. The introduction of additional movements is likely to exacerbate this issue (refer to Tables 7-20 and 7-21 of the environmental impact statement). Some additional impacts to the surrounding road network are inevitable during construction of the project, but these impacts would be limited in duration and would not continue into the operational phase of the project. The construction contractor would investigate options to reduce these potential impacts where feasible and reasonable. This would be documented in Traffic Management Plans and Traffic Control Plans.

e) Appropriate measures to encourage workers to use the Pioneer Avenue parking facility would be developed by the construction contractor. It is the intention to maximise use of the Pioneer Avenue facility, and thereby minimise potential impacts on the surrounding road network and local receivers that may be generated by construction worker vehicles.

f) Condition surveys of local roads used by heavy vehicles would be undertaken prior to works commencing. Any damage to local roads attributable to the project would be rectified by the project at no cost to the relevant council.

g) Consultation would continue to be undertaken with the relevant local council and the local community regarding proposed traffic mitigation measures for all construction sites. This would include in relation to access arrangements for the Bareena Avenue compound (C10).

h) The environmental impact statement provides an assessment of the anticipated impacts on all intersections along Pennant Hills Road from the introduction of construction traffic (refer to Section 7.1 of the environmental impact statement). Appropriate mitigation measures are provided in Table 7-40 of the environmental impact statement.

i) The project has specified haulage routes for heavy vehicles. As identified above, these haulage routes would be subject to further development through consultation between the construction contractor, Roads and Maritime and the Transport Management Centre in order to identify appropriate solutions to reduce the impact on the surrounding road network and the local community. Methods to ensure compliance with the stated haulage routes would be developed by the construction contractor and documented in the Traffic Management Plans and Traffic Control Plans.

5.2.1.10 Operational traffic

Issue description

Council endorses the Hills M2 Motorway integration works to ensure southbound traffic in the tunnel is not delayed by problems on the Hills M2 Motorway westbound. Based on current experience during weekday afternoon peaks and weekend morning peaks, Council believes there is also potential for traffic northbound in the tunnel to be delayed when merging with northbound surface traffic on the M1 Pacific Motorway.

The Department of Planning and Environment may wish to verify with the proponent that northbound traffic from the tunnel has adequate merge opportunities with M1 Pacific Motorway surface traffic to prevent queues forming back into the tunnel during peak traffic periods.

Response

The project has been designed to provide a safe merging point with the M1 Pacific Motorway from the main alignment tunnels. The environmental impact statement presents modelled operational traffic flows in the year of opening (2019) and ten years after opening (2029). The forecast performance of the main alignment tunnels is provided in Table 7-26 of the environmental impact statement. This table shows that the main alignment tunnels would operate with a level of service ranging from A to C. This indicates that the main alignment tunnels would operate as free flowing traffic with spare capacity.

The environmental impact statement also presents the anticipated performance of the M1 Pacific Motorway during peak periods, both with and without the project (Table 7-29, Table 7-30 and Table 7-31). This assessment demonstrates that the operation of the project would not lead to a deterioration in the operation of the M1 Pacific Motorway.

The NorthConnex project has been designed to avoid traffic queuing into the project tunnels or onto surface roads under normal operating conditions. Operational management measures would be developed and implemented to address potential congested traffic conditions, including in the event of breakdowns and incidents.

Issue description

Council welcomes the NorthConnex project because it will generally improve traffic conditions along Pennant Hills Road and other routes along the north-south transport corridor, however Council believes it will not fully resolve the congestion problems in the area in the long term. According to the environmental impact statement, some of the key intersections along Pennant Hills Road will still experience significant congestion during one

or both of the AM and PM peak hours in 2019 and 2029 irrespective of the project as a result of background traffic growth.

Future traffic growth falls outside the scope of this environmental impact statement, however, Council seeks a commitment from the government to resolve longer term congestion problems on Pennant Hills Road and other routes along the north-south transport corridor. The long term solutions should include the following options:

a) Planning commence immediately for a second Hawkesbury River crossing connecting the Westlink M7 Motorway and M1 Pacific Motorway as per the Pearlman Report (2007) recommendations.

b) Widen Pennant Hills Road to six lanes (three travel lanes in each direction) from Carlingford Road to Murray Farm Road.

c) Silverwater Road extension by providing a tunnel from Kissing Point Road to Pennant Hills Road, Carlingford.

d) Provide direct connection from Pacific Highway/ Yirra Road to the intersection with Ku-ring-gai Chase Road. A road corridor to facilitate this connection has already been reserved.

e) Public transport improvements and intersection upgrades along Pennant Hills Road.

f) The northern interchange of the NorthConnex project will result in increased traffic flows and degradation of local residential amenity in adjoining streets. In this regard, there should be a commitment that traffic entering and exiting the northern interchange does not reduce the amenity of adjacent residential areas. A program to monitor the post operation impacts on adjoining roads should be developed. The roads to be monitored should include:

   - Pennant Hills Road between the M1 Pacific Motorway and the Pacific Highway.
   - The Pacific Highway between Pennant Hills Road and Ingram Road.
   - Ingram Road.
   - Hinemoa Avenue.
   - Havilah Avenue.
   - Hewitt Avenue.
   - Eastbourne Avenue.

g) The current proposal is absent of any provision for future connections to either Castle Hill Road or Boundary Road. These routes will be under increasing pressure over the next few decades as developments in the North West Growth Centre and North West Railway Corridor proceed. Council supports direct connections between these State Roads and the NorthConnex project subject to such connections not adversely impacting on the traffic flows in the project tunnels.

Response

The majority of the suggestions identified by Council are outside the scope of the NorthConnex project. If any of these proposals are pursued in the future, they would be subject to separate investigation, development, and environmental impact assessment and approval consistent with the requirements of the *Environmental Planning and Assessment Act 1979*.

Responses to specific issues raised by Council are below:

a) Section 4.2 of the environmental impact statement discusses the need for the Type C or Outer Sydney Orbital road. The Type C corridor, or the Outer Sydney Orbital, is a proposed road link of strategic significance to provide increased capacity and connectivity of the motorway network to meet the future demand of metropolitan Sydney, New South Wales and interstate transport. It is anticipated that the Outer Sydney Orbital would form part of a future north-south motorway link to bypass metropolitan Sydney to the west, connecting the Hume Highway in the south with the M1 Pacific Motorway in the north.

   Consistent with the recommendations of the 2007 Pearlman Review, the NSW Government announced in June 2014 that it had allocated funding for preliminary investigations to inform the identification and reservation of a corridor for the future M9 Motorway (Outer Sydney Orbital). The M9 Motorway would be consistent with the Type C corridor considered by SKM in 2004 (the 2004 report), and supported by the 2007 Pearlman Review as a long term option. The preliminary investigations are underway, with planning for the M9 Motorway being conducted concurrently with delivery of the NorthConnex project.

   The Outer Sydney Orbital would provide increased capacity for the road network to improve accessibility to future housing and employment opportunities in Western Sydney. In particular it is expected to address the future demand from the South West and North West Growth Centres and the Western Sydney Employment Area, and provide a strategic link for both passenger and freight transport within the region.

   Importantly, the Outer Sydney Orbital is anticipated to meet the demands of future transport requirements. The project would meet existing transport demands and relieve existing congestion issues on a key section of the National Land Transport Network.

b) Any widening of Pennant Hills Road, beyond that required to facilitate the new interchanges for the NorthConnex project is outside the scope of the project. In future, there may be separate projects that consider changes or enhancements along Pennant Hills Road, and these would be subject to appropriate assessment, consultation and approval in accordance with the *Environmental Planning and Assessment Act 1979*.

c) An extension of Silverwater Road (A6) is outside the scope of the NorthConnex project.

d) A direct connection from the Pacific Highway/ Yirra Road intersection to Ku-ring-gai Chase Road is outside the scope of the NorthConnex project.

e) There are no plans to alter or reduce the capacity or operation of Pennant Hills Road as part of the NorthConnex project. In future, there may be separate projects that consider changes or enhancements along Pennant Hills Road, and these would be subject to appropriate assessment, consultation and approval in accordance with the *Environmental Planning and Assessment Act 1979*.

   As part of the NorthConnex project, only limited localised changes to Pennant Hills Road would be required to accommodate the new northern and southern

interchanges. Beyond these required changes, no other alterations to Pennant Hills Road are proposed.

Roads and Maritime monitors and manages the operational performance of the arterial road network. The Pinch Point program targets peak hour traffic hotspots and investigates ways to relieve traffic congestion. Pennant Hills Road is one of the corridors that Roads and Maritime is investigating for potential improvements in future years.

f) Changes to operational traffic volumes along this section of Pennant Hills Road have been assessed in the environmental impact statement. In relation to amenity, the operational noise assessment considered the need for operational noise mitigation through this section of road. The majority of properties fronting Pennant Hills Road between the M1 Pacific Motorway and the Pacific Highway intersections have been identified as eligible for consideration of at-property acoustic treatment. Mitigation measure OpNV2 in Table 7-85 of the environmental impact statement identifies that operational traffic noise would be monitored at sensitive receivers between six months and one year after opening. If the traffic noise levels are above the predicted levels, consideration of additional feasible and reasonable mitigation measures would be undertaken.

g) The provision of an intermediate interchange was reviewed as part of the Stage 2 unsolicited proposal process. This review found that:

- The difference in grade between the surface and the main alignment tunnels would likely result in environmental costs associated with significant additional lengths of tunnelling works to implement the intermediate interchange, or steep grades on the ramps resulting in operational inefficiencies and potential air quality impacts.
- Additional property acquisition would likely be required to facilitate the traffic arrangements around the interchange.
- The proximity of the works to the Northern Railway Line would introduce additional constructability challenges, engineering risks and project costs.

Further, a consideration of local and regional traffic conditions and forecast patronage of an intermediate interchange indicated there would only be limited traffic benefits associated with an interchange at this location. On balance it was concluded that, although an intermediate interchange would provide some limited local traffic benefits, these benefits were not sufficient to outweigh the additional impacts, the significant risks and the additional cost associated with constructing the intermediate interchange. The intermediate interchange was therefore not included in the scope of the project.

7.2.1.11 Biodiversity

Issue description

It is Council's view that additional environmental management measures for biodiversity need to be added to those outlined in Section 7.6.4 of the environmental impact statement (Table 7-156). Environmental management measures relating to biodiversity should also include:

- B5 - 'Reuse of trees' needs to be included under the impact of 'clearing native vegetation' during construction. This has been successfully undertaken at the recent North West Rail Link project where trunks were salvaged and removed for later reuse in bushland reserves as bush furniture, seats and children's play structures.
- B8 and B9 - 'Weed management during construction' needs to be included under 'adverse impacts to riparian zones and aquatic habitats' and 'spread of weeds and pathogens'. This will ensure weed issues are minimised during works, resulting in less weed control required into the future.
- B8, B9 and OpB1 – 'Revegetation, restoration and weed management is to be carried out by qualified bush regeneration companies to ensure professional works occur and to minimise ongoing costs. This will avoid poor quality work as seen in the recent Hills M2 Motorway Upgrade project, expensive recurring weed problems and community dissatisfaction.

Response

The intent of the mitigation measure identified by Council for the reuse of trees is generally consistent with the intent of existing mitigation measures B5 in Table 7-156 of the environmental impact statement. This mitigation measure includes the reuse of habitat elements such as woody debris onsite or in adjacent bushland. Council would continue to be consulted during the detailed design and construction stage. Opportunities to provide Council with trunks of cleared vegetation for its re-use in bushland reserves could be further explored during this consultation.

Mitigation measure B9 in Table 7-156 of the environmental impact statement identifies that weeds within the construction footprint would be actively managed prior to vegetation clearing. Cleared weed material would be disposed of to a facility licensed to receive green waste. This includes weed management within riparian areas.

The environmental impact statement commits to appropriate revegetation and ongoing maintenance of these areas. Revegetation and ongoing maintenance would be carried out by appropriately qualified and experienced companies. The exact details of revegetation would be developed as part of flora and fauna management plans.

Issue description

The tunnel dissects the Hornsby Shire and the loss of 2.81 ha of the Critically Endangered Ecological Community Blue Gum High Forest, primarily from Hornsby Shire, will be significant because the community is at very low levels. Where possible, offsets should occur in Hornsby Council reserves using the Biobanking assessment and credit methodology.

Should the project receive planning approval Council requests that the Department of Planning and Environment condition the proponent to:

- Offset the loss of the Critically Endangered Ecological Community by permanent conservation management of Blue Gum High Forest in the Hornsby Shire through the creation of a Biobanking Agreement.
- Investigate Council land suitable for Biobanking to offset the loss of Blue Gum High Forest as well as the sandstone communities, and potentially for *Epacris purpurascens* var. *purpurascens* and Gang-gang Cockatoo (*Callocephalon fimbriatum*).

Council recommends that:

- Offsets should occur within close proximity to impacts within Hornsby Shire.
- Offsets should include Biobanking as the highest priority.
- Offsets should be like for like.
- The Biodiversity Offset Strategy should include a Weed Management Strategy, a Nest Box Plan and Site Landscape Plans utilising indigenous plant species.

Response

Section 7.6.4 of the environmental impact statement identifies the need for biodiversity offsets and provides a preliminary offset calculation, consistent with the Biobanking methodology. Offsets would be provided in accordance with the NSW Offset Principles for Major Projects (State Significant Development and State Significant Infrastructure) (OEH, 2013). Relevant transitional arrangements with the introduction of the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014) would also be taken into account.

The biodiversity assessment presented in the environmental impact statement is based on a conservative assumption of worst-case clearing within each construction site. Opportunities to minimise the extent of clearing and surface disturbance would be identified and implemented during detailed design, where feasible and reasonable, with the aim of minimising the extent of biodiversity impacts and the scale of necessary biodiversity offsets.

All reasonable and feasible attempts would be made to secure an appropriate offset site(s). However, in the event that appropriate offsite sites for the total offset credits cannot be obtained, the offset strategy would include a range of supplementary measures such as:

- Actions outlined in threatened species recovery programs.
- Actions that contribute to threat abatement programs.
- Biodiversity research and survey programs.
- Rehabilitating degraded aquatic habitat.

Roads and Maritime would be pleased to discuss the use of Hornsby Council reserves and other land as biodiversity offset sites.

The ongoing management of weeds, nest boxes and site landscaping would be documented within the Operational Environmental Management Plan, which would be separate and complementary to the Biodiversity Offset Strategy.

7.2.2 The Hills Shire Council

7.2.2.1 Traffic

Issue description

The NorthConnex project should consider longer term options for intermediate access between the Hills M2 Motorway and the M1 Pacific Motorway.

Response

The potential for an intermediate interchange was contemplated in the 2004 report. The preliminary design of and need for an intermediate interchange was reviewed as part of the Stage 2 unsolicited proposal process. This review identified that:

- The difference in grade between the surface and the main alignment tunnels would likely result in environmental costs associated with significant additional lengths of tunnelling works to implement the intermediate interchange, or steep grades on the ramps resulting in operational inefficiencies and potential air quality impacts.
- Additional property acquisition would likely be required to facilitate the traffic arrangements around the interchange.
- The proximity of the works to the Northern Railway Line would introduce additional constructability challenges, engineering risks and project costs.

Further, a consideration of local and regional traffic conditions and forecast patronage of an intermediate interchange indicated there would only be limited traffic benefits associated with an interchange at this location.

On balance it was concluded that although an intermediate interchange would provide some limited traffic benefits, these benefits were not sufficient to outweigh the additional impacts, the significant risks and the additional cost associated with constructing the intermediate interchange. An intermediate interchange was therefore not included in the scope of the project.

Further details are provided in Section 4.3.2 of the environmental impact statement.

Issue description

The use of Aiken Road, Oakes Road and Eaton Road/Karloon Road as a proposed inbound heavy vehicle access route from the north into the southern interchange construction compound (C5) is totally unacceptable. Alternative routes need to be identified that restrict inbound access to the site off Pennant Hills Road or the Hills M2 Motorway.

Response

Based on concerns raised in public submissions and through other community and stakeholder engagement mechanisms (refer to **Chapter 5** of this report), access arrangements to several construction compounds have been reviewed. This has included a review of heavy vehicle access arrangements to the southern interchange compound (C5). These changes would avoid the use of local roads by heavy vehicles, including Aiken Road, Oakes Road, Karloon Road and Eaton Road.

Changes made to access arrangements at the southern interchange compound are detailed and assessed in **Section 9.4** of this report.

During construction, Traffic Management Plans would be developed and implemented to manage the movement of vehicles to and from the project site and to ensure that vehicle movements are conducted in a manner that minimises impacts on local amenity, traffic flows and road safety.

Issue description

A copy of the Construction Traffic Management Plan (CTMP) should be provided to all affected councils for review prior to approval.

Response

As identified in Section 7.1.4 of the environmental impact statement, Traffic Management Plans and Traffic Control Plans would be developed in order to detail the site specific construction vehicle arrangements as well as the safe movement of motorists, cyclists and pedestrians around the construction sites. Additional measures would be considered during the development of Traffic Management Plans such as:

- The use of temporary traffic lights at heavy vehicle egress points.
- Siting heavy vehicle egress point where there are downhill grades where feasible and reasonable.
- Stipulating certain emissions standards (such as Euro 3) from heavy vehicles used as part of the project.
- The use of trucks with greater capacity to reduce the overall number of heavy vehicle movements.

The Community Communications Framework provided in Appendix D of the environmental impact statement identifies targeted consultation activities for specific environmental issues. In relation to construction traffic, local councils are identified as a key stakeholder. A Traffic and Transport Liaison Group would be established to discuss traffic management and road safety mater associated with the construction of the project. The Traffic and Transport Liaison Group would include representative from the relevant local councils.

7.2.2.2 Noise

Issue description

A copy of the Construction Noise and Vibration Management Plan (CNVP) should be provided to all affected councils for review prior to approval.

Response

As identified in Table 7-85 of the environmental impact statement, a Construction Noise and Vibration Management Plan(s) would be prepared and implemented and would include:

- Identification of nearby residences and other sensitive land uses.
- Description of approved hours of work.
- Description and identification of all construction activities, including work areas, equipment and duration.
- Description of what work practices (generic and specific) would be applied to minimise noise and vibration.

- A complaints handling process.
- Noise and vibration monitoring procedures.
- Overview of community consultation required for identified high impact works.

The relevant local council(s) would continue to be consulted during the development of the detailed design and throughout the construction of the project. Relevant issues raised by local councils would be addressed in the Construction Noise and Vibration Management Plan(s).

Issue description

The detailed design of ventilation facilities, jet fans, substations and the motorway control centre should be certified by an acoustic consultant as meeting the project specific noise criteria.

Response

An assessment of the potential noise impacts from fixed facilities and fixed infrastructure has been provided in section 7.2.4 of the environmental impact statement.

This assessment found that under all operation scenarios and weather conditions, fixed infrastructure and fixed facilities, including the motorway control centre would comply with the applicable project specific noise criteria at the most affected receiver location.

Mitigation measure OpNV3 in Table 7-85 of the environmental impact statement provides a commitment for the detailed design of these facilities to meet the project specific noise criteria derived in accordance with the NSW Industrial Noise Policy. This would be achieved during the detailed design phase of the project, using suitably qualified specialists and verified by a qualified independent certifier.

Issue description

A post commencement acoustic assessment should be carried out to verify the findings of modelling and/ or to identify any further acoustic treatment required to protect the acoustic amenity of the neighbourhood around the southern interchange facility.

Response

Mitigation measure OpNV2 in Table 7-85 of the environmental impact statement identifies that operational traffic noise would be monitored at sensitive receivers between six months and one year after opening. If the traffic noise levels are above the predicted levels, consideration of additional feasible and reasonable mitigation measures would be undertaken. This monitoring program would also include monitoring the noise levels from operational ancillary facilities including the motorway operations complex.

7.2.2.3 Air quality

Issue description

The proponent should evaluate the relocation of the southern ventilation outlet to a suitable site within the south-western corner of the Pennant Hills Golf Course, by modelling the air quality impacts from that site to enable comparisons with the proposal in the environmental impact statement to locate the ventilation outlet within facilities at the southern end of the motorway control centre. Should air quality benefits be identified as a result of the evaluation, the southern ventilation outlet should be relocated to the Pennant Hills Golf Course.

Response

The air quality impact assessment and the human health risk assessment included in the environmental impact statement demonstrate that the NorthConnex project would meet ambient air quality criteria and would pose a very low risk to human health. In this context, there is no basis to justify relocation of the southern ventilation facility to an alternative location. These assessments are provided in Section 7.3 and Section 7.4 of the environmental impact statement respectively.

Notwithstanding, the potential relocation of the southern ventilation outlet has been considered as part of the analysis of ventilation system options and alternatives presented in **Section 3.2** of this report.

The most efficient location for ventilation outlets is close to the main alignment tunnel exit portals. This is because vehicles travelling through the tunnels create a piston effect, which draws air into the tunnel and pushes it forward in the direction of traffic flow. Locating the ventilation outlets near the main alignment tunnel exit portals maximises the benefit of the piston effect and minimises the need for additional energy consumption to operate tunnel jet fans and to transport the exhaust air from the tunnel to the outlet. This approach provides environmental benefits through the reduction in energy consumption and greenhouse gas emissions from the project.

The location of ventilation outlets for the project have been determined based on proximity to the main alignment tunnel exit portals, as well as consideration of other factors including land access and acquisition requirements, geology, engineering and construction constraints, potential landscape and visual impacts, and the location of other major infrastructure.

With regard to the southern ventilation outlet, the location chosen is within land already owned by Roads and Maritime and is co-located with other operational infrastructure, while still being located as close as practical to the southbound tunnel portal. The adoption of this location has resulted in an efficient ventilation system and has minimised land acquisition requirements.

The rationale for the location of the ventilation facilities is provided in Section 4.4.1 of the environmental impact statement.

7.2.2.4 Urban design, landscape character and visual amenity

Issue description

Where practicable, advanced tree species should be planted prior to the operational occupation of the southern interchange facility and motorway control centre and particularly where there is an interface with residential properties on Eaton Road and Karloon Road and where the site adjoins Hillside Place and Gum Grove Place.

Response

The concept landscape design for the motorway operations complex is provided in the Technical Working Paper: Urban Design (Appendix I of the environmental impact statement). The landscape design includes informal native tree planting along the boundaries of the site adjacent to residential receivers, including the use of native species with a mature height of around 30 to 45 metres to provide a visual screen between the residential area and the motorway control complex.

As identified in the Community Communications Framework provided in Appendix D of the environmental impact statement, an Urban Design and Landscape Plan would be developed as part of the detailed design. This plan would be developed in consultation with the local community and the relevant local councils. The provision of mature planting in certain locations would be further considered as part of this process.

7.2.2.5 Surface water

Issue description

The environmental impact statement has not adequately considered the impacts on flood prone land and overland flow paths for the waterways and catchments in the vicinity of the Hills M2 Motorway as it relates to the proposed widening works and any stormwater infrastructure upgrades. Further information is required in order to satisfy Council's concerns about these potential impacts.

Response

The proposed Hills M2 Motorway integration works would involve the augmentation of existing drainage infrastructure associated with the motorway. As identified in Section 7.9.3 of the environmental impact statement this is expected to include:

- Demolition and reconstruction of pits and pipes.
- Modification to four existing detention basins along the Hills M2 Motorway.
- Extension of five transverse drainage culverts along the Hills M2 Motorway.

Modifications to existing drainage infrastructure have been designed to replicate the current design standards and operational functionality of the Hills M2 Motorway. For example, the detention basins along the Hills M2 Motorway were designed and constructed to capture the first flush from a one year ARI event. Where the project would increase the road surface area draining to a particular basin, the basin would be modified to continue to capture the first flush from a one year ARI event. Despite this, opportunities to design to a higher standard and to provide improved environmental outcomes have been incorporated into the design where feasible and reasonable.

Issue description

Any design carried out for alterations to the existing drainage structures and culverts associated with the Hills M2 Motorway integration works and any connection into Council's existing stormwater system needs to be undertaken with a complete understanding of the local flood regime, the receiving stormwater system's capacity and the associated flood hazard and impacts to the local community affected. Flood impacts to the local community as a result of the proposed works should be reduced or at least not exacerbated. Where there will be a negative impact on the performance and capacity of Council's existing stormwater system arising from the project, it must be upgraded by the project.

Response

The proposed Hills M2 Motorway integration works would involve the augmentation of existing drainage infrastructure associated with the motorway. As identified in Section 7.9.3 of the environmental impact statement and based on the concept design, this is expected to include:

- Demolition and reconstruction of pits and pipes.
- Modification to four existing detention basins along the Hills M2 Motorway.
- Extension of five transverse drainage culverts along the Hills M2 Motorway.

Modifications to existing drainage infrastructure have been designed to replicate the current design standards and operational functionality of the Hills M2 Motorway. For example, the detention basins along the Hills M2 Motorway are currently designed and function to capture the first flush from a one year ARI event. Where the project would increase the road surface area draining to a particular basin, the basin would be modified to continue to capture the first flush from a one year ARI event. Despite this, opportunities to design to a higher standard and provide improved environmental outcomes have been incorporated into the design where feasible and reasonable. As such, these works would not worsen the existing flood characteristics of the area.

Relevant local councils would continue to be consulted in relation to the design of stormwater infrastructure and any impacts to Council managed stormwater infrastructure.

The project would also involve the collection, treatment and discharge of groundwater inflow into the tunnel. This operational discharge is proposed to be to Blue Gum Creek or Darling Mills Creek. Section 7.9.3 of the environmental impact statement identifies the potential impact associated with this discharge including the potential for increased erosion and localised flooding.

The exact location of discharge to Blue Gum Creek or Darling Mills Creek would be further investigated during the detailed design phase. Additional mitigation measures such as stream bed and bank stabilisation, or re-sizing of existing drainage infrastructure would be determined at this stage based on the location of discharge. Detailed design of the discharge and identification of an appropriate location for the discharge would take into account potential geomorphic, property and ecological impacts.

7.2.2.6 Other matters

Issue description

Following its lease to Council by Roads and Maritime for construction of a commuter carpark, an alternative site would need to be found for the proposed Windsor Road construction compound (C1).

Response

The project is currently reviewing the need for the proposed Windsor Road construction compound and investigating suitable alternatives in the vicinity of that site. If, during detailed design, a construction compound is determined to be necessary at or around the current location of the Windsor Road construction compound site, further investigations into alternative location(s) would be undertaken and appropriate assessments would be conducted.

Issue description

All relevant emergency services should be consulted on the proposed firefighting, evacuation and rescue arrangements during the detailed design phase of the project.

Response

Fire and Rescue NSW has been consulted during development of the project design conducted to date in order to develop appropriate firefighting, evacuation and rescue design features of the project. This consultation would continue during the development of the detailed design and the development of incident response management plans, and as part of the formal fire engineering brief. All other relevant emergency services would be consulted during the detailed design and construction phases.

Issue description

It is essential that the project delivery incorporates engagement activities that allow the community and other key stakeholders such as the affected councils to be involved in the project's actual delivery. This will help manage the impacts on residents by providing an opportunity for them to influence and feel part of the project. Community liaison or reference groups similar to other recent major infrastructure projects such as the Westlink M7 Motorway, the Hills M2 Motorway Upgrade and North West Rail Link all provide successful models.

Response

Ongoing community and stakeholder consultation during the construction stage of the project is described in Section 6.6.1 of the environmental impact statement. Appendix D of the environmental impact statement also provides a Community Communications Framework which would be developed into a Community Liaison Implementation Plan. This plan would document the proposed methods and consultation tools during the construction stage.

Issue description

At the conclusion of the project, Roads and Maritime should dedicate any existing parcels of land still in its ownership that are located on carriageway and footway areas on Pennant Hills Road around the southern interchange facility, as public road.

Response

On completion of the project, Roads and Maritime would investigate options for the use of residual land. The preference is for the land to be sold for future use in accordance with the relevant existing land use zonings. This would involve consultation with the relevant local council(s).

Issue description

Maintenance of the native vegetation rehabilitation areas should occur for a period of at least five years following construction, to ensure weeds are controlled and native plants are surviving and thriving in these areas.

Response

The project is committed to revegetating or landscaping residual areas on completion of construction. Where this land falls within the motorway corridor, the ongoing maintenance of these areas would continue to be the responsibility of Roads and Maritime or the motorway operator.

Residual land outside the motorway corridor may be sold or handed over to other government bodies such as local councils on completion of the project. In this case, the ongoing responsibility for maintenance of these areas may be transferred to others. Commercial arrangements to ensure the ongoing maintenance of these areas are outside the scope of the environmental impact statement.

Issue description

A detailed economic impact assessment incorporating proposed mitigation measures relating to the Carmen Drive neighbourhood centre during the construction and operational phases of the project should be provided for consideration by Council.'

Response

A business impact assessment was undertaken as part of the environmental impact statement (refer to Appendix K and Section 7.7 of the environmental impact statement).

The business impact assessment identified that the Carmen Drive neighbourhood centre may be impacted through reduced amenity or accessibility during the construction phase. Mitigation measures identified in Section 7.1 (Traffic and transport), Section 7.2 (Noise and vibration) and Section 7.3 (Air quality) of the environmental impact statement would minimise these potential impacts as far as feasible and reasonable.

During operation, potential impacts to these businesses may arise from reduced amenity associated with increased road traffic noise and operational air quality. The air quality assessment determined that the expected pollutant concentrations resulting from the project are low and within applicable ambient air quality criteria. No noise exceedances are predicted from operational ancillary facilities, and feasible and reasonable noise mitigation measures (such as low noise pavement and noise barriers) have been identified and detailed in the environmental impact statement for road traffic noise.

7.2.3 Ku-ring-gai Council

7.2.3.1 Air quality

Issue description

The background air quality has been quantified by adopting either the maximum predicted roadside concentrations from the CAL3QHCR model or from maximum levels recorded by the Office of Environment and Heritage monitoring stations at Prospect and Lindfield. The derived background concentrations were then added to model predictions to determine cumulative impacts. These cumulative predictions were compared to the Environment Protection Authority's air quality assessment criteria.

Five air quality monitoring stations were installed in December 2013 specifically for this project at Headon Sports Park, James Park, Observatory Park, Brickpit Park and Rainbow Farm reserve). Monitored levels from these sites for the period between December 2013 and March 2014 were reported in the environmental impact statement.

A generally conservative approach has been adopted to the quantification of existing air quality. Based on a comparison between the assumed background levels and the measured concentrations at James Park, the assumed background levels are conservative for nitrogen dioxide (NO_2) although potentially underestimated for particulate matter of 10 micrometres or less in diameter (PM_{10}) and particulate matter 2.5 micrometres or less in diameter. ($PM_{2.5}$). The differences between the assumed air quality and the air quality in the vicinity of the northern ventilation outlet, as measured at James Park, are not significant in terms of affecting the conclusions of the assessment.

Response

Ku-ring-gai Council's view that the background air quality data applied to the air quality impact assessment was appropriate is noted.

Further information on the selection of background air quality data used in the air quality impact assessment is provided in **Section 2.11** of this report. This includes a demonstration that air quality data used from the Prospect and Lindfield monitoring stations is comparable to air quality along the project corridor, through direct comparison with data collected from project monitoring stations.

Appendix C of the Technical Working Paper: Air Quality (Appendix G to the environmental impact statement) presents a statistical analysis of background air quality data from the Prospect and Lindfield monitoring stations, against the data collected from the project monitoring stations along the Pennant Hills Road corridor. The statistical analysis demonstrates that data from Prospect and Lindfield is, for most of the time, higher than data collected from the project monitoring stations.

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Issue description

The air quality impact assessment has provided wind roses showing the CALMET simulated wind patterns in the vicinity of the northern ventilation outlet (refer to Appendix F of the Technical Working Paper: Air Quality). From these wind roses, CALMET has simulated that calm conditions occur at this location for around one per cent of the time. At Lindfield, the percentage of calm conditions is 27 per cent. Wind speed is important for determining the amount of dispersion. It is important that the meteorological data are representative of the area around the modelled emission sources.

The comparison of modelled and measured (Lindfield) wind speeds suggests that the CALMET simulation of conditions in the vicinity of the northern ventilation outlet needs further verification. A comparison between the modelled and measured (for example, James Park) wind patterns are required in order to demonstrate that the CALMET output is representative of local conditions.

Response

Further discussion and analysis of CALMET meteorological modelling and local meteorological conditions is provided in **Section 2.10** of this report. This analysis demonstrates that peak ground level impacts from the project would occur during light to moderate wind conditions, and because these conditions are well represented in the air dispersion modelling, the air quality impact assessment is conservative.

Issue description

Council's submission presents an analysis of terrain around the northern ventilation outlet using Shuttle Radar Topography Mission (SRTM) data, and applying terrain resolution assumptions of 50 metres, 150 metres and 250 metres. Comparing the 250 metre resolution, as was applied in the CALMET meteorological modelling for the project, and 'actual terrain' (assuming that the 50 metre resolution is closest to the actual terrain), there are differences in terrain height in the order of five to 10 metres, depending on the location.

The SRTM data has a limitation as the radar imaging technique does not always map the true surface, especially when the ground is covered by dense vegetation.

The differences between modelled and actual terrain need to be explained, in terms of whether the simulated meteorological conditions in the vicinity of the northern ventilation outlet will change because of the data source (SRTM) and selected resolution.

Response

Further discussion and analysis of terrain data and assumptions is provided in **Section 2.12** of this report. As part of this analysis, additional screening level modelling has been conducted using SRTM data at 250 metre resolution, and LiDAR data at one metre resolution. The additional modelling demonstrates that the SRTM data at 250 metre resolution tends to lead to overestimates of ground level impacts relative to the modelling predictions using more accurate LiDAR terrain data.

Section 2.12 of this report also provides further discussion of the application of SRTM data and the conservative assumptions applied to establish terrain inputs used in the air quality impact assessment for the project.

Issue description

Table 18 in the Technical Working Paper: Air Quality shows the estimated in-tunnel pollutant concentrations at one kilometre increments along each tunnel, for peak hours of 9 am and 6 pm. From the provided data, it appears that the assumed pollutant concentrations of the incoming air are zero. The southern portal of the northbound tunnel is located in the vicinity of Pennant Hills Road and the Hills M2 Motorway interchange where CO, NO_2 and PM_{10} concentrations will not be zero but generally higher than at ambient monitoring stations. The Permanent International Association of Road Congresses (2012) recommends the concentrations in the ambient air supplied to the tunnel be considered for emission calculations and ventilation requirements.

Concentrations of pollutants in the in-coming air should be estimated and included in the emission calculations, with ventilation outlet emission estimates updated as appropriate. Additional information is required to demonstrate that the northern ventilation outlet emissions and resultant concentrations in the vicinity of the northern ventilation outlet are not underestimated because of the assumed concentrations in the intake air.

Response

Further discussion and analysis of pollutant loads drawn into the project tunnels through entry portals is provided in **Section 2.8.2** of this report. This analysis includes additional screening level modelling which demonstrates that this additional pollutant load would not significantly affected modelled ambient air quality outcomes.

Issue description

From Table 18 of the Technical Working Paper: Air Quality, the estimated in-tunnel pollutant concentrations in the northbound main alignment tunnel at 6 pm by 2019, are up to 6.26 mg/m^3, 0.86 mg/m^3 and 0.504 mg/m^3 for CO, NO_2 and PM_{10} respectively.

In-tunnel monitoring for the Lane Cove Tunnel (see for example Ecotech April 2014 report from http://www.lanecovemotorways.com.au) shows 30 minute average CO concentrations up to around 25 mg/m^3 during peak hours. Online in-tunnel 15 minute average, CO concentration data for the Brisbane Airport Link tunnel (6.7 kilometres long and in the order of 50,000 vehicles per day) are typically 20 to 30 mg/m^3. These measurements are higher than the 6.26 mg/m^3 estimated for the NorthConnex project.

The difference between the estimated in-tunnel concentrations for the NorthConnex project and measured concentrations from other tunnels should be explained, with consideration of differences between traffic volumes, ventilation flow rates and tunnel lengths to make sure modelled emissions for NorthConnex have not been under-estimated.

Response

Concentrations of carbon monoxide in the project's main alignment tunnels have been calculated based on emission factors published by the Permanent International Association of Road Congresses (2012) and taking into account designed ventilation rates for the project as a function of traffic volumes and in-tunnel air quality. Further discussion of the approach to calculating in-tunnel air quality and the emissions inventory for discharges from the project's ventilation outlets is provided in **Section 2.8** of this report.

While it is beyond the scope for the NorthConnex project environmental impact statement, or this report, to conduct a detailed analysis of the in-tunnel air quality performance of other road tunnels, it is important to recognise that the NorthConnex tunnels, the Lane Cove Tunnel and the Brisbane Airport Link tunnels are fundamentally different. Relevantly, several of the factors that have a significant influence over in-tunnel air quality are significantly different across these road tunnels, including:

- **Tunnel length (and tunnel gradient)**. The NorthConnex project main alignment tunnels would be around nine kilometres long. In comparison:
  - The Lane Cove Tunnel is around 3.6 kilometres long.
  - The Brisbane Airport Link tunnels are around 5.7 kilometres long (note that the link itself is around 6.7 kilometres long, with 5.7 kilometres in tunnel).
- **Vehicle patronage**. In 2019, the NorthConnex project is forecast to carry around 30,000 vehicles per day (around 15,000 vehicles per day in each direction), with peak hour traffic in each main alignment tunnel around 1,200 to 1,300 vehicles in the relevant peak hour. In comparison:
  - In September 2014, the Lane Cove Tunnel was recorded carrying around 70,000 to 75,000 vehicles per day (around 30,000 to 35,000 vehicles in the eastbound tunnel and around 35,000 to 40,000 in the westbound tunnel). Peak hour traffic numbers in the Lane Cove Tunnel were up to three times the forecast peak hour traffic volumes for the NorthConnex project, at around 3,200 to 3,600 vehicles (September 2014).
  - The Brisbane Airport Link tunnels are reported to currently carry around 50,000 vehicles per day (which is assumed to be divided between the two tunnels at around 25,000 vehicles per day in each direction). While there is no publicly available information on hourly traffic volumes, assuming a similar diurnal pattern to the NorthConnex project and the Lane Cove Tunnel, peak hour traffic volumes could be expected to be around 10 per cent of total daily traffic (ie around 2,500 vehicles in the peak hours).
- **Vehicle (fuel) fleet mix**. In 2019, the NorthConnex project is forecast to carry around 28 per cent of all traffic as heavy vehicles. In comparison:
  - The Lane Cove Tunnel carries around three to five per cent of all traffic as heavy vehicles.
  - There is limited information about the vehicle mix currently using the Brisbane Airport Link tunnels. However, given the nature of the tunnels, their location in the road network and land use patterns, it is expected that heavy vehicle percentages would lie between those for the Lane Cove Tunnel and the NorthConnex project (and more likely closer to the Lane Cove Tunnel figure, noting that heavy vehicles associated with the operation of the Port of Brisbane are more likely to use the Gateway Motorway than to travel through Brisbane via the Clem 7 Motorway and Brisbane Airport Link).
- **Ventilation design and operation**. The NorthConnex project has been designed to operate with ventilation flow rates from 300 m^3/s to 700 m^3/s in each main alignment tunnel. In comparison:
  - The Lane Cove Tunnel has a much broader range of potential operating ventilation flow rates than the NorthConnex project (between 200 m^3/s and 1,350 m^3/s westbound, and 185 m^3/s to 900 m^3/s eastbound). However, it typically operates with ventilation flow rates around 400 m^3, rising to around 540 m^3/s in the morning peak hour.

- There is limited information on how the ventilation system for the Brisbane Airport Link tunnels is currently operated. However, it is noted that the original air quality impact assessment for the project (Holmes Air Sciences, 2008) contemplated ventilation flow rates at the different project ventilation outlets from around 200 m^3/s to around 1,050 m^3/s.

Of the factors above, it is relevant to note that differences in tunnel length and vehicles numbers are likely to offset each other, such that all three tunnels are comparable based on these factors. The Lane Cove Tunnel, for example, is around 40 per cent of the length of the NorthConnex project but carries around 2.5 to three times the peak hour traffic volumes. The Brisbane Airport Link tunnels are around 60 per cent of the length of the NorthConnex project but are anticipated to carry around two times the peak hour traffic volumes.

Part of the difference in in-tunnel CO concentrations is likely to be attributable to ventilation flow rates. In the case of the Lane Cove Tunnel, for example, ventilation flow rates are around 20 per cent lower in the peak hour than anticipated for the NorthConnex project.

The rest of the explanation for differences in in-tunnel CO concentrations between these roads can be seen by comparing other in-tunnel pollutants:

- The peak hour concentration of CO in the NorthConnex project (6.26 mg/m^3, northbound, 2019) is significantly lower than CO recorded in the Brisbane Airport Link tunnels (reported as 20 to 30 mg/m^3).
- The peak hour concentration of NO_2 in the NorthConnex project (0.860 mg/m^3, northbound, 2019) is significantly higher than NO_2 recorded in the Brisbane Airport Link tunnels (reported on-line as up to 0.06 ppm in peak hours, which is equivalent to 0.113 mg/m^3).

The comparison of CO and NO_2 concentrations is relevant because fuel type (petrol/ diesel) has a significant effect on emissions of both of these compounds:

- Petrol fuelled vehicles emit higher levels of CO than diesel fuelled vehicles.
- Petrol fuelled vehicles emit lower levels of NO_2 than diesel fuelled vehicles.

The significantly higher proportion of heavy vehicles (diesel fuelled) using the NorthConnex project is likely to be a key contributor to both higher NO_2 and lower CO concentrations when compared with the Lane Cove Tunnel and the Brisbane Airport link.

Issue description

The emission calculations are based on an average heavy goods vehicle (HGV) mass of 23 tonnes (a typical fleet consisting of single lorries, trailer trucks and coaches). Traffic forecasts for the NorthConnex project indicate that the proportion of HGVs will range from 28 to 28.5 per cent northbound by 2019, which means total emissions from the tunnel will be sensitive to the HGV mass assumptions. The air quality assessment has not discussed the variation in different sized HGVs. The emissions are strongly related to the total vehicle mass and different vehicle masses may need to be considered by using the Permanent International Association of Road Congresses vehicle mass factors.

The air quality assessment should document the variation in different sized HGVs (single lorries, trailer trucks and coaches) to support the use of the average HGV mass of 23 tonnes.

Response

The vehicle fleet composition applied to the calculation and assessment of in-tunnel air quality and potential ambient air quality impacts has been taken from the Australian Bureau of Statistics – Motor Vehicle Census (31 January 2013). Further discussion about vehicle fleet and fuel mix assumptions is provided in **Section 2.8** of this report.

Issue description

In-tunnel vehicle speed data for each hour of the day, and assumptions on congestion during peak hours, are not documented in the air quality assessment. These assumptions are important for the emission calculations.

This data should be documented in order to verify the northern ventilation outlet emissions and resultant concentrations in the vicinity of the northern ventilation outlet are not underestimated.

Response

Unless otherwise expressly stated (such as in the case of a breakdown incident), the environmental impact statement assesses the potential impacts of the project based on how it has been designed to operate for majority of the time. The project has been designed to operate with average traffic speeds around 80 km/h.

The project has been designed to provide free flowing motorway standard traffic conditions under forecast traffic volumes at an average traffic speed of 80 km/h. Reductions in traffic performance (ie congested traffic conditions including reduce average traffic speeds) would be encountered if:

- Actual traffic volumes approach or exceed the design capacity of the main alignment tunnels, being 4,000 passenger car units per hour (two lane operation). This is equivalent to 'design analysis A' considered as part of the air quality impact assessment, and as outlined above, is considered unlikely to eventuate in the foreseeable future based on current traffic forecasts. In the event that additional capacity is required in the future, the project has been designed to enable marking of a third traffic lane in each direction. If this additional capacity is required in the future to maintain free flowing traffic conditions, further environmental impact assessments would be conducted as required under the *Environmental Planning and Assessment Act 1979*.
- There is a breakdown or other incident within the project tunnels. The project has been designed to mitigate the potential impacts of such an event, through provision of a dedicated breakdown lane and monitoring of in-tunnel traffic conditions. Management measures would be developed and implemented to manage breakdowns and other incidents, and to ensure that free flowing traffic conditions are restored as quickly as possible.

The likelihood of either of these scenarios eventuating is low. Neither is expected to occur, or to occur at sufficiently high frequency to be characteristic of typical tunnel operating conditions. The potential for the project tunnels to operate below average traffic speeds of 80 km/h in the majority of cases is very low – the project has been specifically designed to avoid operational conditions other than free flowing motorway standard traffic conditions with average traffic speeds around 80 km/h. Low traffic speeds, congested traffic conditions resulting from a breakdown or other incident in the project tunnels have been assessed as part of the breakdown scenario in the air quality impact assessment presented in the environmental impact statement.

Issue description

Peak hour (6 pm) emissions from the northern ventilation outlet for 'design analysis A' (2019) are estimated to be 7.31 g/s, 10.9 g/s and 0.67 g/s for CO, total NO and PM_{10} respectively (refer to Appendix H of the Technical Working Paper: Air Quality).

Based on a flow rate of 700 m^3/s, these mass emission rates correspond to concentrations of 10 mg/m^3, 16 mg/m^3 and 1 mg/m^3 for CO, total NO_x and PM_{10} respectively. The same calculations have been conducted for 'design analysis B'. The estimated concentrations are shown in the table below, and compared to data and limits from the Lane Cove Tunnel and Brisbane Airport Link Tunnel. The calculations show the modelled in-tunnel concentrations for the NorthConnex project are lower than typical maximum measured concentrations from the Lane Cove Tunnel and Brisbane Airport Link Tunnel.

It is recommended the Department of Planning and Environment consider the predicted ambient concentrations in light of the modelled source concentrations, if concentration limits are to be set.

Table 7-30 Ku-ring-gai Council comparison of in-tunnel concentration limits

Pollutant	NorthConnex project estimated concentrations, (northbound, 2019, 6 pm, hourly, mg/m^3)		Typical maximum measured concentrations (mg/m^3)		Concentration limits (mg/m^3)	
	Design analysis A	Design analysis B	Lane Cove Tunnel (30 min)	Airport Link (15 min)	Lane Cove Tunnel	Airport Link tunnel
CO	10	6	~25	20-30	62.5 (50 ppm)	87 (70 ppm)
NO_x	16	8	N/A	N/A	32.8 (in-stack)	20 (1 ppm NO_2, 10% NO_x is NO_2)
PM_{10}	1	0.4	N/A	N/A	1.6 (in-stack)	None (0.005 m^{-1} visibility)

Response

Should the Department of Planning and Environment consider it appropriate to recommend that the Minister for Planning apply conditions of approval including ambient and/ or in-tunnel air quality criteria, such criteria should be based on the protection of human health, the environment and amenity. Any such criteria should also take into account feasible and reasonable measures available to mitigate potential impacts.

Ambient and/ or in-tunnel air quality criteria should be project specific, and should not be based on the current performance of other road tunnels or the performance criteria that may be applied to them.

Issue description

CAL3QHR has been used to model emissions from surface roads and CALPUFF to model emissions from ventilation outlets. CALPUFF is a model which is listed by the Environment Protection Authority as an approved model for these types of assessments. CAL3QHCR is not listed by the Environment Protection Authority in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC, 2005) but is listed by the US Environmental Protection Agency as a recommended model for simulating air quality in the vicinity of roadways.

Response

The CAL3QHCR model has been accepted by the Environment Protection Authority for use in the assessment of the NorthConnex project.

Issue description

The air quality assessment has used CALPUFF to predict ambient pollutant concentrations across an area of approximately 15 kilometres by 10 kilometres.

In the vicinity of the ventilation outlets, predictions have been made at discrete receiver locations with a grid resolution of 150 metres, up to 2.5 kilometres from each ventilation outlet. Additional receiver locations have been added along the project corridor, spaced at 10 metres, 35 metres, 60 metres, 105 metres, 160 metres and 225 metres from the road centreline.

Based on a review of the density and distribution of receiver locations, there may be areas of very little receiver coverage in the air dispersion model. This means that maximum ground level concentrations, due to emissions from the 15 metre high ventilation outlet, may not be identified by the air dispersion model.

The proponent should demonstrate maximum ground level concentrations have not been under-estimated because of the selected receptor resolution around the ventilation outlets.

Response

For the purpose of the air dispersion modelling, relevant receivers were indicative locations rather than specific individual premises, were determined through the use of variable grid sizes depending on distance from a project ventilation outlet or a major road (Pennant Hills Road, the Hills M2 Motorway or the M1 Pacific Motorway).

As indicated in Section 4.2.6 of the environmental impact statement, a high density receiver grid of 150 metre spacing was applied to a five kilometre by five kilometre area around each of the project ventilation outlets. Outside this area (more than 2.5 kilometres from each ventilation outlet) a receiver grid with 300 metre spacing was applied.

For receivers along major road corridors, receiver locations were spaced at 10 metres, 35 metres, 105 metres, 160 metres and 225 metres from the road centreline.

In total, 6,919 receiver locations were considered in the air quality impact assessment. Figure 8 in the Technical Working Paper: Air Quality (Appendix G to the environmental impact statement) shows the receiver locations considered in the assessment.

The resolution of the receiver grids applied as part of the air quality impact was developed having regard to the guidance document Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia (OEH, 2011). One of the authors of that document, who is an internationally-recognised meteorological and air dispersion modelling specialist, peer reviewed and endorsed the CALMET and CALPUFF parameters used in the air quality assessment for the project. This included the receiver grid resolution.

As noted in Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia (OEH, 2011), the best receiver grid spacing for each modelling project is dependent on the size of the modelling domain and the complexity of the terrain within the domain. The guidance document states that typical CALMET applications should include between 100 and 300 grid cells in both the x and y directions (OEH, 2011, page 18). Furthermore, it states that near-field applications may require modelling grid spacings of about 250 metres, while grid spacings of 150 metres may be required to resolve dominant terrain features (OEH, 2011, page 18).

Modelling domains and receiver grid resolutions for the air quality impact assessment have been developed consistent with the direction provided in the abovementioned guidance document. The CALMET meteorological modelling domain had 240 by 250 cells with a 250 metre spacing, while the CALPUFF air dispersion modelling domain had a grid spacing of 150 metres around the ventilation outlets to accommodate near-field effects. The terrain around the ventilation outlets is undulating, but was not considered to be complex with dominant terrain features. Based on advice provided in the guidance document (OEH, 2011), the project location and the project scale, the meteorological and air dispersion modelling grids were considered appropriate.

In addition the base receiver grids applied to the air quality impact assessment, a further 60 receiver locations were included in the air quality modelling. These receiver locations were health sensitive sites, including schools, hospitals, aged care and nursery care centres. Air quality modelling outcomes for these 60 locations were used to inform specific health risk assessments for those locations as part of the broader human health risk assessment presented in Section 7.4 and Appendix H of the environmental impact statement.

Although a 150 metre grid spacing around the project ventilation outlets is considered to be appropriate, a further screening level analysis has been conducted to demonstrate the potential effect of a reduced grid spacing. The screening level assessment has been based on:

- A 150 metre and a 25 metre receiver grid around the northern ventilation outlet.
- Forecast traffic flows in 2019.
- One year of meteorological data.
- Annual and 24 hour average $PM_{2.5}$ concentrations.

Section 2.13.1 summarises the outcomes of the screening level assessment. It presents the maximum value modelled in the domain around the northern ventilation outlet, as well as the average value across the modelling domain. The table shows that:

- On average across the modelling domain around the northern ventilation outlet, a 25 metre grid spacing produces a slightly higher 24 hour average and annual average value $PM_{2.5}$ concentration. However, the increase in the average value across the modelling domain is less than 0.5% of the advisory reporting standard in both cases.
- The peak 24 hour average and annual average $PM_{2.5}$ concentrations are both higher with a 150 metre grid spacing than with the application of a 25 metre spacing. In the case of the 24 hour average, the relative difference is two percent of the advisory reporting standard. The difference in the annual average is less, at only 0.13%.

This demonstrates that the difference in the modelling domain grid spacing has a negligible impact on predicted ground level concentrations, on average. However, the use of a 150 metre grid spacing in the air quality impact assessment for the project is likely to have led to an overestimation of impacts at the most affected receiver location. This overestimation is negligible in the case of the annual average $PM_{2.5}$ concentration, but up to two percent of the advisory reporting standard for the 24 hour average. This supports the conclusion that a 150 metre grid spacing is appropriate, and may in fact be conservative for shorter duration averaging periods.

Issue description

The Environment Protection Authority's air quality impact assessment criteria apply to existing or likely future off-site sensitive receivers. The air quality impact assessment provides model predictions for ground level locations but does not comment on likely future sensitive receivers or elevated locations.

A multi (five) storey residential development is proposed for 11-21 Woniora Avenue, approximately 200 metres to the south of the proposed northern ventilation outlet. No predictions of concentrations at elevated locations are available in order to check that compliance with air quality criteria can be achieved at this proposed development (for example, at 15 metres above ground level).

The air quality impact assessment should demonstrate air quality criteria will not be exceeded at elevated sensitive receiver locations, such as at the proposed multi (five) storey residential development proposed at 11-21 Woniora Avenue.

Response

It is understood that the proposed development referred to in Council's submission relates to development consent DA0951/10. Council granted deferred commencement consent to the development application on 10 November 2011. It is unclear whether the deferred commencement provisions of the development consent have been met, and whether the development authorised by the development consent has lawfully commenced.

From the plans provided with the development application available through Council's on-line development application tracking system, it appears that the proposed development would include:

- Two residential apartment towers with four habitable storeys. The height of the fourth storey ceiling is recorded at 13.4 metres.
- The two residential apartment towers would have a total height of five storeys, although it appears from available plans that the fifth storey is not habitable and is occupied by building services.

Given the proposed elevation of this development, it is relevant to consider the potential for air quality impacts on receivers above ground level.

It is also relevant to consider whether environmental planning instruments would authorise other developments in the area around the northern ventilation outlet with elevated receivers:

- Under the current *Hornsby Local Environmental Plan 2013*:

- Properties in Waitara to the south of the Pacific Highway have height limits of 10.5 metres and 12.0 metres. These properties are around 600 metres to 1,000 metres from the northern ventilation outlet and are beyond the extent of measurable air quality effects (refer to the isopleths presented in Figure 11 to Figure 34 in the Technical Working Paper: Air Quality (Appendix G to the environmental impact statement)).
- Properties in Waitara to the north of the Pacific Highway have height limits from 10 metres up to 38.5 metres in central Waitara. These properties are around 600 metres to 1,300 metres from the northern ventilation outlet and are beyond the extent of measurable air quality effects (refer to the isopleths presented in Figure 11 to Figure 34 in the Technical Working Paper: Air Quality (Appendix G to the environmental impact statement)).
- Properties in Hornsby have height limits from 10 metres up to 48 metres in central Hornsby. These properties are more than 1,000 metres from the northern ventilation outlet and are beyond the extent of measurable air quality effects (refer to the isopleths presented in Figure 11 to Figure 34 in the Technical Working Paper: Air Quality (Appendix G to the environmental impact statement)).
- Most other properties, including those through Wahroonga in proximity to the northern ventilation outlet, have a height limit of 8.5 metres.

- Under the current *Ku-Ring-Gai Planning Scheme Ordinance*, residential dwelling houses and dual occupancies are limited to eight metres in height (clause 46(2)). This includes properties in proximity to the southern ventilation outlet. Multi-unit housing is limited in height based on the size of the particular lot (clause 25I(5)):
  - Three storeys for properties less than 1,800 m^2.
  - Four storeys for properties between 1,800 m^2 and 2,400 m^2.
  - Five storeys for properties in excess of 2,400 m^2.

- Under the *draft Ku-Ring-Gai Local Environmental Plan 2013*:
  - Properties along Woniora Avenue, Woonona Avenue and Neringah Avenue are proposed to have a maximum height limit of 17.5 metres. The properties are around 200 to 400 metres from the northern ventilation outlet and could be expected to lie within, or in proximity to, areas affected by peak air quality impacts from the project.
  - Various properties along the western edge of the local government area, south of the North Shore Railway Line, are proposed to have maximum height limits of 11.5 metres or 17.5 metres. These properties are around 600 metres to 800 metres from the northern ventilation outlet, within an area likely to experience measurable impacts from the project, but outside areas of peak impacts.
  - Most other properties in the Ku-ring-gai local government area in proximity to the northern ventilation outlet, are proposed to be restricted to a maximum height limit of 9.5 metres.

A screening level air quality assessment has been conducted around the northern ventilation outlet to determine how elevated receivers may be affected by air quality impacts compared with predicted ground level concentrations. For the purpose of the screening level assessment:

- Peak (24 hour average) $PM_{2.5}$ concentrations have been considered.
- Forecast traffic volumes in 2029 have been assumed.
- A hypothetical receiver located at the most affected location around the northern ventilation outlet has been assessed, at elevations in two metres increments above ground level up to a maximum receiver height of 20 metres.
- A single year of meteorological data has been used for the purpose of comparison.

Table 7-31 summarises the outcomes of the screening level assessment, and shows that:

- At the most affected receiver location around the northern ventilation outlet, the maximum 24 hour $PM_{2.5}$ concentration varies relatively little up to an elevation of around 12 metres to 14 metres above ground level (around four storeys). At this height, increases in $PM_{2.5}$ concentrations would be up to around double the concentrations expected to be experienced at ground level. However, relative to the advisory reporting standard of 25 $\mu g/m^3$ would remain low (generally less than 10 per cent).
- At elevations of more than 12 metres to 14 metres, relative increases in the maximum 24 hour average $PM_{2.5}$ concentrations have roughly tripled by 16 metres and almost quadrupled by around 20 metres. As a percentage of the advisory reporting standard, concentrations at these elevations still remain relatively low at up to around 20 per cent.

Other air emissions are expected to show similar relative increases in maximum concentrations as a function of receiver elevation.

For most development around the northern ventilation outlet, which is limited to 9.5 metres in height, maximum air quality impacts would be around 10 to 30 per cent above ground level concentrations, and less than seven per cent of the advisory reporting standard (in the case of $PM_{2.5}$ 24 hour average).

Developments around Woniora Avenue, Woonona Avenue and Neringah Avenue, which may be up to 17 metres in height, may experience air quality impacts up to three to four times those at ground level. These are, however, worst case maximums at the most affected receiver location, and incremental increases above ground level concentrations would be lower for other locations around the northern ventilation outlet.

Table 7-31 Potential air quality impacts as a function of receiver elevation

Receiver elevation (m)	Prediction $PM_{2.5}$ concentration (24 hour average) ($\mu g/m^3$)	Predicted concentration (% increase above ground level)	Predicted concentration (% of advisory reporting standard)
Ground level	1.21 $\mu g/m^3$	0%	4.8%
+2 metres	1.23 $\mu g/m^3$	+1.7%	4.9%
+4 metres	1.29 $\mu g/m^3$	+6.6%	5.2%
+6 metres	1.31 $\mu g/m^3$	+8.3%	5.2%
+8 metres	1.35 $\mu g/m^3$	+11.6%	5.4%
+10 metres	1.60 $\mu g/m^3$	+32.2%	6.4%
+12 metres	2.09 $\mu g/m^3$	+72.7%	8.4%
+14 metres	2.70 $\mu g/m^3$	+123.1%	10.8%
+16 metres	3.44 $\mu g/m^3$	+184.3%	13.8%
+18 metres	4.31 $\mu g/m^3$	+256.2%	17.2%
+20 metres	5.32 $\mu g/m^3$	+339.7%	21.3%

Note: the predicted concentrations presented in this table are based on a 15 metre ventilation outlet height. With the increase in ventilation outlet heights to 20 metres, the predicted concentrations will decrease. As such, this table presents a conservative overestimate of potential air quality impacts for elevate receivers and a 20 metre ventilation outlet.

Potential issues associated with elevated receivers are fewer around the southern ventilation outlet because:

- Under the current *Hornsby Local Environmental Plan 2013*:
  - Most properties around the southern ventilation outlet are limited in height to 8.5 metres (typically two storeys plus a roof structure).
  - Properties with greater height limits lie beyond the measurable effects of the southern ventilation outlet and include land on the corner of Pennant Hills Road and Castle Hill Road (17.5 metres), land adjacent to Observatory Park (10.5 metres) and land at Beecroft, between Beecroft Road and the Main Northern Railway Line (17.5 metres).

- Under the current *The Hills Local Environmental Plan 2012*:
  - Most properties around the southern ventilation outlet are limited in height to 8.5 metres (typically two storeys plus a roof structure).
  - The closest land with a greater height limit is on Coonara Avenue (the IBM Australia Pty Ltd site) at up to 22.0 metres. This land lies beyond the measurable effects of the southern ventilation outlet.

Issue description

The air quality assessment has referenced the air quality impact assessment criteria from the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005). In the absence of air quality impact assessment criteria for $PM_{2.5}$, the $PM_{2.5}$ advisory reporting standards from the National Environment Protection Measure have been adopted. The adopted criteria are appropriate.

Response

Council's recognition of the appropriateness of the air quality assessment criteria applied to project is noted.

Issue description

In terms of construction impacts, the Director General's environmental assessment requirements state:

> *"The assessment should provide an assessment of risk associated with potential discharges of fugitive and point source emissions, and include: details of the proposed methods to minimise adverse impacts on air quality during construction, particularly in relation to mobile plant…".*

Section 5 and Section 7.1 of the Technical Working Paper: Air Quality (Appendix G to the environmental impact statement) have addressed the Director-General's environmental assessment requirements in relation to construction air quality.

Response

Council's recognition that the Director-General's environmental assessment requirements relating to construction air quality impact have been met is noted.

Issue description

Council has considered the potential air quality impacts associated with two alternatives, being:

- Moving the northern ventilation outlet to the industrial area around 1.6 kilometres to the north of its current location.
- Moving the northern main alignment tunnel portals and the northern ventilation outlet around one kilometre north, and adjusting the grade of the main alignment tunnel exits from four per cent to zero per cent.

Council's analysis suggests that:

- The environmental impact statement concluded the project would not cause any greater impact relative to ambient air quality criteria. It is likely that moving the northern ventilation outlet to the industrial area can also demonstrate this outcome, however the level of compliance with air quality criteria would need to be confirmed by site-specific dispersion modelling or similar assessment technique.
- The likely net change in air quality cannot be quantified without detailed modelling but, in a general sense, emissions from motor vehicles using surface roads would continue to be the more significant factor for determining ambient air quality.
- The mass emission rates from the longer tunnel, even the zero per cent grade are likely to be higher.

These findings and the level of compliance with air quality criteria would need to be confirmed by site specific dispersion modelling or similar assessment technique.

Response

Council's suggested alternatives are generally consistent with:

- The scenario of moving just the northern ventilation outlet to the Asquith Industrial Estate. This scenario is considered in **Section 3.2** of this report.
- The scenario of extending the main alignment tunnels and relocating the northern portals and northern ventilation outlets, the Equilibria proposal. The Equilibria proposal is considered in **Section 8.2.1** of this report.

Section 3.2 of this report demonstrates that the relocation of the northern ventilation outlet would lead to a slight increase in maximum air quality impacts, and no appreciable change in air quality impacts for residential receivers. It would require complex and costly engineering, which would introduce additional environmental and land use impacts, particularly associated with constructing a ventilation connection from the main alignment tunnels to the relocated ventilation outlet. On balance, this option would not provide superior outcomes to the project design presented in the environmental impact statement.

Section 8.2.1 of this report demonstrates that the Equilibria proposal would introduce significant additional capital and operating costs, for no significant change in air quality performance of the project. The Equilibria proposal would also lead to less than optimal road network outcomes and traffic performance would be lower than for the project design presented in the environmental impact statement. Given the lengthened tunnel, it is likely that a third ventilation outlet and a third emergency smoke extraction facility would be required, which would increase environmental and land use impacts. On balance, this option would not provide superior outcomes to the project design presented in the environmental impact statement.

7.2.3.2 Construction compounds

Issue description

The northern interchange construction compound (C9) is expected to operate 24 hours per day, seven days per week. This would include the use of equipment. Access to/ from the site by heavy vehicles is expected during all hours. Activities at the construction compound can be expected to result in constant significant impacts on hundreds of nearby residents, some whose houses border the proposed compound. Impacts are expected to include noise from a range of sources as well as fumes and dust.

Response

Section 7.2 and Section 7.3 of the environmental impact statement present assessments of the potential impacts of the northern construction compound in terms of noise and air quality, respectively.

In relation to construction noise, the assessment identified that there would be a number of properties where applicable noise management levels would be exceeded during the daytime and the night-time periods, despite the provision of mitigation measures including acoustic sheds. Consistent with the requirements of the Interim Construction Noise Guideline (DEC, 2009), all feasible and reasonable noise mitigation and management measures would be applied to minimise and manage construction noise from the northern

interchange construction compound. These measures are discussed in more detail in **Section 4.5** of this report.

Based on concerns raised in public submissions and through other community and stakeholder engagement mechanisms (refer to **Chapter 5** of this report), construction traffic access routes to the northern interchange compound have been reviewed. The review has focused on opportunities to avoid construction traffic amenity impacts on local streets and for surrounding residential receivers. Further information on the review of construction traffic access arrangements and changes made to construction traffic haulage routes is provided in **Section 9.4** of this report.

In relation to construction air quality impacts, the environmental impact statement presents a qualitative assessment of these potential impacts. The use of construction equipment and heavy vehicles to deliver and remove material from the construction sites would generate exhaust emissions. These are anticipated to be relatively minor in comparison to the vehicle emissions from the surrounding road network. Additionally, plant and equipment used during construction would comply with the emissions concentration limits outlined in the *Protection of the Environment Operations (Clean Air) Regulation 2010*.

The potential for dust generation would be managed through mitigation measures identified in Table 7-104 of the environmental impact statement. At the northern interchange construction compound, this would include undertaking spoil handling mainly within the acoustic shed, water spraying of unsealed areas, wetting down of dusty activities, covering loads of spoil removal trucks and progressive stabilisation works.

Issue description

Access to the northern interchange construction compound (C9) by heavy vehicles, will in effect, be left in/ left out from the M1 Motorway. This means heavy vehicles with the compound as their destination, will have to access the M1 Motorway from further north, at either Ku-ring-gai Chase Road at Asquith, or further north, at Berowra. It is requested access to the compound for heavy vehicles be restricted to/ from the M1 Motorway only, as shown in the proposal, with no access to the site from any Council controlled roads, including Eastbourne Avenue and Lucinda Avenue.

Response

Access to and from the northern interchange construction compound (C9) is proposed to be directly to and from the M1 Pacific Motorway. Based on concerns raised in public submissions and through other community and stakeholder engagement mechanisms (refer to **Chapter 5** of this report), access arrangements to several construction compounds have been reviewed. This includes consideration of access and egress arrangements at the northern interchange construction compound. Changes made to access arrangements at the northern interchange compound are detailed and assessed in **Section 9.4** of this report.

Heavy vehicle use of local roads to and from the northern interchange construction compound would be required for site establishment and site demobilisation as some of these activities cannot be safely undertaken from the M1 Pacific Motorway. These requirements are outlined in Table 7-15 of the environmental impact statement.

Issue description

It is estimated that 1,140 heavy vehicle movements per day are expected to/ from the northern interchange compound, all directly to/ from the M1 Pacific Motorway. If excavated material is taken to either Hornsby Quarry, or to the Central Coast, as proposed, there would be no need for heavy vehicles to use Pacific Highway, south of Pearces Corner and, in fact, movement should be banned.

Response

Access to and from the northern interchange construction compound (C9) is proposed to be directly to and from the M1 Pacific Motorway. Based on concerns raised in public submissions and through other community and stakeholder engagement mechanisms (refer to **Chapter 5** of this report), access arrangements to several construction compounds have been reviewed. This includes consideration of access and egress arrangements at the northern interchange construction compound. Changes made to access arrangements at the northern interchange compound are detailed and assessed in **Section 9.4** of this report.

None of the proposed vehicle movements involve the use of the Pacific Highway south of Pearces Corner.

Issue description

Details of types of heavy vehicles to be used on the project are not provided, but vehicles are likely to include a large fleet of large tippers with dog trailers, each truck having an aggregate mass exceeding 42 tonnes.

It is noted that an enforceable three tonne gross mass limit is applicable to traffic on Fox Valley Road, between Pacific Highway and The Comenarra Parkway, Wahroonga.

Response

Heavy vehicle use of local roads to and from the northern interchange construction compound (C9) would be required for site establishment and site demobilisation as some of these activities cannot be safely undertaken from the M1 Pacific Motorway. These requirements are outlined in Table 7-15 of the environmental impact statement.

It is also noted that load limits on local roads do not apply if the vehicle has a genuine destination along those road, and there is no other alternative access.

Issue description

Light vehicles are to gain access to the northern interchange compound directly off Eastbourne Avenue and other local streets, including Lucinda Avenue, within the Ku-ring-gai local government area. Eastbourne Avenue and Lucinda Avenue have steep grades, of up to 20%. This means that those streets and their residents would be impacted by noise at all times of the day and night by the approximate additional 200 vehicle movements expected to/ from the construction compound.

Direct access to the site to /from the M1 Pacific Motorway, for light vehicles only is suggested. This would minimise impacts on local residential streets, particularly during night hours.

It is not clear whether the access road for light vehicles, from Eastbourne Avenue to the construction compound, would be sealed and/ or if it would provide for two way traffic movements. Details of the arrangements for traffic movement at Eastbourne Avenue are required. Due to the number of traffic movements and proximity to houses, it is considered

the access road should be two lanes in width (minimum of 7.5 metres) and be sealed to minimise dust generation. To minimise noise, the access road off Eastbourne Avenue should not be used between the hours of 8.00 pm and 7.00 am daily. A suitable intersection arrangement would need to be provided at Eastbourne Avenue to ensure traffic on Eastbourne Avenue is not disrupted by construction vehicles and safety is not compromised.

Traffic movements onto/ off the access road to the northern compound will be hazardous, because of a pronounced crest in Eastbourne Avenue, approximately 50 metres east of the access road. Some motorists speed on Eastbourne Avenue and such vehicles could come into conflict with slow travelling, entering/ exiting vehicles to/ from the compound site.

Response

The 100 light vehicles anticipated to access and egress the northern interchange construction compound (C9) on a daily basis would be spread throughout the day and night time periods. As such, the potential noise impacts from these light vehicles are anticipated to be insignificant.

Direct access for light vehicles to the construction compound to and from the M1 Pacific Motorway is not a desirable outcome in terms of construction safety. The initial aim of construction site access is to physically separate heavy vehicles and light vehicles.

The light vehicle access road from Eastbourne Avenue to the northern interchange construction compound would be wide enough for one-way traffic in order to limit the amount of vegetation clearing and potential impacts to the Blue Gum High Forest Endangered Ecological Community identified on the site. At this stage it is not planned to seal the access road. The generation of dust would be managed through the use of water carts and restrictions on speed limits.

It is acknowledged that the access and egress point to and from the construction compound would introduce an interface between construction traffic, local traffic, pedestrians and potentially cyclists. Site specific traffic management plans and traffic controls plans would be developed in order to effectively manage this interface. This may include measures such as temporary diversions for pedestrians and cyclists, and traffic controllers at access/ egress points.

Issue description

A road dilapidation report is requested for Eastbourne Avenue, Fox Valley Road and Junction Road, if these roads are used. This to ensure that any damage to Council's roads used by construction traffic for the NorthConnex project, during the life of the project, are identified and repaired to Council's satisfaction.

Response

Road condition surveys would be undertaken on all local roads proposed to be used during construction of the project (ie from the construction site access points to the arterial road network). Any damage to these roads caused during construction of the project, would be rectified at no cost to the relevant local council(s).

Issue description

It is expected any temporary works, including the northern interchange construction compound (C9) and all access roads would be removed at the end of the project. This would include, in consultation with Council, any bushland area.

Response

The northern interchange construction compound would be a temporary facility only. All components including site access roads would be removed at the completion of the construction phase and the site would be revegetated. This would be undertaken in consultation with Council.

Issue description

The Junction Road construction compound (C11) is expected to operate 24 hours per day, seven days per week. Tunnelling works are expected to occur continuously. Movements to and from the construction compound can be expected to result in impacts to residents in Coonanbarra Road (north of Junction Road). Some of the houses adjoin the proposed compound. Temporary crossing of Cockle Creek is proposed as part of the site works.

Response

The Junction Road construction compound (C11) is not anticipated to ordinarily be in use 24 hours per day and seven days per week. The anticipated 100 light vehicle movements to and from the construction compound would be spread throughout the day and would not be expected to result in a significant impact to the local road network or the surrounding community.

Ongoing design refinement and construction planning has identified a need for a construction materials storage and laydown area within this site compound. This proposed change is described and assessed in **Section 9.4** of this report.

The watercourse crossing would be installed with reference to the Guidelines and Policies for Aquatic Habitat Management and Fish Conservation' (Smith and Pollard 1999), Why do fish need to cross the road?: Fish passage requirements for waterway crossings (Fairfull and Witheridge, 2003) and Fish and Fauna Friendly Waterway Crossings (Fairfull and Witheridge, 2003).

Issue description

Access to the Junction Road construction compound (C11) by vehicles would be from Junction Road. Heavy vehicles would only need to access the site during establishment and dismantling/ rehabilitation of the compound. Approximately 15 heavy vehicles are expected per day for three to six months during site establishment, with the same number for dismantling/ rehabilitation. Table 7-15 in the environmental impact statement suggests that heavy vehicles involved in the establishment and subsequent dismantling/rehabilitation of the site would access the site from Myra Street/ Ingram Road/ Edgeworth David Avenue/ Junction Road. It is requested that access to the compound for heavy vehicles be restricted to/ from this route only, as shown in the environmental impact statement, with no access to the site from any Council controlled roads including Eastern Road/ Burns Road and the remainder of Regional Road 2043. It should be noted that an enforceable three tonne gross mass limit is applicable to Regional Road 2043.

Response

The proposed access route to and from the Junction Road construction compound (C11) for heavy vehicles during site establishment and demobilisation would be as described in Table 7-15 of the environmental impact statement.

Ongoing design refinement and construction planning has identified a need for a construction materials storage and laydown area within this site compound. This also involves an increase in heavy vehicles accessing the site from one to five per day. This proposed change is described and assessed in **Section 9.4** of this report.

Issue description

Approximately 100 light vehicle movements per day or around 16 movements during the AM/ PM peak hours are expected to/ from the Junction Road construction compound (C11). These movements would be to/ from Coonanbarra Road and Junction Road. While this is not a significant volume of traffic, it probably represents a doubling of existing traffic volumes on Coonanbarra Road. It is suggested that light vehicles be made to use the same route to access the site as the heavy vehicles to minimise the impact on Regional Road 2043.

Response

The access route for light vehicles to and from the Junction Road compound would largely be dependent of the origin and destination of the vehicles. Given the location of the compound, vehicles would have to utilise some portion of Coonanbarra Road to access the site. Wherever possible, workers would be encouraged to use major roads to access the site rather than local roads. The volume of light vehicles and their distribution throughout the day would be unlikely to impact on Regional Road 2043 (which includes Junction Road, Burns Road and Killeaton Road).

Issue description

It is not clear whether the access road to the Junction Road construction compound (C11) would provide for two-way traffic movements. Because of the number of traffic movements and proximity to residences, it is considered that the access road should be two lanes with minimum width of 7.5 metres and be sealed to minimise dust generation. To minimise noise, the access road off Coonanbarra Road should not be used between the hours of 8.00 pm and 7.00 am daily. A suitable intersection arrangement would need to be provided at Coonanbarra Road to ensure traffic on Coonanbarra Road is not disrupted by construction vehicles and that safety on Coonanbarra Road and Carrington Street is not compromised.

Response

The 100 light vehicles anticipated to access and egress the Junction Road construction compound (C11) on a daily basis would be spread throughout the day time period. As such, the potential noise impacts from these light vehicles are anticipated to be insignificant.

The Junction Road construction compound is not anticipated to ordinarily be in use 24 hours per day and seven days per week, however the compound may need to be used outside of standard construction hours from time to time to support other out of hours works in the vicinity.

The vehicle access road would be wide enough for one-way traffic in order to limit the amount of vegetation clearing on the site. At this stage it is not planned to seal the access road. The generation of dust would be managed through the use of water carts and restrictions on speed limits.

It is acknowledged that the access and egress point to and from the construction compound would introduce an interface between construction traffic, local traffic, pedestrians and potentially cyclists. Site specific traffic management plans and traffic controls plans would be developed in order to effectively manage this interface. This may include measure such as temporary diversions for pedestrians and cyclists, and traffic controllers at access / egress points.

Issue description

A road condition report is requested for Coonanbarra Road and Junction Road (between Coonanbarra Road and the M1 Pacific Motorway), to ensure that any damage to Council's roads used by construction traffic for the NorthConnex project, during the life of the project, is identified and repaired to Council's satisfaction.

Response

Road condition surveys would be conducted on all local roads proposed to be used during construction of the project (ie from the construction site access points to the arterial road network). Any damage to these roads caused during construction of the project, would be rectified at no cost to the relevant local council(s).

Issue description

It is expected the Junction Road construction compound (C11) and all access roads would be removed at the end of the project and this should be considered as a condition of approval.

Response

The Junction Road construction compound (C11) would be a temporary facility only. All components including site access roads would be removed at the completion of the construction phase and the site would be revegetated. This would be undertaken in consultation with Council.

7.2.3.3 Project road design and configuration

Issue description

The artist's impression of the northern interchange (view looking towards the north-west) in the Technical Working Paper: Urban Design (Appendix I to the environmental impact statement) shows two eastbound/ northbound lanes on the M1 Pacific Motorway immediately beside the NorthConnex tunnel entrance. As the northbound lanes on the M1 Pacific Motorway pass under the Pacific Highway bridge, the number of lanes are shown as two lanes, merging to one lane north of the Pacific Highway bridge.

There is concern that one northbound lane on the M1 Pacific Motorway does not provide sufficient capacity for northbound traffic. This would result in traffic congestion back onto Pennant Hills Road. An extra northbound lane should be provided at this location to maintain satisfactory levels of service.

Response

Traffic northbound on the M1 Pacific Motorway north from Pennant Hills Road is predicted to be 901 passenger car units per hour in the AM peak and 1,913 passenger car units per hour in the PM peak in 2029. The design capacity of the northbound lane in this location is 2,200 passenger car units per hour. As such, a single lane in this location is sufficient to accommodate forecast traffic volumes into the foreseeable future.

Issue description

Figure 5-21 in the environmental impact statement shows the M1 Pacific Motorway tie-in works. In particular, under the existing Edgeworth David Avenue bridge, there are four northbound lanes shown in the proposed layout, as well as nominal shoulders and a separation space between the traffic lanes from the northbound tunnel and the northbound M1 Pacific Motorway lanes.

In the northbound carriageway, under existing Edgeworth David Avenue/ Junction Road bridge, there are currently three northbound lanes with associated shoulders between the bridge abutment and the central bridge support. It is difficult to see how four northbound lanes, nominal shoulders and a separation space could be accommodated without major modifications to the abutments and central support at the Edgeworth David Avenue/ Junction Road bridge. This has not been identified or analysed in the environmental impact statement. Modifications to the bridge would have significant impacts on Edgeworth David Avenue, Junction Road and the Regional Road 2043 route between Roseville and Hornsby.

Response

The proposed design for the NorthConnex project is for four lanes under the existing Edgeworth David Avenue bridge.

The width between the abutment and centre pier of the bridge is 20.4 metres. This width provides sufficient space for four 3.5 metre wide lanes plus shoulders of 2.5 metres with one metre on each side (a total of 17.5 metres) and clearance beyond the barriers. It is proposed that the existing rock face to the western abutment would be cut back, plus the right side barrier moved closer to the centre piers.

Issue description

The environmental impact statement describes tunnels with two lanes in each direction, with the provision for three lanes in each direction to cater for future traffic demand.

It is unclear from the environmental impact statement if the southbound entry portal, shown as two lanes wide as part of the current proposal, would need to be widened to three lanes as well. If this is the case, then the proposed southbound bicycle overpass at the southbound entry portal would be impacted and possibly be made redundant. The provision of cycling facilities on the M1 Pacific Motorway is questioned, as cyclists tend not to cycle this route.

It would be preferable to improve conditions for cyclists on the Pacific Highway at the northern interchange as well as at the Millewa Avenue/ Alexandria Avenue overbridge, and at the Junction Road/ Edgeworth David Avenue overbridge. These are the routes more used by cyclists and roads in the Ku-ring-gai Bicycle Plan which features cycling routes.

Response

The main alignment tunnel portals would be constructed with sufficient width to enable potential marking of three lanes in the future if required without impacts to the adjacent infrastructure such as the proposed cycle bridge.

The proposed cycle bridge is intended to provide a grade separated connection across the tunnel portal and to allow a similar level of access for cyclists which currently exists on the M1 Pacific Motorway. The provision of permanent cycle infrastructure away from the motorway is not within the scope of the NorthConnex project.

The project would also provide an alternative cycle route during the construction phase when it would be necessary to exclude cyclists form the motorway shoulder for safety reasons. On completion of the project, relevant local council(s) would be consulted in relation to potential retention of any temporary cycle facilities as their permanent assets.

7.2.3.4 Ecological issues

Issue description

The northern interchange compound (C9) would result in the removal of 1.14 hectares of the Blue Gum High Forest Critically Endangered Ecological Community (Eco Logical Australia 2013) which is listed under the *Threatened Species Conservation Act 1995* (TSC Act).

The 1.14 hectares of Blue Gum High Forest which is proposed to be removed to establish the northern interchange compound is one of the largest stands of this community outside of local bushland reserves (Dalrymple Hay, Sheldon Forest, Brown's Forest and Clive Evatt).

The remaining area of Blue Gum High Forest is less than 170 hectares (OEH 2013c). The project as a whole will result in the removal of approximately 2.81 hectares or 1.5 per cent of the remainder of the Blue Gum High Forest community (Eco Logical Australia 2013).

Response

A biodiversity impact assessment is provided in Section 7.6 and Appendix J of the environmental impact statement. This includes an assessment of potential impacts to Blue Gum individuals and the Blue Gum High Forest community.

The environmental impact statement includes an assessment of offset requirements in accordance with the NSW Offset Principles for Major Projects (State Significant Development and State Significant Infrastructure (OEH, 2013), as required by the Director-General's environmental assessment requirements for the project. It is recognised that the new NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014) is now in place and there may be transitional arrangements relevant to the project.

The assessment recommends mitigation measures to limit impacts to vegetation and provides an offset calculation for impacts which cannot be avoided. Further opportunities to limit the clearing of vegetation would be investigated during the detailed design stage of the project. At this stage, biodiversity offset requirements would be recalculated, taking into account any further opportunities identified during detailed design to reduce vegetation clearing requirements.

Issue description

To offset the impacts of the loss of 2.81 hectares of Blue Gum High Forest as a result of the project, 163 biodiversity offset credits are required (Eco Logical Australia 2013).

The Office of Environment and Heritage principles for the use of biodiversity offsets in NSW have been reviewed with consideration of achieving the requirement of 163 biodiversity offset credits for the loss of Blue Gum High Forest. Principle 8 of the principles for the use of biodiversity offsets states that:

> *"Offsets should be agreed prior to the impact occurring. Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval".*

No details have been provided to demonstrate that offsets can be secured for the loss of Blue Gum High Forest.

The Technical Working Paper: Biodiversity (page 124) states the following:

> *"The credit report identifies that 280 ecosystem credits are required for the clearance associated with the project (Table 16). Based on an average 9.3 credits generated per hectare of Biobank site (based on the* [Office of Environment and Heritage] *credit converter), this would require an estimated 30.1 hectares of offset lands. The quantum and location of offsets would be confirmed in the Offset Strategy".*

Based on the above assumptions to offset 163 Blue Gum High Forest Biodiversity credits, approximately 17.52 hectares of Blue Gum High Forest would be required to be secured and protected as a result of the project. The northern interchange compound within the Ku-ring-gai local government area would result in the loss of 1.14 hectares of Blue Gum High Forest community. In the Ku-ring-gai local government area, this equates to approximately 65 biodiversity credits, which would require an offset area of approximately 6.56 hectares.

No Blue Gum High Forest biodiversity credits sites have been identified in the Technical Working Paper: Biodiversity. The Technical Working Paper: Biodiversity fails to demonstrate compliance with Director-General's environmental assessment requirements relating to biodiversity or to fulfil the requirement to offset in accordance with the New South Wales offset principles for major projects. The project, if approved, would require 10 per cent or 17.52 hectares of all the remaining Blue Gum High Forest community to be protected and conserved. In accordance with the Office of Environment and Heritage principles, the project should not be approved until such time as the offset of 163 Blue Gum High Forest biodiversity credits can be demonstrated for the loss of 2.81 hectares of Blue Gum High Forest.

Response

The biodiversity impact assessment presented in Section 7.6 and Appendix J of the environmental impact statement is based on a worst-case assumption with respect to vegetation clearing and surface disturbance. Opportunities to minimise the need for vegetation clearing, particularly of the Blue Gum High Forest community, would be considered and pursued if feasible and reasonable during the detailed design of the project.

Subject to the outcomes of the detailed design process, biodiversity offset requirements would be confirmed and revised if required. The Office of Environment and Heritage would be consulted during this process to ensure that the scope of the final biodiversity offsets package is appropriate.

7.2.3.5 Heritage issues

Issue description

Some of the information used in the heritage impact assessment presented in the environmental impact statement for the Statements of Significance and Statement of Heritage Impacts is outdated. However, it is recognised these oversights do not substantially alter the substance of the heritage impact assessment in relation to most of the items (except 11A Lucinda Avenue) and the Heritage Conservation Area within the Ku-ring-gai Council local government area.

Response

The heritage impact assessment presented in the environmental impact statement has appropriately used the current (at time of preparation) statements of significance contained within the statutory listings for each of the non-Aboriginal heritage items and heritage conservation areas.

As identified by Council, changes that may have occurred to statements of significant do not affect the outcomes of the heritage impact assessment. Heritage issues associated with 11A Lucinda Avenue are addressed further below.

Issue description

The property at 11A Lucinda Avenue (Hindfell) is substantially intact and of potential State significance. It is appropriate that a more detailed impact assessment and vibration monitoring program be established for 11A Lucinda Avenue. The issue of acoustic treatment needs to be addressed with regard to the intactness of the property and its aesthetic significance.

Response

The Technical Working Paper: Non-Aboriginal Heritage identifies that 11A Lucinda Avenue (Hindfell) may be impacted by vibration and is potentially eligible for acoustic treatment. In relation to potential vibration impacts, mitigation measure NAH5 identifies that further consideration would be given to these potential impacts during the detailed design stage. This would include the use of vibration monitoring where the recommended maximum vibration levels for protection of the integrity of the structure are predicted to be exceeded.

In relation to at-property acoustic treatment, the need for this treatment would be confirmed during the detailed design stage and would consider potential impacts to the heritage value of the property in consultation with the property owner. Should at-property acoustic treatment be required for Hindfell, this would be sympathetic to the property's heritage values. Any at-property treatments would be undertaken in accordance with the Burra Charter, which stipulates that changes which reduce cultural significance should be reversible.

This approach would be taken where appropriate for all heritage listed properties, regardless of their potential or otherwise for State significance.

Issue description

The environmental impact statement does not define the scope of vibration monitoring that would be undertaken, in particular how impacts would be addressed if they arise. Also, the heritage impact assessment has not taken into account the fabric of the property in its assessment.

The vibration impact assessment in the environmental impact statement (page 78) notes that the individual features of a property need to be factored into impact assessments. This should be considered to confirm the potential degree of impact and to ensure adequate measures are put in place to protect the properties.

Response

The construction vibration impact assessment in Section 7.2.4 of the environmental impact statement identifies that vibration from surface and tunnelling works would not exceed levels at which structural damage would be expected to occur.

Mitigation measure NAH5 in Table 7-186 of the environmental impact statement identifies that specific vibration assessments would be undertaken on a case by case basis based on the detailed design of the project. The specifics regarding geology, structure of the heritage item and the detailed nature of works would be taken into account as part of the consideration of potential impacts and in the development of specific, detailed mitigation strategies to avoid vibration related impacts.

Issue description

The environmental impact statement identified that some properties have the potential to be subject to at most minor cosmetic damage. However, the assessment does not take into account the fabric of the property in its assessment. The vibration impact assessment in the environmental impact statement (page 78) notes that the individual features of the property need to be factored into impact assessments. This should be considered to confirm the potential degree of impact and ensure adequate measures are put in place to protect the properties.

Response

The construction settlement assessment in Section 7.8.3 of the environmental impact statement identifies that settlement from tunnelling works is expected be a maximum of 20 millimetres. At this level, potential impacts would be minor cosmetic damage only.

Mitigation measure NAH5 in Table 7-186 of the environmental impact statement identifies that specific settlement assessments would be undertaken on a case by case basis based on the detailed design of the project. The specifics regarding geology, structure of the heritage item and the detailed nature of works would be taken into account as part of the consideration of potential impacts and in the development of specific, detailed mitigation strategies to avoid vibration related impacts.

Issue description

The environmental impact statement determines that the majority of the visual impact to heritage items would be negligible due to the plan for the replacement of noise walls and revegetation once construction is completed. However, it is noted for the property at 4 Burns Road, that the potential visual impacts described in the environmental impact statement would not be screened by neighbouring properties, as these properties are marked for acquisition and demolition. The environmental impact statement should be amended to address this potential impact.

Response

Table 7-185 of the environmental impact statement identifies that there would be potential visual impacts to 4 Burns Road (LEP ID I855). Potential for visual impacts would be further considered during the detailed stage of the project, including opportunities to minimise or avoid visual impacts.

In this location, proposed landscaping treatments would minimise the potential for visual impacts to and from this property.

Issue description

The environmental impact statement recommends one heritage property for potential acoustic treatment. The reasons for the selection of this property and the exclusion of neighbouring properties is not stated in the heritage impact assessment, nor is it made clear in the noise impact assessment. Community consultation has raised the possibility that acoustic treatment is being considered for other properties. If this is the case, the appropriate heritage assessments should be carried out.

Response

Properties eligible for consideration of at-property acoustic treatment are identified in the Technical Working Paper: Noise and Vibration (Appendix F of the environmental impact statement) and Section 7.2 of the environmental impact statement.

Further detailed design would be undertaken together with more detailed noise modelling to confirm the reasonable and feasible operational noise mitigation measures to be applied to the project. Based on the outcomes of this assessment, acoustic treatment at additional properties may be considered. This is consistent with the approach taken on major infrastructure projects of a similar nature and scale.

Section 7.10.3 of the environmental impact statement identifies the process for at-property acoustic treatment for heritage listed properties. Should at-property acoustic treatment be required for heritage listed properties, this would be sympathetic to the heritage value and would be undertaken in accordance with the Burra Charter, which stipulates that changes which reduce cultural significance should be reversible.

Issue description

The heritage impact assessment in the environmental impact statement includes inconsistencies and in some cases uses outdated significance assessments as the basis for investigation of impacts. Notwithstanding, the general thrust of the document is considered to be accurate. The project would avoid direct impacts to heritage properties and heritage conservation areas.

The potential for impacts has not been adequately addressed. The environmental impact statement has left many aspects of future planning to detailed design. This has created confusion and uncertainty in the community and has made it difficult for the community to understand the ongoing process.

In addition, the low legibility of the document, cross referencing to technical papers are not interpreted and difficult to read maps has made it difficult to clarify points of confusion.

Response

The heritage impact assessment presented in the environmental impact statement has appropriately used the current (at time of preparation) statements of significance contained within the statutory listings for each of the non-Aboriginal heritage items and heritage conservation areas. As identified by Council, changes that may have occurred to statements of significant do not affect the outcomes of the heritage impact assessment.

All relevant potential impacts to heritage items have been considered including vibration, settlement and visual impacts. These are considered unlikely to result in impacts to heritage listed properties. The heritage impact assessment does identify, however, that the nature of these impacts may change based on the detailed design development of the project and based on the specific of the property itself. In this regard, the environmental impact statement identifies appropriate mitigation measures and future processes to review these impacts and implement mitigation measures to ensure that heritage listed properties are not negatively impacted by vibration, settlement or a change in visual context.

The heritage impact assessment appropriately cross-references other technical assessments where relevant, such as for more detailed consideration of potential vibration or settlement impacts. This is consistent with the approach taken for environmental impact statements for major infrastructure projects of this nature and scale. The environmental impact statement should be read and considered as a whole when assessing the project, consistent with a balanced merit assessment approach.

The graphics provided in the environmental impact statement convey necessary details taking into account the needs of various potential audiences. Mapping within the Technical Working Paper: Non-Aboriginal Heritage has been provided as five sequential maps with a logical flow from south to north in order to provide necessary detail to interpret the potential impacts. For readers who may wish to see more detail of the location of heritage items in relation to the project, maps with an additional level of detail are provided in Appendix A of the Technical Working Paper: Non-Aboriginal Heritage. Again, these have been arranged in a logical order from south to north to allow the reader to easily navigate through the maps.

7.2.3.6 Noise issues

Issue description

Noise catchment areas (NCAs) defined in the environmental impact statement should be further subdivided to ensure that each catchment represents similar existing acoustic environments. Additional noise monitoring should be carried out to determine rating background levels for the revised noise catchment areas. Additional monitoring should also be carried, where required, to determine existing traffic noise levels for the revised noise catchment areas.

Response

The noise catchment areas applied to the noise impact assessment and illustrated in the environmental impact statement have been identified based on consideration of:

- Areas likely to experience similar types of noise impacts from the same project sources.
- The nature of development and receivers around each project noise source.
- Other noise sources in the area.
- Topographic factors.

Noise catchment areas have been used for the purpose of assessing construction noise impacts and operational noise from fixed facilities. The construction and operational noise impact assessments have considered all relevant receiver locations individually, and are independent of the noise catchment areas.

The noise catchment areas identified and applied to the project are considered to be sufficient in terms of number and extent for the purpose of conducting an appropriately level of noise impact assessment. Noise catchment areas and the number noise monitoring locations are comparable to other recent major infrastructure projects in the region, including the Epping to Thornleigh Third Track Project and the North West Rail Link Project.

Noise monitoring locations for each catchment area have been located in accordance with the NSW Industrial Noise Policy (EPA, 2000) and reflect the potentially most affected receiver location(s) for each noise catchment area. Noise monitoring has reinforced that there is little change in background noise levels within noise catchment areas given that in most cases, noise levels are dominated by existing major roads (the M1 Pacific Motorway, Pacific Highway, Pennant Hills Road and the Hills M2 Motorway) and railway lines. Construction and operational noise sources from the project lie within the areas influenced by noise from these existing sources.

The construction noise isopleths presented in Appendix F of the Technical Working Paper: Noise and Vibration (Appendix F to the environmental impact statement) demonstrate that peak noise impacts from the project would not extend across the majority of each noise catchment area. In most cases, the spatial extent of elevated noise impacts is limited to areas affected by existing noise sources and adequately represented by noise monitoring conducted for the project. The potential for more distant receivers towards the boundaries of each noise catchment area to be adversely impact is therefore low.

Noise monitoring would be conducted at the commencement of construction activities and periodically during the construction program (refer to mitigation measure NV17 in Table 7-186 of the environmental impact statement). This monitoring would be used to confirm rating background levels at the commencement of construction and to monitor noise compliance over time. The construction noise mitigation and management measures discussed in more detail in **Section 4.5** of this report have been developed and committed to relative to rating background levels determined at the time of the relevant works, rather than the background noise levels presented in the environmental impact statement. This provides an additional level of certainty that mitigation and management measures would be delivered consistent with the actual background noise levels at the time of construction (which may have changed since the monitoring conducted for the purpose of the environmental impact statement).

Issue description

Further information should be provided regarding the northern ventilation facility and tunnel portal jet fans, and a review of potential sleep disturbance from the operation of the northern ventilation facility.

Response

The Road Noise Policy (DECCW, 2011) states that:

> *"A summary of the current literature concerning sleep disturbance due to noise indicates that the main noise characteristics that influence sleep disturbance are the number of noisy events heard distinctly above the background level, the emergence of these events and the highest noise level."*

Noise from the operation of the project's ventilation facilities and tunnel portal jet fans would be steady and consistent, and as such, the L_{Aeq} and L_{A1} noise levels from the facilities would be within 2-3 dB(A) of each other.

The noise assessment of the northern ventilation facility (including jet fan noise from the northern portals) indicates that, under the worst case weather conditions and during low speed or emergency conditions when the facility would be operating at its maximum capacity, noise from the facility would be 29 dB(A), compared the applicable noise criterion of 45 dB(A). As such, complying with the L_{Aeq} noise criterion would also ensure compliance with the sleep disturbance criterion for surrounding receivers.

Similarly for the southern ventilation facility (including jet fan noise from the southern portals), compliance with the 41 dB(A) operational criterion at surrounding receivers would also ensure compliance with the sleep disturbance criterion.

Issue description

Details should be provided to clarify how the study area was derived (ie how was it calculated that the project adds no more than 2.0 dB(A) to the total existing noise levels) and the boundary of the study area should be defined.

Response

For the southern interchange and the Hills M2 Motorway integration works, the entire 600 metre catchment area of the 'envelop method' referred to in the NSW Road Noise Policy (DECCW, 2011) has been modelled and assessed. Compared with the northern interchange and the M1 Pacific Motorway, this area has fewer competing (non-project) noise sources.

For the northern interchange and M1 Pacific Motorway tie-in, the noise impact assessment study area has been reduced from the 600 metres area by applying the 'highly urban' area approach. This approach has been adopted to address other significant sources of noise in this area, including major roads (such as the Pacific Highway) and railway lines.

Applying the 'highly urban' area approach has not resulted in diminished mitigation outcomes or increased noise impacts to the surrounding community.

Issue description

Operational daytime $L_{Aeq(15\text{-}hour)}$ and night-time $L_{Aeq(9\text{-}hour)}$ traffic noise contours should be provided.

Response

Provision of operation traffic contours are not a requirement of the Road Noise Policy (DECCW, 2011) or the Director-General's environmental assessment requirements for the project. They have not been included in the environmental impact statement because they are not as accurate as façade calculations and in some circumstances can be misleading. Noise levels at individual receiver locations have been provided to community members on request.

This does not affect the results of the operational traffic noise assessment.

Issue description

Detail should be provided to clarify what receiver heights were assessed as part of the operational traffic noise impact assessment. Confirmation would be required as to whether this affects the outcomes of the noise barrier assessment.

Response

Receiver calculation heights were assessed at 2.4 metres above ground for the first floor and then at 1.5 metre increments for each additional floor. All levels of multi-level residential buildings have been considered. As such, this does not affect the outcomes of the noise barrier assessment.

Issue description

More information is required as to how the open graded asphalt (OGA) corrections for the M1 Pacific Motorway southbound carriageway have been derived.

Response

Existing pavement corrections have been derived based on a combination of site measurements and calculations. Future pavement corrections have been obtained from the Environmental Noise Management Manual (RTA, 2001).

Issue description

With regard to pavement corrections it should be clarified whether the corrections have been applied equally for each vehicle emission string (car exhaust/engine; car/truck tyre noise; truck engines and truck exhaust) or just for the car/truck tyre noise emission string.

Response

Pavement corrections have been appropriately applied to the road/ tyre interface only.

Issue description

It is not clear why the southbound carriageway of the M1 Pacific Motorway has assumed to be resurfaced with open graded asphalt (OGA) for the 'no build opening year' and 'design year' scenarios. This would imply that the resurfacing is not project related and has perhaps already been undertaken post noise monitoring for the environmental impact statement (ie after December 2013).

Response

Council's conclusion is correct. Resurfacing of the M1 Pacific Motorway with Open Graded Asphalt was undertaken around one month after noise monitoring was completed for the environmental impact statement.

Issue description

Details should be provided to clarify whether ARRB (originally known as the Australia Road Research Board) corrections or any other calibration corrections and safety factors have been applied to operational traffic noise predictions.

Response

Corrections are discussed in Table 57 and Section 5.1.1 of the Technical Working Paper: Noise and Vibration (Appendix F of the environmental impact statement). The standard ARRB correction has not been used; rather, specific corrections have been derived from the measured and modelled noise levels. A safety factor has not been applied, however it is noted that the model was calibrated to provide a conservative approach (ie on average the predicted road traffic noise levels are slightly higher than the measured road traffic noise levels).

Issue description

More information is required with regard to the portal correction used in noise impact assessment.

Response

Details of the portal modelling are discussed in Section 5.1.6 of the Technical Working Paper: Noise and Vibration (Appendix F of the environmental impact statement). The portal noise assessment has been conducted using SoundPLAN's implementation of the Nord2000 standard. This standard considers portal dimensions, sound absorption of the tunnel and the road traffic noise sources. Inputs to this modelling have included the portal dimensions and the assumption of a smooth concrete surface in relation to absorption. This is a conservative assumption.

Issue description

A more detailed assessment of maximum noise level impacts associated with the northern interchange should be provided.

Response

The maximum noise level assessment provided in Section 5.1.9 of the Technical Working Paper: Noise and Vibration (Appendix F of the environmental impact statement) has been undertaken in accordance with the Environmental Noise Management Manual (RTA, 2001) and has met all requirements of that documentation. Details of the existing noise situation have been provided along with indicative impacts as a result of operation of the project. Maximum noise levels are not expected to increase with the project, however the number of events at maximum noise levels may increase.

As noted in the Technical Working Paper: Noise and Vibration mitigation options are not made on the basis of the maximum noise level assessment, rather the assessment can be used to prioritise the installation of noise mitigation measures recommended on the basis of the L_{Aeq} road traffic noise assessment.

Issue description

A reasonable and feasible noise barrier analysis in accordance with Environmental Noise Management Manual Practice Note (iv) should be conducted for Lucinda Avenue properties (including IDs 1617, 1626, 1648, 1656 and 1661) which are located north-east of the on and off-ramp portals.

Response

In this location, five properties have been identified as exceeding the relevant traffic noise assessment thresholds as derived from the Road Noise Policy (DECCW, 2011) and the Environmental Noise Management Manual (RTA, 2001). Three of these properties would be

exposed to acute noise levels in 2029 regardless of the project, whilst two would have noise level increases of 2.1 dB(A) and 2.2 dB(A) respectively.

Based on these predicted noise levels, consideration of feasible and reasonable noise mitigation has been conducted. Following adoption of feasible and reasonable at-source mitigation through the selection of road pavements included in the project, further consideration has been given to:

- Installation of noise barriers.
- Potential at-receiver noise mitigation (through at-property acoustic treatments).

In this location, the M1 Pacific Motorway is located within a cutting. The provision of an operational noise barrier in this location is not considered feasible or reasonable because any noise barrier in this location would need to be located at the top of the cutting to be effective. This would result in:

- A significant increase in vegetation clearing beyond that required for the road widening.
- An increase in construction work closer to residential properties.
- Potential for significant visual and overshadowing impacts to residential properties.

Because noise barriers are not considered feasible and reasonable in this location, further consideration has been given to potential at-property acoustic treatments. Five properties have been identified as being eligible for consideration of at-property acoustic treatments.

Operational traffic noise and feasible and reasonable noise mitigation would be considered further during detailed design (subject to the project being approved), and the final form of feasible and reasonable noise mitigation measures would be confirmed at that time.

Issue description

The noise and vibration impact assessment in the environmental impact statement needs to provide more information to ensure that the receivers affected by the northern interchange where noise barriers are to be replaced are provided with replacement noise barriers of at least the equivalent performance of the existing barriers.

Response

Noise barriers have been recommended in accordance with the Road Noise Policy (DECCW, 2011) and the Environmental Noise Management Manual (RTA, 2001).

Section 7.1 of the Technical Working Paper: Noise and Vibration (Appendix F of the environmental impact statement) states that:

> *"the top of the new noise barrier should be no lower than the top of the existing noise barrier (that is, the reduced level (RL) of the top of the existing barrier must be maintained)." The performance would therefore be at the least equivalent."*

Noise barriers that are relocated/ replaced would provide equivalent or better noise attenuation performance as existing noise barriers, consistent with Roads and Maritime policy.

Issue description

A cumulative noise impact assessment should be included in the environmental impact statement to address operational (northern ventilation facility, portal noise) and operational traffic noise.

Response

In accordance with EPA policy, noise from the northern ventilation facility and from jet fan noise emitted from the M1 Pacific Motorway main alignment portals has been assessed against the Industrial Noise Policy (EPA, 2000).

Noise from road traffic on the surface road and from the tunnel portals has been assessed in accordance with the Road Noise Policy (DECCW, 2011).

There is no requirement to assess combined noise from fixed facilities and road traffic. Additionally, there are no criteria against which to assess this potential cumulative impact.

Regardless, the assessed worst-case noise levels from the northern ventilation facility and the portal jet fans combined is 29 dB(A). The traffic noise levels in this area are in the order of 55 to 65 dB(A). As such, there would not be a cumulative noise impact from the combination of these two sources. Traffic noise would be dominant in this location, with negligible contribution from the ventilation facility and jet fan noise from the tunnel portals.

Issue description

Details should be provided to clarify whether the property treatments identified within Table 59 of the Technical Working Paper: Noise and Vibration are applicable to the ground floor and/or first floor of multi-storey dwellings.

Response

The noise impact assessment has considered all façades and floors for each relevant affected building. Further analysis of traffic noise impacts and mitigation would be conducted during detailed design of the project. The aim of this analysis would be to identify further feasible and reasonable noise mitigation measures that could be applied to reduce noise impacts, if necessary.

Issue description

The noise and vibration impact assessment in the environmental impact statement should include a commitment to provide a road surface with similar acoustic performance to open graded asphalt (OGA) when the road is resurfaced in future.

Response

The existing road surface on the M1 Pacific Motorway is open grade asphalt. The proposed surface for the M1 Pacific Motorway (excluding the portal ramps) is also open graded asphalt. This design pavement would be maintained in the future.

Issue description

Council recommends that:

a) Detailed design stage background noise monitoring should be conducted at a receiver located west of the Bareena Avenue construction compound (C10).

b) Care should be taken when installing the northern ventilation facility and supporting structure to ensure ground-borne noise is not an issue.

c) For the ventilation fans and jet fans, an assessment to identify any "annoying characterises" such as tonality / low frequency noise would need to be undertaken.

d) Detailed design stage ground-borne noise predictions would need to be more comprehensive and include predictions associated with cross passage excavation and rock hammers.

e) It is recommended that existing noise barriers within the project area, which are not proposed to be replaced with new noise barriers, undergo a condition report and be repaired.

f) The environmental impact statement should clarify if Woonoona Avenue would be utilised for access to the Bareena Avenue compound (C10). If so, a construction traffic noise assessment should be undertaken.

g) The Construction Noise and Vibration Management Plan (CNVMP) would need to provide details and protocols for minimising and managing the risk of noise and vibration impacts from construction activities. Construction noise management and mitigation measures would have to be comprehensively covered within the plan.

h) Assessment of impacts on heritage properties should be included in the conditions of approval.

Response

Responses to Council's specific recommendations are as follows:

a) Background noise monitoring already conducted at location NL02 on Douglas Avenue, Wahroonga provides an adequate representation of the likely background noise in the vicinity of the Bareena Avenue compound (C10). No further noise monitoring in this area is required.

b) Ground-borne noise is not anticipated to be a significant issue from the construction or operation of the northern ventilation facility.

c) The assessment of ancillary fixed infrastructure such as axial fans and jet fans has considered the potential for "annoying characterises" such as tonality / low frequency noise. Section 5.2.1 of the Technical Working Paper: Noise and Vibration (Appendix F to the environmental impact statement) identifies that noise emissions from the operation of the ventilation facilities would not contain any "annoying characteristics' as described in the Industrial Noise Policy. No further assessment of this issue is required.

d) The potential impacts from the use of rock hammers in the tunnel would be considered during detailed design and construction planning. Where this may result in significant ground-borne noise impacts additional feasible and reasonable mitigation measures would be investigated including the use of alternative or smaller equipment.

e) In the event that noise barriers within the project area do not need to be directly impacted by construction works, an inspection and assessment of the condition of the noise barrier would be conducted. Repair works would be conducted as required to

ensure that the retained noise barrier adequately attenuates road traffic noise consistent with its design specifications and the needs of the project.

f) The environmental impact statement identifies in Table 7-15 that access to the Bareena Avenue compound (C11) would use the local road network (including Woonona Avenue) for some works. This is anticipated to be an average of 15 heavy vehicles per day for a period of around two to four months. Fifteen heavy vehicles spread across the day is not anticipated to result in significant road traffic noise increases. As such, a construction traffic noise assessment is not warranted.

g) Further information on construction noise mitigation and management measures is provided in **Section 4.5** of this report.

h) The environmental impact statement commits to undertaking further consideration of potential impacts to heritage items based on the detailed design. Specifically, mitigation measure NAH5 in Table 7-186 identifies that further assessment would be undertaken regarding potential for vibration and settlement impacts to non-Aboriginal heritage items and the implementation of additional feasible and reasonable mitigation and management measures if necessary.

5.2.3.7 Vibration issues

Issue description

The literature source for the sound power level (SWL) of 98 L_{Aeq} dB(A) adopted for delivery trucks, truck and dogs and articulated dump trucks should be stated. Justification should be provided as to why this seeming low sound power level is applicable.

Response

The sound power levels have been taken from experience on similar projects considering the proposed operations and are consistent with those provided in the UK Department for Environment Food and Rural Affairs (DEFRA) Update of Noise Database for Prediction of Noise on Construction and Open Sites (2005).

Issue description

Confirmation is required as to whether a penalty has been applied to noise sources identified in the Interim Construction Noise Guideline as having particularly annoying characteristics, including jackhammering, rock hammering or rock breaking.

Response

Where appropriate, annoying characteristics have been included in the assessed construction activities. The potential for annoying noise characteristics would be taken into account as part of the detailed design and construction planning for the project, with appropriate mitigation and management measures reflected in the Construction Noise and Vibration Management Plan(s).

Issue description

The number of spoil truck movements proposed to occur during the daytime, evening and night-time for the northern interchange compound should be quantified. The number of spoil truck movements which have been assumed for the construction noise predictions should be clearly stated. Deciphering the data within the construction road traffic noise assessment (Section 4.3 of the Technical Working Paper: Noise and Vibration), shouldn't have to be relied on to acquire this information.

Response

Total light and heavy vehicle numbers are clearly indicated in Section 4.3 of the Technical Working Paper: Noise and Vibration. Vehicle numbers are listed for each affected road and grouped by construction site for two scenarios:

- All spoil haulage to the north.
- All spoil haulage to the south.

Vehicles numbers have been listed for the AM and PM peak periods, as well as for two periods outside of standard construction hours (late night and early morning).

The information provided is sufficient to inform the construction traffic noise impact assessment and to interpret the assessment's inputs, assumptions and outcomes.

In response to issues raised in submissions, haulage routes associated with the southern interchange compound (C5), the Trelawney Street compound (C7) and the northern interchange compound (C9) have been reviewed and revised. Further details of these changes are provided in **Section 9.4** of this report.

Issue description

Further information is required regarding the excavation methodology for the construction of the tunnels near portals. Due to the close proximity of these works to residential receivers, this stage of construction may cause significant noise impacts.

Response

A Construction Noise and Vibration Management Plan(s) would be prepared during the detailed design stage of the project when construction practices are developed by the construction contractor. The plan(s) would include more specific details about the construction methodology and associated noise and vibration impacts.

Further discussion of construction noise and vibration management measures is provided in **Section 4.5** of this report.

Issue description

It is not clear in the environmental impact statement whether existing noise barriers earmarked for replacement have been included in the construction noise assessment. There should be a commitment in the environmental impact statement that where possible, new noise barriers should be constructed prior to or as soon as practical after the commencement of construction.

Response

Noise barriers that are earmarked for replacement have not been included in the construction noise assessment. This provides a conservative assumption for the purpose of the construction noise impact assessment, as potential impacts have not taken into account the potential presence of relocated noise barriers as an early mitigation measure for construction noise.

Where feasible and reasonable, the relocation and/ or replacement of noise barriers would be prioritised for implementation during the early phases of construction as an effective noise mitigation measure.

Issue description

Further consideration of the noise benefits of increasing the height of compound perimeter barriers should be explored to address the high level of construction noise impacts predicted within the environmental impact statement.

Response

Feasible and reasonable noise mitigation and management measures have been identified in accordance with the Interim Construction Noise Guideline (DECC, 2009). Further discussion of construction noise mitigation and management measures is provided in **Section 4.5** of this report.

Site specific mitigation and management measures would be detailed in the Construction Noise and Vibration Management Plan(s) for the project which would be developed during the detailed design stage.

Issue description

A review of on-site heavy vehicle movements at the northern interchange compound outside of standard construction hours is required to identify potential impacts and to confirm that the proposed compound mitigation and shed structure would satisfactorily mitigate noise.

Response

The construction noise impact assessment presented in Section 4 of the Technical Working Paper: Noise and Vibration (Appendix F of the environmental impact statement) includes assessment of site establishment and earthworks at each construction compound. This scenario is expected to have a significantly higher impact than on-site heavy vehicle movements, and is therefore considered an appropriate worst-case construction noise impact scenario.

7.2.3.8 Property value issues

Issue description

There are a number of properties likely to be impacted by the project. The main area of concern would be those properties in Lucinda Avenue and Eastbourne Avenue where the tunnel would be directly under the properties and fairly close to the surface. The owners of these properties need to be consulted with regard to the possibility of any impacts the tunnel works would have on the structural integrity of the properties and whether any covenants would be required.

There is a need to consult with all property owners on what avenues are available for compensation should any damage be caused to properties and what impacts the project would have on property values. Independent valuations need to be sought to determine the

effects the project would have on property values that are directly affected by the project and construction compounds.

Response

All properties within 50 metres of the project tunnels or within 50 metres of a surface construction site would be offered a condition survey. Any damage to properties attributable to the construction of the project would be repaired at no cost to the property owner.

The environmental impact statement demonstrates that potential impacts associated with the construction and operation of the NorthConnex project are within acceptable limits. On this basis, there is no basis for negative changes in property values as a result of the project.

In Sydney and elsewhere around Australia large infrastructure projects have been shown to add value and better amenity to the area in which they are built and as such property prices have increased accordingly.

There is potential for positive impacts on property values, particularly along the Pennant Hills Road corridor. This is likely to result from improvements in amenity, including improved air quality, reduced traffic noise and improved road safety along that corridor.

The belief that home values around the ventilation outlet and portals may drop up to 25 per cent or more and that it will be difficult to sell houses near the outlets appears to have no credible supporting evidence.

For example, a property at Gum Grove Place, West Pennant Hills (adjacent to the southern ventilation outlet) was put on the market on 22 May 2014 with a guide price of over $980,000. The property sold by mid June 2014, less than four weeks later, at a price of $1,370,000 (around 40 per cent over price guide). In the north there have been four properties sold in Woonona Avenue since the end of May 2014 with the recent sale of a property on Woonona Avenue, which sold on 30 July 2014 eight days after being put on the market and another on Woonona Avenue sold on 14 July 2014 only five days after being put on the market, and both higher than the price guide provided.

Additionally, there is no evidence from previous road tunnel projects suggesting that these projects resulted in a decrease in property values.

With respect to the M5 Motorway ventilation outlet in Turrella; research indicates in the last 10 years the average median price in Turrella has increased 4.6 per cent per year in line with neighbouring suburbs of Earlwood (4.3 per cent) and Arncliffe (4.5 per cent) and in excess of Wolli Creek (3.6 per cent). Further, in the last five years the median price has increased almost 70 per cent which is 20 per cent more than Earlwood and Arncliffe.

With respect to the Lane Cove Tunnel ventilation outlet, research indicates that, in the last 10 years, the average annual increase in median property in Lane Cove (the suburb adjacent to the Lane Cove Tunnel ventilation outlet) was 4.7 per cent. This is similar to nearby suburbs of Chatswood (five per cent) and Artarmon (four percent) over the same period.

7.2.3.9 Traffic issues

Issue description

While the project when completed will assist congestion on Pennant Hills Road, there is a four year period of construction that will add additional traffic on the local road network. Council will require consultation on any Traffic Management Plans to ensure residential amenity is protected during construction and Council's infrastructure is maintained and restored to Council's satisfaction at the completion of the project.

The use of the compounds in Ku-ring-gai will have a significant impact on local traffic conditions and they need to be managed to reduce the impact on the local community. There are local schools in the vicinity of these compounds and road and traffic safety will need to be included in any consent conditions. This needs to be heavily consulted with Council and representatives of the local schools to ensure the safety of school children.

Response

The environmental impact statement provides an assessment of potential construction traffic impacts in Section 7.1.4 and Appendix E. It is acknowledged that the construction of the project has the potential to result in impacts to the local road network.

Traffic Management Plans and Traffic Control Plans would be developed in order to detail the site specific construction vehicle arrangements as well as the safe movement of motorists, cyclists and pedestrians around the construction sites. Additional measures would be considered during the development of Traffic Management Plans such as:

- The use of temporary traffic lights at heavy vehicle egress points.
- Siting heavy vehicle egress point where there are downhill grades where feasible and reasonable.
- Stipulating certain emissions standards (such as Euro 3) from heavy vehicles used as part of the project.
- The use of trucks with greater capacity to reduce the overall number of heavy vehicle movements.

The Community Communications Framework provided in Appendix D of the environmental impact statement identifies targeted consultation activities for specific environmental issues. In relation to construction traffic, local school communities and local councils are identified as key stakeholders. A Traffic and Transport Liaison Group would be established to discuss traffic management and road safety mater associated with the construction of the project. The Traffic and Transport Liaison Group would include representative from the relevant local councils.

Issue description

The connection between the Hills M2 Motorway (east of Pennant Hills Road) and the NorthConnex project should be incentivised.

From a Ku-ring-gai perspective, the notion of a link between the M1 Pacific Motorway and the Hills M2 Motorway could have had the potential to reduce through vehicle movements through the LGA. However, it's connection to the M2 Motorway at Pennant Hills Road favours traffic west of Pennant Hills Road, targeting the main north-south heavy vehicle route, and clearly the analysis in Section 8.5 of Volume 2 of the EIS indicates reductions in traffic volumes on Pacific Highway (between the M1 Motorway and A3 Ryde Road) are expected to be modest at best. Some increases in heavy vehicles are expected southbound

on Pacific Highway (south of the M1 Motorway interchange) due to the NorthConnex, probably as a result of heavy vehicles avoiding the toll.

While there is provision for stubs at the southern end of the NorthConnex to permit future connection to the M2 Motorway to the east under Pennant Hills Golf Course, under the proposed configuration there would be no incentive for motorists to connect between the NorthConnex and the M2 Motorway east of the Pennant Hills Road interchange. In particular, the movement from the M2 Motorway (westbound) to the NorthConnex (northbound) would require traffic to exit the M2 Motorway and be subjected to the traffic signal intersection at Pennant Hills Road and its associated delays. In the reverse, the movement from NorthConnex (southbound) to the M2 Motorway (eastbound) would be subject to slightly less delays as this would involve a left turn movement which would only be held during certain turning movements.

The proposal should incorporate incentives to facilitate these movements, as this has the potential to further reduce traffic volumes (and heavy vehicles) on the A1 Pacific Highway/A3 Ryde Road-Lane Cove Road route.

Response

The provision of an incentive to prevent trucks using the Pacific Highway is beyond the scope of the NorthConnex project.

The NorthConnex project has been designed to allow for potential future construction of ramps onto and off the Hills M2 Motorway east of Pennant Hills Road, if required as identified in Section 4.3.2 of the environmental impact statement.

A review of an east facing connection between the purple corridor and the Hills M2 Motorway was conducted as part of the Stage 2 unsolicited proposal design development process. Analysis of the traffic implications associated with east facing ramps indicated that:

- East facing ramps connecting to the Hills M2 Motorway would only provide minor travel time benefits for motorists, compared with requiring this traffic to emerge from the main alignment tunnels and use the one existing traffic light to access the Hills M2 Motorway east of Pennant Hills Road.
- The minor nature of incremental travel time benefits would not be sufficient to attract additional users and provide any further material congestion relief to the Pacific Highway and Pennant Hills Road.

In addition, significant engineering and environmental constraints were identified (including the presence of Pennant Hills Golf Course and Devlins Creek) that would need to be overcome at significant cost in order to provide east facing ramps. On balance, these constraints and the limited traffic benefits of east facing ramps supported exclusion of this design option from the scope of the project at this time. However, future proofing measures are being incorporated into the design of the project to safeguard for the potential future inclusion of east facing ramps in the future. The measures include stub tunnels to facilitate tunnelling for east facing ramps without affecting operation of the main alignment tunnels, and tunnel support features where the future ramp alignments would pass close beneath the main alignment tunnels.

Issue description

Once the NorthConnex project is completed, there would be a significant portion of Sydney's motorway network managed and operated by Transurban. From the M7 Motorway at Casula, this would incorporate the M2 to North Ryde and the Lane Cove Tunnel to Artarmon.

There is the opportunity, therefore, for Transurban to implement distance-based tolling (as currently applies to the M7 Motorway) to these other sections managed and operated by Transurban. This would provide an incentive for motorists to use a short section of the M2 Motorway to access the NorthConnex (and vice-versa) and pay a fair amount for doing so, rather than paying a flat fee for the current use of the M2 Motorway. Alternatively, a discount could apply for a vehicle logged using the eastern portion of the M2 Motorway and the NorthConnex in close time proximity.

Response

Commercial arrangements and tolling structures on existing motorways are outside the scope of the NorthConnex environmental impact statement.

7.3 Peak groups and advisory organisations

7.3.1 National Roads and Motorists' Association (NRMA)

Issue description

The fundamental issues for the NorthConnex project are how well it will work for traffic and how well it will be perceived by users and the wider community.

In March 2014 the NRMA put forward a number of new ways to keep tunnels moving as part of our strategy to positively influence the design and operation of the proposed mega motorway projects – the NorthConnex project and the WestConnex projects.

In July 2014 the NRMA followed this up by publishing a key report "WestConnex: Getting it Right". The report brought together the NRMA's suggestions and highlighted the need to focus on keeping traffic moving, reducing the numbers of incidents such as crashes and breakdowns, as well as ways to manage these incidents when they do occur.

The NRMA is pleased that many of the general principles covered in its "WestConnex: Getting it Right" report appear to now have been embraced by the NorthConnex project. The NRMA has attached a copy of "WestConnex: Getting it Right". The main themes of this document are:

- New ways to keep WestConnex [ie NorthConnex in this instance] moving. This includes consideration of future traffic demand, active motorway management, merge locations and distances and road gradients.
- New ways to minimise crashes and breakdowns. This includes measures relating to over-height vehicles and dangerous goods, and innovative lighting and in-tunnel design.
- New ways to manage incidents and their impacts. This includes rapid incident response.
- Celebrate tunnel infrastructure through interesting portal and in-tunnel design.

Response

The project has been designed to provide for efficient, free flowing traffic with physical capacity to accommodate forecast traffic volumes. The project design includes geometry, pavement, lighting and signage, consistent with current Australian Standards, road design guidelines and industry best practice. In doing so, the design of the project has been developed to inherently minimise the likelihood of incidents and accidents.

In relation to the four recommendations identified by the NRMA in "WestConnex: Getting it Right", the NorthConnex design includes the following:

- The project tunnels would be built wide enough to be marked for three lanes if required in the future.
- The project would include active management of the motorway which would allow restrictions on the number of vehicles entering the tunnels, if required, in order to manage potential congestion.
- Merge points have been designed to meet appropriate standards including Roads and Maritime and Austroads guidelines.
- The gradient of the main alignment tunnels has been limited to a maximum of four percent in order to allow cars and heavy vehicles to maintain speeds through the tunnel.

- The project tunnels would be highest in Sydney at 5.3 metres in order to reduce the likelihood of an incident involving over height vehicles. The project would also include electronic over height detectors prior to the tunnel portals, vehicle presence detectors, and warning signs with lanterns installed that would light up upon detection of an over height vehicle.
- The in-tunnel urban design has been developed to provide interest to the journey and to limit driver fatigue. This includes two in-tunnel 'visual events' which provide a sense of place and a measure of progress through the tunnel. The 'visual events' divide the tunnel into three distinct zones allowing differing driver experiences along the journey. Each in-tunnel 'zone' would be highlighted by different wall colours.
- The project tunnel would include closed circuit television (CCTV) and active monitoring to rapidly respond to incidents. Incident response vehicles would be located at the motorway operations complex, close to the southern interchange to enable rapid access into the project tunnels.

Issue description

The recent Hills M2 Motorway Upgrade project has made a very positive difference to motorists' travel times, however, one section of the westbound carriageway, to the west of Pennant Hills Road, was not widened. This section of the Hills M2 Motorway would become an important connection between the NorthConnex project and the Hills M2 Motorway.

Traffic heading southbound via the NorthConnex project and destined for the Westlink M7 Motorway would enter the Hills M2 Motorway westbound in this two lane section. It is disappointing that widening this current PM peak bottleneck does not appear to have been considered within the NorthConnex project environmental impact statement, or included within the NorthConnex project scope of works, particularly if toll concession extensions on the Hills M2 Motorway are being considered by the NSW Government.

Response

The scope of the NorthConnex project and the environmental impact statement includes widening of the westbound carriageway of the Hills M2 Motorway from the Pennant Hills Road interchange to the existing Windsor Road off-ramp. These Hills M2 Motorway integration works would provide for three lanes for the full length of the motorway from Pennant Hills Road to Windsor Road. This is identified in Section 5.1.1 of the environmental impact statement and the extent of works are shown in Figure 5-2, Figure 5-3 and Figure 5-4 of the environmental impact statement.

Issue description

The NRMA would like the Department of Planning and Environment to include a condition of approval that requires the quarterly publication of crash and breakdown data, along with traffic volume data. This would help the NRMA and the community to gauge how well the project is working, including any innovative treatments within the tunnels, to make comparisons with other motorways and to have positive inputs into future road projects.

Response

The New South Wales Centre for Road Safety is responsible for gathering and publishing data on road traffic crashes. Relevant data would be provided to the Centre for Road Safety as required, and it is not proposed to duplicate its reporting role.

7.3.2 Public Health Association of Australia

Issue description

The Public Health Association of Australia recommends the relocation of the ventilation outlets to higher ground and extending the height of the ventilation outlets such that adequate atmospheric dispersion occurs.

Response

Section 3.2 of this report considers alternative ventilation designs, including changes in the locations and heights of the northern and southern ventilation outlets. Based on this analysis, the heights of both the northern and southern ventilation outlets are proposed to be increased in height by five metres above the heights detailed and assessed in the environmental impact statement. This proposed project change and an assessment of its impacts are provided in **Section 9.2** of this report.

Based on the analysis presented in **Section 3.2** of this report, relocation of the northern and/ or southern ventilation outlets is expected to have a minimal effect on air quality and human health risks. In both cases, relocation of the ventilation outlets would introduce additional environmental and land use impacts, engineering constraints and project costs that are not warranted or desirable based on expected minimal changes in air quality or human health risks. The environmental impact statement has already demonstrated that the air quality impacts and human health risks posed by the project are very low. On this basis, relocation of the project's ventilation outlets has not been pursued.

Issue description

The Public Health Association of Australia recommends the installation of an efficient filtration system on the ventilation outlets, and operating procedures that ensure the filtration remains switched on.

Response

Further information about the availability and efficacy of in-tunnel air treatment systems such as filtration is provided in **Section 3.1** of this report, while application of that technology to the NorthConnex project is considered in **Section 3.2**.

Issue description

The substantive health costs downstream from multi system health effects should be by placing the tunnel portals and ventilation outlets in non-residential and non-school areas.

Response

The air quality impact assessment and the human health risk assessment included in the environmental impact statement demonstrate that the NorthConnex project in its current form would meet ambient air quality criteria and would pose a very low risk to human health. In this context, there is no technical basis to justify relocation of the northern portals and/ or northern ventilation facility to an alternative location. Further, the analysis of ventilation options and alternatives presented in **Section 3.2** of this report shows that relocation of the northern ventilation outlet would introduce additional environmental and land use impacts, engineering constraints and project costs with no material change in air quality impacts or human health risks.

The most efficient location for ventilation outlets is close to the main alignment tunnel exit portals. This is because vehicles travelling through the tunnels create a piston effect, which draws air into the tunnel and pushes it forward in the direction of traffic flow. Locating the ventilation outlets near the main alignment tunnel exit portals maximises the benefit of the piston effect and minimises the need for additional energy consumption to operate tunnel jet fans and to transport the exhaust air from the tunnel to the outlet. This approach provides environmental benefits through the reduction in energy consumption and greenhouse gas emissions from the project.

The locations of ventilation outlets for the project have been determined based on proximity to the main alignment tunnel exit portals, as well as consideration of other factors including land access and acquisition requirements, geology, engineering and construction constraints, potential landscape and visual impacts, and the location of other major infrastructure.

Issue description

Modelling accuracy depends on the assumptions and parameters used, and cannot be fully relied upon given the degree of uncertainty in meteorological assumptions, topography, and the projected amount of vehicular emissions. The Public Health Association of Australia recommends that local microclimate conditions be assessed prior to decisions regarding the placement of ventilation outlets.

Response

It is recognised that the veracity of modelling outputs is influenced by the quality and accuracy of modelling assumptions and inputs. In the case of uncertainty in those assumptions and inputs, it is good practice to apply a reasonable level of conservatism to ensure that the modelling outputs are similarly conservative. This approach has been applied to the environmental impact assessment of the NorthConnex project, including in relation to the assessment of air quality impacts and human health risks. Despite the application of several levels of conservative assumptions, the environmental impact statement has demonstrated that the project will have a very low impact on local and regional air quality and a very low impact on human health. Based on the conservatism inherent in the modelling and assessment of these potential impacts, the actual impacts of the project during its implementation are likely to be lower than predicted.

Further discussion of key air quality modelling inputs and assumptions is provided in **Chapter 2** of this report.

Issue description

Consideration should be given to tunnel ventilation design options and freight transport alternatives such as surface orbital routes or railway transport that may assist in mitigation of risks to health, whilst ensuring efficient freight transport.

Response

An analysis of ventilation design options and alternatives is provided in **Section 3.2** of this report.

Prior to the NorthConnex project being proposed, an alternatives and options assessment including rail upgrades and consideration of various potential road alignments was undertaken by SKM in 2004 (the 2004 report). Specifically, the 2004 report considered a number of strategic alternatives. This included a 'do nothing / do minimum' alternative which involved upgrades to the existing road corridor, a rail and public transport upgrade alternative, and a road link between the M1 Pacific Motorway and the Sydney Orbital Road Network.

This investigation found that:

- The 'do nothing / do minimum' alternative would not provide a suitable long term solution from a strategic, regional, local planning or transport perspective.
- The rail and public transport upgrade alternative alone would not be unlikely to satisfy future growth in transport demand.

In recent years significant investments in rail-based freight and passenger transport have been committed and the Epping to Thornleigh Third Track project and the North West Rail Link are currently under construction.

Although these improvements will play an important role in servicing the region, public transport alone and in particular rail transport, is unlikely to completely satisfy future growth in transport demand. As traffic volumes grow, there will be greater pressure to improve the efficiency of the National Road Network to service expanding commercial centres and to cater for local and district freight transport demands and in doing so, support the State's economy.

Based on the above, a road link between the M1 Pacific Motorway and the Sydney Orbital Road Network was identified as the preferred solution from a strategic, regional, local planning and transport perspective.

Issue description

The Public Health Association of Australia urges intersectoral collaborative approaches between government planning departments, roads ministries, private developers, and the medical and scientific communities to ensure there is protection for public health.

Response

The NSW Government, principally through the Environment Protection Authority, continues to work to improve air quality in Sydney and across New South Wales. Action for Air (EPA, 1998) and regular updates, the most of recent of which was released in 2009, provide an air quality management for Sydney, the Illawarra and the Hunter regions. It also details the initiatives and actions being undertaken to manage and improve air quality across these regions. Initiatives progressed as part of Action for Air involve various government agencies as relevant to the action. For example, Roads and Maritime works with the Environment Protection Authority to investigate and implement actions relating to road transport.

Issue description

Given the substantive known health risks, and emerging data on risks to health from ultrafine particulates, the Public Health Association of Australia urges policymakers to apply the precautionary principle to mitigate risks to public health.

Response

The human health risk assessment conducted for the project and presented in Section 7.4 and Appendix H of the environmental impact statement recognises that there is no threshold below which exposure to particulate matter, and particularly fine particulate matter (2.5 micrometres or less), does not generate a human health effect. Because of this, a risk-based assessment approach for particulate matter exposures has been adopted and applied as part of the environmental impact statement. The human health risk assessment has demonstrated that the project would pose a very low health risk, and taking into account all relevant populations along the Pennant Hills Road corridor, is likely to have a net positive human health outcome.

Issue description

Tunnels concentrate the flow of vehicular traffic into their entry and exit areas, thereby increasing emissions at these points. Tunnels further concentrate vehicular emissions, and at the ventilation points they are then pumped into the atmosphere. The dispersion of these concentrated emissions depends on the velocity of the emissions, as well as wind speeds and topography. The local microclimate has a significant impact on dispersion and has not been modelled in the NorthConnex environmental impact statement.

The dispersion effect of a ventilation outlet is dependent on its height, meteorology, topography of the surrounding area, and the levels of in tunnel vehicular emissions.

Response

As noted by the Public Health Association of Australia, dispersion of emissions from the project's ventilation outlets will depend on several factors, including the thermodynamic conditions of the discharge (temperature and pressure), the velocity and flowrate of the discharge, the initial concentration of pollutants at the point of discharge, the height of the discharge location above the ground and relative to surrounding structures, topography and meteorology. Each of these factors has been taken into account as part of the air dispersion modelling and air quality impact assessment presented in the environmental impact statement.

The air quality impact assessment has included modelling of meteorological conditions in and around the northern and southern ventilation outlets, and across the region surrounding the project. Further discussion of air dispersion modelling assumptions and inputs, including meteorological modelling, is provided in **Chapter 2** of this report.

Issue description

A valley is the least ideal location for a ventilation outlet because the height of valley will detract from the height of outlet - this results in poorer dispersion and in accumulation of particulate matter. For example, the northern ventilation outlet will be located in a valley 15 metres deep, surrounded by dense tree canopy approximately 20 metres high. The ventilation outlet height of 23 metres will be inadequate to disperse pollutants away from this location.

If the air mass is stable there is no dispersion the emission plume will descend into the valley and remain there, leading to significant pollution episodes. Further compounded by topography, pollutants released in a valley would be more likely to be trapped under such conditions. In the case of the northern ventilation outlet there is limited wind flow and predominantly stable air in the proposed valley location. Ventilation outlets located in this valley will therefore increase deposition of particulate matter in the immediate surrounds.

Response

Further discussion of air dispersion modelling assumptions and inputs, including meteorological modelling, is provided in **Chapter 2** of this report. This includes discussion of how local topography has been conservatively accommodated in the air dispersion modelling.

A more detailed analysis of the potential for emissions from the project's ventilation outlets to become 'trapped' under thermal inversion layers in light wind conditions has been analysed in more detail as part of the response to Hornsby Council's submission. This analysis is included in **Section 7.2.1.1** of this report.

Issue description

The NorthConnex tunnel at present has no exhaust fan system to ensure outside air will be actively drawn into the tunnel entry. The design proposes to use a piston effect from the moving vehicles to propel the emissions along the tunnel. However the air flow from the piston effect may not be sufficient to propel emissions into the ventilation outlets. It is likely that emissions will pool at the tunnel entry, within the tunnel and at ground level at the exits.

Response

The project's ventilation system has been designed to operate with a pressure differential between the ventilation off-take and the portal. This pressure differential will act to draw air close to the tunnel portals back into the tunnel for collection and management with other tunnel air, via the relevant ventilation off-take and associated ventilation facility. This operational principal has been applied to both main alignment tunnel and off-ramp tunnel portals such as the off-ramp at Pearce's corner. Further details regarding the operation of the project ventilation system is provided in Section 5.2.5 of the environmental impact statement.

Issue description

The models for predicting ambient air quality around ventilation outlets depend on multiple variables that are not easy to take into account. Emission levels vary dependent on time of day, traffic congestion and type of vehicles. The background monitoring of air quality data has to be collected at the site of the outlet to have any meaningful comparisons in modelling scenarios.

In the case of the NorthConnex tunnel assessment, the background air quality data has been collected at sites remote from the emission outlet locations at meteorological stations in Prospect and Lindfield, some 21 kilometres away. This data may not be representative of the local microclimates in which the emission outlets are being placed. The Public Health Association of Australia recommends that prior to a significant infrastructure project of this magnitude being approved that appropriate microclimate data be collected and assessed by the project proponents, to justify the site of the emission outlets and to ensure adequate dispersion occurs, above atmospheric inversion layers that are commonly present in stable microclimate areas such as valleys.

Response

Chapter 2 of this report provides further information and analysis of inputs and assumptions into the air dispersion modelling conducted for the project. This analysis demonstrates that assumptions and modelling of background air quality, local topography and local meteorology are reasonable and conservative. In most cases the assumptions applied to the air dispersion modelling are likely to have contributed to an overestimation of potential air quality impacts, and consequently, an overestimation of potential human health risks.

Issue description

There are no models for estimating ultrafine particles in ambient air. Existing standards for air quality that rely purely on PM_{10} or $PM_{2.5}$ are insufficient to gauge the full risk to public health from finer particles. There are at present no World Health Organization guidelines or Australian standards for ultrafine particles; however, there exists a reasonable understanding of the potential health consequences of exposure to these particles.

Response

A detailed discussion of particulate matter, including studies into the health effects of exposures to $PM_{2.5}$ (as well as the ultrafine components of the $PM_{2.5}$ fraction) is provided in Section 4.4.2 of the Technical Working Paper: Human Health Risk Assessment.

When assessing health impacts from fine particulates, the robust associations of effects (that are based on large epidemiology studies primarily from the US and Europe) have been determined on the basis of $PM_{2.5}$, as $PM_{2.5}$ is what is commonly measured in urban air. No robust associations (that can be used in a quantitative assessment) are available for PM_1 and the current science is inconclusive in relation to ultrafine particulates. The associations developed for $PM_{2.5}$ would include a significant contribution from PM_1 (as $PM_{2.5}$ comprises a significant proportion of PM_1) and hence health effects observed for PM_1 would be captured in the studies that have been conducted on the basis of $PM_{2.5}$. It is important that the quantitative evaluation of potential health impacts adopts robust health effects associations and utilises particulate matter measures that are collected in the urban air environment. Hence the assessment of exposure to fine particulate matter presented in the environmental impact statement has focused on particulates reported/evaluated as $PM_{2.5}$.

Issue description

There is no validated understanding of interactions between air pollutants and their compounded harmful effects. Once emitted, air pollutants are modified by meteorological factors such as sunshine, temperature and humidity, as well as the interactions between the mixes of pollutants. These interactions lead to nucleation processes, which form particles of different sizes - which are more complex to investigate.

Response

The human health risk assessment presented in Section 7.4 and Appendix H of the environmental impact statement has assessed exposures to volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). Health related evidence supports the approach taken it he human health risk assessment, which involved the addition of individual risks, rather than supporting synergistic interactions (multiplication of risks) for these chemicals.

Oxides of nitrogen undergo reactions with ozone in the atmosphere, through well-understood atmospheric chemistry associated with the formation of photochemical smog. These reactions have been taken into account in the air dispersion modelling and impact assessment presented in the environmental impact statement.

Carbon monoxide can be involved in many different atmospheric reactions, including having a role in ozone and photochemical smog formation. Carbon monoxide typically eventually oxidises to carbon dioxide in the atmosphere. In the context of the air quality impact assessment for the NorthConnex project, carbon monoxide has been assumed to not react in the atmosphere. This is a conservative approach, noting that carbon monoxide is a more significant air quality and potential human health issue than carbon dioxide.

Under normal atmospheric conditions, volatile organic compounds and polycyclic aromatic hydrocarbons may undergo reactions and/ or degrade to form a series of other hydrocarbon compounds. These reactions are typically complex, and in some cases not well understood. This level of atmospheric chemical complexity has not been taken into account in the air quality impact assessment for the project. Instead, volatile organic compounds and polycyclic aromatic hydrocarbons have been considered in two groups (despite both groups containing several different compounds), and conservatively compared with the most stringent ambient air quality criterion from the compounds in each group. These most stringent ambient air quality criteria relate to benzo[a]pyrene and benzene, for polycyclic aromatic hydrocarbons and volatile organic compounds, respectively.

In the case of particulate matter, it is recognised that under some conditions, particles can combine in the atmosphere to generate coarser particulates. This mechanism has not been taken into account in the air dispersion modelling. This is a conservative approach, because

an important focus of the air quality impact assessment and human health risk assessment presented in the environmental impact statement is fine particulates ($PM_{2.5}$). Any reaction, combination or agglomeration of fine particulates to produce larger particulate matter would generally reduce the concentration of fine particulates, and as a corollary, the key air quality and human health risks considered in the environmental impact statement

Issue description

The plume effect of ventilation outlets results in short bursts of highly polluted air being released from the outlet into its immediate vicinity. The plume effect is difficult to measure since most measurement devices estimate hourly ambient air quality or average ambient air quality over a period of time such as 12 months. Monitoring is generally averaged over 12 months hence plume effects are not accounted for in the environmental impact statement for NorthConnex.

There exists no particle that can effectively be measured to indicate if ambient air pollution is from surface roads or from a ventilation outlet. The source appointment of emissions in the case of NorthConnex outlets is very complex.

Response

The air dispersion modelling conducted for the project has modelled the concentration of pollutants at more than 6,900 individual receiver locations for every hour over a three year modelling period. Averaging periods have been applied to modelling results to enable direct comparison with applicable ambient air quality criteria, which typically including averaging periods over one hour, eight hours, 24 hours or one year.

It is recognised that ambient monitoring of air quality impacts from a project like the NorthConnex project can be difficult due to the very low contributions it would make to the local air shed, and given that the pollutants in question are commonly emitted from other sources in the air (ie surface roads). In these circumstances, monitoring is typically conducted at the ventilation outlets concurrently with ambient monitoring for a specified period of operation. This monitoring is used to confirm the relationships between outlet discharge conditions and ambient air quality impacts, and to provide confidence that outlet discharge limits are sufficient to ensure that ambient air quality criteria are not exceeded. This sort of monitoring data is also useful in calibrating air dispersion models such as the one used for the air quality impact assessment of the project. An air dispersion model for the project which has been calibrate with operational air quality data provides a higher level of confidence about the air quality performance of the project.

Issue description

Given the levels of direct increases in air pollutants in the immediate surrounds of a ventilation outlets, difficulties in accurately predicting and modelling the dispersion of the particulate and gaseous pollutants from the outlet, and the serious nature of potential health impacts on adults and children, this submission reaffirms that any decrease in ambient air quality below background levels in densely populated regions, represents a significant risk to the morbidity and mortality of the exposed population.

Response

The human health risk assessment presented in Section 7.4 and Appendix I of the environmental impact statement recognises that changes in air quality has the potential to affect human health – both positively and negatively. This is particularly the case for particulate matter ($PM_{2.5}$) for which there is no recognised threshold below which there would not be a health effect.

Section 7.4 and Appendix I of the environmental impact statement present a risk based assessment of potential changes in human health outcomes as a result of the project. This includes for parts of the population that would experience increases in ambient concentrations of air pollution, as well as populations along Pennant Hills Road that would experience a net reduction in air pollution. The human health risk assessment demonstrates that the project would have a net positive human health effect, when all potentially affected populations are taken into account. Those populations that may experience a minor deterioration in air quality have been assessed as likely to be affected by a very low change in human health risks.

Issue description

The modelled air quality in the NorthConnex environmental impact statement predicts a negligible increase in pollutants above background levels. This prediction heavily relies on wind speed and terrain data that has been extrapolated from remote sites – these data may not be representative of the local microclimate.

Two air quality monitoring stations were used to establish ambient air quality for the modelling, one at Lindfield and the other Prospect. These air quality monitoring stations are both south of NorthConnex and are 9.7 kilometres and 11 kilometres respectively from the southern portal, and 9 kilometres and 21 kilometres respectively from the northern portal. The stations are also located at 60 metres AHD whereas the northern outlet is at 180 metres AHD. Both monitoring stations are also located in residential areas.

It is recognised that the methodology for the estimation of background ambient air concentrations complied with the Approved Methods. However, because of the difference in the distance, location, land-use context and height of these stations, the use of data from these air quality stations cannot be considered representative of air sheds in Wahroonga and Pennant Hills. This is particularly in relation to pollutants emitted in high concentrations by vehicles such as NO_2 and $PM_{2.5}$.

Also $PM_{2.5}$ is not measured at either air quality monitoring stations and had to be estimated from the PM_{10} concentrations. The Lindfield air quality monitoring station also does not meet the current Australian and international standards for the siting of air quality and meteorological monitoring stations.

Due to these issues, the ambient air quality data used in the modelling cannot be guaranteed to be representative of actual air quality. For a nine kilometre longitudinally ventilated tunnel such as the NorthConnex project, ambient air quality at either end of a tunnel is important as the local air sheds and associated air quality can be very different.

The Public Health Association of Australia recommends the collection of sufficient site-specific ambient air quality information for at least one year (as per the Environment Protection Authority's Approved Methods) and repeat air quality modelling. The Public Health Association of Australia also recommends that the proponents undertake longer term ambient air quality monitoring at key project locations.

Response

Further discussion of assumptions and inputs into the air dispersion modelling conducted for the project is provided in **Chapter 2** of this report. This includes analysis of background air quality data used in the air quality impact assessment and demonstrative that it is appropriate for use in the assessment of the project.

Issue description

In addition to potentially inaccurate meteorological and terrain assumptions, there are several further assumptions in the modelling for the environmental impact statement that the Public Health Association of Australia believes are questionable:

- The assumption that the tunnel intake is "fresh air" with no levels of pollutants has been made however, the intake areas are at busy surface roads.
- There is an underestimation of the concentrations of pollutants that are emitted from heavy freight diesel vehicles.
- Increases in tunnel users over time will result in increases in emissions over time.
- There is a reliance on low background levels of air pollution in Sydney compared with Beijing. While the overall air quality in Sydney may not be affected, there is no consideration of susceptible local populations.

As a result of these assumptions the actual amounts of pollutants discharged into local microclimates via ventilation outlets is likely to result in significantly higher pollutant concentrations than the "negligible" amounts that have been predicted in the environmental impact statement.

Response

Further information on meteorological and terrain assumptions applied to the air quality impact assessment is provided in **Chapter 2** of this report. This information demonstrates and confirms that meteorological and terrain assumptions are reasonable and conservative.

With respect to the other issues raised by the Public Health Association of Australia, **Chapter 2** provides details of air quality impact assessment assumptions, including:

- Further analysis of the potential implications of drawing ambient air from within the road corridor into the project's entry tunnels of predicted air quality impacts. The analysis demonstrates a negligible change in modelled ambient air quality outcomes.
- Further consideration of changes in petrol-diesel fuel mix in the vehicle fleet. Although this analysis demonstrates a minor change in total emissions across the vehicle fleet considered with a change in petrol-diesel assumptions, a more conservative petrol-diesel assumption has nonetheless been used in the additional air dispersion modelling to support the five metre increase in ventilation outlet heights (refer to **Section 9.2** of this report).
- The project has been assessed under forecast traffic volumes in 2019 and 2029, as well as a worst case traffic scenario ('design analysis A'). Further information on traffic forecasts and the derivation of 'design analysis A' are provided in **Section 2.7** of this report (in response to the submission received from the Environment Protection Authority). The assessment of the project has therefore taken into account the full potential range of traffic volumes that could conceivably use the project.
- Background air quality data used in the air quality impact has been monitored in the Sydney air shed, and is to be conservative and appropriate for use. The background air quality data does not rely on comparisons with air quality in other cities, including Beijing.

Issue description

As stated, the medical and scientific community has recently revised its current National Environmental Protection Measures (NEPM) to better reflect the growing and substantive health impacts from vehicular air pollutants in the medical literature.

These changes are described in depth at:
http://www.environment.gov.au/system/files/pages/dfe7ed5d-1eaf-4ff2-bfe7-dbb7ebaf21a9/files/aaq-nepm-draft-variation-impact-statement-executive-summary.pdf

The new NEPM guidelines state:

> *"The need to reduce atmospheric concentrations of particulate matter (PM) derives principally from its well-recognised and quantified effects upon human health. The recent historical trend of decreasing ambient concentrations of PM_{10} and $PM_{2.5}$ is expected to be reversed in the future due to growth in population, economic activity and emissions, with subsequent increases in population exposure and the incidence of adverse health outcomes, and increases in the monetary costs of air pollution to society.*
>
> *It is likely to be more difficult to meet the national air quality standards and goals for particulate matter in the future without proactive intervention, risking sufficient protection for Australian public health. Intervention is considered necessary to prompt and accelerate policies and measures to reduce population exposure to particulate air pollution. Updating the AAQ NEPM will reduce these adverse effects by highlighting potential problems and assisting jurisdictions in the formulation of air quality policies to reduce emissions from different sectors.*
>
> *The WHO numerical guideline for 24-hour PM_{10} of 50 µg/m3 has been adopted in Australia and elsewhere (but not in the United States), even though the number of permitted exceedances is greater in Australia than in the WHO guideline. However, fewer exceedances of the standard are provided for in Australia than in most other countries/regions (an exception being New Zealand).*
>
> *The annual advisory mean standard for $PM_{2.5}$ of 8 $\mu g/m^3$ in Australia is lower than the current WHO guideline. The current 24-hr $PM_{2.5}$ advisory reporting standard of 25 $\mu g/m^3$ is identical to the WHO 2005 guideline."*

Although the Australian particulate matter standards are numerically lower than, or equivalent to, those in other countries and regions, it is not straightforward to interpret such comparisons and they do not necessarily mean that the Australian standards are more stringent. For example, the proponents state that the Australian guidelines are more stringent than other countries, and as long as the "average" levels over 24 hours and 12 months meet the standards the project will be safe. However, averages of pollutants over a given timeframe, do not account for exposures to emission plumes (large amounts of emissions) from emission outlets for the population in close proximity to the outlets.

As noted earlier, there would still be health benefits in Australia from setting the particulate matter standards as low as reasonably achievable, given there is no safe threshold for particulate matter exposure. Also, there are differences in implementation of standards in Australia compared with other countries. For example, there are no sanctions associated with non- compliance with the standards and goals in Australia, whereas there are in other countries and regions.

Response

The environmental impact statement does not state that average particulate matter concentrations would be safe, provided that those averages are below current advisory reporting standards. On the contrary, the environmental impact statement accepts that there is no threshold below which exposure to particulate matter ($PM_{2.5}$) would not generate a health effect. Because of this, the environmental impact assessment includes a human

health risk assessment that expressly calculates the change in health outcomes associated with predicted exposures to $PM_{2.5}$ (without the application of a dose-response threshold).

The human health risk assessment is presented in Section 7.4 and Appendix I to the environmental impact statement. It demonstrates that the human health risks posed by the project are essentially negligible, and that predicted increases in incidence of health outcomes are within existing background variability.

Issue description

Particulate matter is a non-threshold pollutant. This means that adverse health impacts occur at levels below current standards. As stated below in the latest NEPM review:

> *"In Australia for non-threshold pollutants such as PM, overall health outcomes in a population are driven by large- scale exposure to the prevailing average concentrations, rather than by relatively small-scale exposure to higher concentrations. Where there are no exceedances of air quality standards there may be no impetuses to implement measures to further reduce exposure to PM. This has compelled a shift in the approach to air quality management, and in some countries and regions (notably the European Union) this has taken the form of an 'exposure-reduction framework'. The scientific support for the exposure-reduction approach to managing PM has been strengthened by the latest health findings".*

This articulates the current scientific thinking that infrastructure projects minimise population exposure to particulate matter, to below current standards, as significant health impacts occur even below current standards, especially when large populations are exposed, as is the case with the NorthConnex project design.

The NEPM provides a guideline only to assist policymakers, and these guidelines should not be used as an absolute value against which to measure the safety of NorthConnex tunnel emission levels. Rather, the NorthConnex tunnel, ventilation outlets, and portal emissions sites should be designed to ensure there is an overall reduction of population exposures to particulate matter.

As stated in the NorthConnex project environmental impact statement:

> *"Particulates that are derived from specific sources, such as diesel emissions, are known to comprise other compounds such as volatile organic compounds and polycyclic aromatic hydrocarbons that are known to also be associated with adverse health effects. The presence of these other compounds has been addressed separately however the presence of these (and likely other compounds) compounds and other co-pollutants (also derived from combustion sources) adds to the complexity of utilising data from urban air epidemiological studies for assessing health effects from particulate matter."*

As the epidemiological data is complex, and interactions between particulates and other compounds emitted are unknown, the Public Health Association of Australia questions the conclusion as stated in the environmental impact statement that there are negligible health impacts from such a long tunnel, with large amounts of diesel emissions, two ventilation outlets and no filtration.

The Public Health Association of Australia's concern is that the nature of health risks associated with the emissions is too serious to rely solely on the modelling and assumptions that predict negligible health risks in the proponent's environmental impact statement.

Government departments would be prudent in applying the precautionary principle, to safeguard public health from known and future health risks. The problems associated with the exposure to emissions from the placement of outlets and portals in residential areas should be considered now, and rectified in the design stages to ensure harm minimisation.

Response

The environmental impact statement accepts that there is no threshold below which exposure to particulate matter ($PM_{2.5}$) would not generate a health effect. Because of this, the environmental impact assessment includes a human health risk assessment that expressly calculates the change in health outcomes associated with predicted exposures to $PM_{2.5}$ (without the application of a dose-response threshold). Further analysis of feasible and reasonable measures to minimise exposures to vehicle emissions, including particulate matter is included in **Section 3.2**. Based on this analysis, an increase in the height of the southern and northern ventilation outlets has been demonstrated as a feasible and reasonable measure to further minimisation ambient air quality impacts and associated human health risks.

It is relevant to note that the project would not generate air pollution that is not already released in an uncontrolled manner at ground level along Pennant Hills Road. In fact, the free flowing motorway standard connection provided by the project is likely to lead to a net reduction in pollution loads emitted to the air shed by providing an alternative to stop-start congested traffic conditions along Pennant Hills Road. Avoiding stop-start congested traffic congestions along Pennant Hills Road, a heavy vehicle would emit 80 to 86 per cent less carbon monoxide, 70 to 80 per cent less oxides of nitrogen and 71 to 78 per cent less particulate matter (as PM_{10}). The NorthConnex project is therefore not just better managing vehicle emissions – it is actually facilitating a reduction in total vehicle emissions along the Pennant Hills Road corridor

It is also relevant to recognise that vehicle emissions are not an issue that is unique to the NorthConnex project, with vehicle emissions already occurring across Sydney along surface roads and other road tunnels.

Issue description

The environmental impact statement for the NorthConnex project states:

> *"Based on the available studies, there is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur.*
>
> *At present, at the population level, there is not enough evidence to identify differences in the effects of particles with different chemical compositions or emanating from various sources."*

However, whilst these factors pose difficulties in the assessment and specific modelling of ultrafine particulates, our current knowledge suggests that there are reasonable scientific grounds to believe ultrafine particles negatively impact health, and reductions in population exposure in the longer term is imperative to protect health. We cannot conclude that there is no risk from ultrafine particles to human health, merely because the medical research is evolving and that specific monitoring of ultrafine particles has not generally been performed in the available research to date. The precautionary principle needs to be applied.

Response

The environmental impact statement does not conclude that there is no risk from ultrafine particulate matter to human health. In fact, the human health risk assessment presented in

Section 7.4 and Appendix I to the environmental impact statement expressly includes a risk based assessment of potential human health risks from exposures to $PM_{2.5}$. As noted earlier, no robust associations (that can be used in a quantitative assessment) are available for PM_1 and the current science is inconclusive in relation to ultrafine particulates. The associations developed for $PM_{2.5}$ would include a significant contribution from PM_1 (as $PM_{2.5}$ comprises a significant proportion of PM_1) and hence health effects observed for PM_1 would be captured in the studies that have been conducted on the basis of $PM_{2.5}$.

Issue description

The NorthConnex environmental impact statement states that filtration is:

> *"Bulky and less cost-effective than conventional ventilation systems, both in terms of investment and operation. Generally-speaking, these systems are also energy-intensive given the surplus ventilation requirements."*

The NorthConnex environmental impact statement also quotes from a French government international assessment of the air in road tunnels stating:

> *"Others emphasise the potential benefits of first optimising the various pollution dispersion factors linked to tunnels, such as the position of portal or the location of stacks enabling the displacement and dispersion of pollutants away from residential areas."*

The NorthConnex project primarily uses the costs and performance of the M5 East Motorway filtration trial in Sydney as the main justification for not considering filtration of the tunnel emissions before discharge via emission outlets into residential precincts.

The M5 East Motorway filtration trial involved a retrofit of an in-tunnel air treatment system. To do this for additional tunnels, an underground cavern for the filtration equipment, additional auxiliary infrastructure (such power supply) and additional jet fans were required to be installed and operated. As this electrostatic precipitator system (ESP) was retrofitted, and it was not included in the original design, the filtration system was not able to be optimised.

The AMOG Consulting report on the M5 East Motorway filtration trial recognised that electrostatic precipitators were significantly under capacity for the volume of air delivered to them. The report suggests that this was the reason for the relatively poor efficiency of the electrostatic precipitators in removing particulates and the reliability issues of the electrostatic precipitators. The poor efficiency and reliability of the electrostatic precipitators were also a major factor in relatively high operating costs of the M5 East Motorway filtration trial.

Despite this, the electrostatic precipitators removed 65 per cent of particulate matter, and hence were effective in this regard. In addition this estimate was derived from the filtration of only 50 per cent of the westbound tunnel and with the electrostatic precipitator only turned on for four hours a day. With these operating parameters of course the trial was only able to show removal of a small proportion of the total in tunnel particulate matter.

The costs and works required to install a filtration system for the NorthConnex project require consideration. The filtration system could be designed and installed in the proposed ventilation buildings during the design and development stages. Realistic cost estimates for installing filtration and an independent study on the costs and benefits of filtration, need to be undertaken.

Response

Further information on the availability and efficacy of in-tunnel air treatment systems (including filtration) is provided in **Section 3.1** of this report. The analysis of ventilation system design options and alternatives in **Section 3.2** of this report considers the application of in-tunnel air treatment systems to the NorthConnex project and concludes that these systems are not feasible and reasonable.

The environmental impact statement includes an analysis of tunnel filtration systems and explains why such systems are not warranted for the NorthConnex project (refer to Section 7.3.1 of the environmental impact statement). The environmental impact statement demonstrates that the NorthConnex project would meet ambient air quality criteria and would pose a very low risk to human health. In this context, there is no technical basis to justify installation of filtration systems.

Issue description

Because of the reliance on the piston effect in the NorthConnex project tunnel design it is more difficult to propel all emissions into the tunnel, successfully capture all the tunnel air, and discharge it via a ventilation outlet. It is more likely that a proportion of the tunnel air will not be captured and will escape via the tunnel portals such as those for the M5 East Motorway tunnel.

Whilst this proposal does not seek approval for portal emissions, the proponents refuse to rule out future portal emissions, and the ability to discharge emissions via portals in residential areas is included in the tunnel design.

This poses specific risks to human health, as unfiltered emissions will be discharged at ground level, near residences and schools located close to portals. The Public Health Association of Australia suggests that the portals should be sited away from residential and educational precincts, and that emission outlets are designed with adequate dispersion to reduce the need to discharge emissions through portals.

Response

The project does not propose any emissions from the tunnel portals under normal operating conditions. As such, the assessment has not considered portal emissions. If portal emissions are considered in the future, this would be subject to appropriate assessment and approval at the relevant time.

The project's ventilation system has been designed to operate with a pressure differential between the ventilation off-take and the portal. This pressure differential will act to draw air close to the tunnel portals back into the tunnel for collection and management with other tunnel air, via the relevant ventilation off-take and associated ventilation facility. This operational principal has been applied to both main alignment tunnel and off-ramp tunnel portals. This is a common management approach in road tunnels where portal emissions are prohibited.

Issue description

In addition to the scientific arguments there are strong economic arguments to mitigate health risk.

The recent review of the NEPM guidelines states:

> *"Any reduction in exposure to particle pollution will have public health benefits. The health cost of particle air pollution in the NSW Greater Metropolitan is estimated to be*

around $4.7 billion per year (NSW DEC 2005; Jalaludin et al. 2011). The greatest proportion (>99%) of the health costs accrue from avoiding premature deaths due to long-term exposure to $PM_{2.5}$"

Health costs downstream from poorly designed infrastructure are a key motivation to ensure vehicle transport projects are well designed. Public and private sector infrastructure developers must also improve in their attitude to global citizenship. These companies should be accountable for the health effects on populations. Government should apply risk mitigation strategies. For example, this may include appropriate design of surface transport infrastructure, consideration of rail freight transport options which produce less diesel, appropriate placement of tunnel portal emissions and ventilation outlets in non-residential areas, and installation and continuous operation of filtration in tunnel emission outlets.

Given the substantive and emerging data on health risks posed by vehicular emissions, especially diesel vehicles, the Public Health Association of Australia calls on policy makers to take action to promote clean air, reduce population exposure. Particularly as Australia is an advanced economy, cost limitations for these projects should not affect the protection of population health.

Response

Air quality in Sydney and in New South Wales is generally very good. This is supported by monitoring and reporting through reports such as the State of the Environment (EPA, 2012).

The NSW Government, principally through the Environment Protection Authority, continues to work to improve air quality in Sydney and across New South Wales. Action for Air (EPA, 1998) and regular updates, the most of recent of which was released in 2009, provides an air quality management for Sydney, the Illawarra and the Hunter regions. It also details the initiatives and actions being undertaken to manage and improve air quality across these regions. Roads and Maritime are working with the Environment Protection Authority to investigate and implement actions in relation to road transport to improve air quality.

The NorthConnex project will not generate air pollution. Emissions from the project's ventilation outlets are vehicle emissions that are currently released at ground level along Pennant Hills. These emissions currently occur and would continue to occur, irrespective of the NorthConnex project. Importantly, the NorthConnex project would collect, manage and effectively disperse these emissions in a controlled manner and would lead to an overall improvement in air quality and human health outcomes along the Pennant Hills Road corridor.

The environmental impact statement has demonstrated that the project would comply with applicable ambient air quality standards. However, recognising that there is no threshold below which there is no observable health effects for some vehicle exhaust components, particularly fine particulate matter (measured as PM2.5), a detailed human health risk assessment has also been conducted. This approach recognises that reliance on ambient air quality standards as a measure of potential human health effects is insufficient, and that a more detailed analysis of health risks is warranted. This more detailed analysis is presented in section 7.4.4 and Appendix H of the environmental impact statement. The human health risk assessment demonstrates that the project is expected to have a net positive effect on human health outcomes along the Pennant Hills Road corridor. Where increased incidence of human health effects are predicted, these effects would not be discernible from background incidence rates.

Further analysis of feasible and reasonable measures to minimise exposures to vehicle emissions, including particulate matter is included in **Section 3.2**. Based on this analysis, an increase in the height of the southern and northern ventilation outlets has been

demonstrated as a feasible and reasonable measure to further minimisation ambient air quality impacts and associated human health risks. The analysis of ventilation system design options and alternatives also considers the application of in-tunnel air treatment systems to the NorthConnex project and concludes that these systems are not feasible and reasonable.

Issue description

The health impacts on the exposed population may be assessed using a large-scale prospective cohort study. This study would look at the health consequences of exposure to air pollutants on 9,300 school children. As found by Gaudermann et al in a study of school children in California, we could anticipate reduced lung growth in this susceptible age group. For a similar prospective cohort analysis we would enlist children in Grade 4 at all the local schools in Wahroonga in the year prior to the NorthConnex tunnel opening. Baseline pulmonary function values would be recorded for these children. Once the tunnel opens, these children would be followed up for a period of eight years, with annual spirometric testing and recording of symptoms. A comparison cohort in Grade 4 from schools outside the two kilometre radius of the outlet would also be enlisted. If there is any decline in the exposed children's lung development, the Public Health Association of Australia would be concerned about the long term effects on mortality and morbidity of this subgroup, the long term health costs, opportunity costs to the economy and reduced productivity, and the impairment to the daily functioning of these children.

Response

A human health risk assessment has been carried out as part of the environmental impact statement (refer to Section 7.4 and Appendix F). The assessment was carried out in accordance with the Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards (enHealth, 2012). The human health risk assessment includes consideration of potential impacts on the general population, as well as more sensitive receivers such as children, the elderly and people with existing respiratory issues.

The results of this assessment identify that the potential increase in health outcomes has been determined to be negligible and undetectable above the normal annual variability in cases per year for all health outcomes assessed.

7.3.3 Woolcock Institute of Medical Research

Issue description

Clarification is sought on whether the Advisory Committee on Tunnel Air Quality includes a public health practitioner with air quality-health experience, given that the mandate of the Committee is to review national and international practice and experience with motorway tunnels to safeguard public health and the health of motorists.

Response

The Advisory Committee on Tunnel Air Quality is chaired by the New South Wales Chief Scientist and Engineer, Professor Mary O'Kane and includes senior representatives from relevant Government agencies, including NSW Health, the Environment Protection Authority and the Department of Planning and Environment. The Committee can draw on the expertise of those agencies, as required.

Issue description

The ventilation outlets will have maximum exhaust capacity of around 700 m^3 per second. Comment is sought on the minimum and average capacities of the ventilation system.

Response

The maximum ventilation outlet flow rate is 700 m^3/s. In practice, a minimum ventilation flow rate of 300 m^3/s is likely to be required to maintain acceptable in-tunnel air quality. Ventilation flow rates applied to the project's main alignment tunnels would vary during the day between these two limits, depending on the traffic volumes carried by the project at the time and the ventilation required to maintain acceptable in-tunnel air quality.

Issue description

The southern outlet would be approximately 15 metres in height, with a building height of seven metres "when measured from Pennant Hills Road". Clarification is sought in relation to whether this translates to an outlet height of seven metres above Pennant Hills Road. Similarly, the northern ventilation outlet would be approximately 15 metres high with a building height of seven metres when "measured from the neighbouring land". It is not clear what this means in terms of absolute height.

Response

The ventilation outlet heights as described in the environmental impact statement are 15 metres from Pennant Hills Road for the southern ventilation outlet and 15 metres from the surrounding residential area for the northern ventilation outlet. These measurements are for the ventilation outlets themselves, and do not include associated building and structures adjacent or connected to the ventilation outlets.

The building height of seven metres is referring to the remainder of the building associated with the ventilation facilities and not the ventilation outlets themselves.

In response to the analysis of ventilation system design options and alternatives (refer to **Section 3.2** of this report), the height of the southern and northern ventilation outlets has been increased by five metres (to a total height of 20 metres when measured from Pennant Hills Road in the case of the southern ventilation outlet and from the adjacent residential area in the case of the northern ventilation outlet). Further information about the increase in ventilation outlet height and an assessment of the further reductions in air quality impacts and human health risks is provided in **Section 9.2** of this report.

Issue description

The Technical Working Paper: Air quality states that during low traffic conditions, tunnel support facilities would be used to supply additional fresh air to tunnels. This section should define “low traffic conditions”. It is not clear whether this term refers to lower traffic numbers or higher numbers but slower flow (speed), or whether it means lower flow (speed), but congested conditions?

Response

As identified in Section 5.2.5 of the environmental impact statement, these facilities can be used to draw fresh air into the tunnels when required. It is expected that this would be required during low average traffic conditions (which can occur at high or low traffic volumes) when the piston effect of vehicles travelling at higher speeds would be reduced.

Issue description

The environmental impact statement presents results of the project and the Office of Environment and Heritage monitoring, but only for one and 24 hour averaged data. A table is needed with project and the Office of Environment and Heritage site data together for easier comparison. The James Park site seems to have higher particulate matter levels but lower nitrogen dioxide levels than other project sites.

Response

Data collected at the Office of Environment and Heritage monitoring stations is typically presented based on the relevant average periods for each air pollutant, being one hour, eight hour, 24 hour or annual average, as appropriate. Monitoring data is publically accessible on the Office of Environment and Heritage’s website (www.environment.nsw.gov.au).

Further information on background air quality from Office of Environment and Heritage monitoring stations, and from project monitoring stations (including at James Park) is provided in **Section 2.11** of this report.

Issue description

It is not clear how the maximum design capacity of 4,000 passenger car units has been reached, including whether it is based on current and projected traffic flows or other tunnel experiences. Further comment should be provided on whether the environmental impact statement should also include some diesel heavy vehicles in these design analyses scenarios.

Comment should be provided on how these design capacities would compare with flows if a third lane in each direction is built, including whether there would be sufficient capacity to accommodate this.

Response

The maximum traffic capacity of a two lane motorway tunnel is 4,000 passenger car units per hour. This is based on the physical and engineer design capacity of a traffic lane. 'Passenger car units' is a standard, consistent basis for measuring the 'space' taken up by different size vehicles. For example:

- A standard passenger vehicle is one passenger car unit.
- An articulated truck is 2.9 passenger car units.
- A truck and dog is two passenger car units.

Further discussion of the design capacity of each main alignment tunnel is provided in **Section 2.5.1** of this report.

The mix of vehicles forecast to use the project includes passenger cars, light commercial vehicles and heavy vehicles. The environmental impact statement includes an assessment of impacts based on the forecast traffic volumes and vehicle fleet mix derived from data published by the Australian Bureau of Statistics. The air quality impact assessment for the project conservatively assumes that all heavy vehicles are diesel fuelled.

The environmental impact statement is seeking approval to operate the tunnel at two lanes only. If three lanes are required in the future, this would be subject to separate assessment and approval.

Issue description

The text in Section 4.2.2.2 of the Technical Working Paper: Air Quality is slightly contradictory in relation to design analysis B. In the first paragraph it states that design analysis B considers constant emission rates, and in second paragraph, it states that they used forecast hourly volumetric flow rates suggesting variable emissions. Clarification of this issue is required.

Response

Design analysis B has assumed a maximum constant emission rate at the project's ventilation outlets over a 24 hour period. In reality, emissions rates would usually vary as vehicle numbers using the project ebb and flow throughout the day.

Section 4.2.2.2 of the Technical Working Paper: Air Quality (second paragraph) explains that forecast hourly volumetric flow rates (as would be expected in reality, with traffic volumes ebbing and flowing) have been used to calculate the maximum constant hourly emission concentrations for the purpose of design analysis B. This calculation has involved 'scaling up' forecast hourly volumetric flow rates so that a constant maximum concentration at the ventilation outlets is maintained over the 24 hour cycle.

Issue description

It is stated that meteorological data generated for use in the dispersion model "were considered to be representative of local meteorological conditions", but does not specify by whom. It is not clear how the comparisons between the three year-2009-2011 data and the 30 year meteorological data from Sydney Airport or five years of Prospect data were made. Although some of the differences look small, they might be statistically significant. It is not clear whether appropriate analyses have been conducted to test these differences. Also comment should be provided on whether it would be appropriate to use long term weather data from 1929-2013 as a comparison, given that our climate is changing.

Could a meteorologist advise on the appropriate time span for meteorological data for comparative purposes given that the meteorological inputs to the models are critical? For instance, perhaps it is more relevant to compare only data from the last decade. Also, is three years of meteorological data sufficient as inputs to CALMET. What is the sensitivity of the model if more data were used, eg five or ten year timeframe? Is the timeframe limited to three years because of the constraints of the model?

Response

Further discussion of the adequacy and representativeness of meteorological data used in the air quality impact assessment is provided in **Section 2.10** of this report. Advice on meteorological data, modelling inputs and assumptions, and peer review of the air quality impact assessment has been provided by an internationally-recognised meteorological and air dispersion modelling specialist.

Longer term trends in meteorological data have been taken into account through comparison of the meteorological years used in the air quality impact assessment with longer term averages. This comparison has demonstrated that the meteorological data is reasonable, representative and appropriate for use in the air quality impact assessment.

The air quality impact assessment for the NorthConnex project has been conducted in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC, 2005) (the Approved Methods guidelines). The Approved Methods guidelines require a minimum of one year of background air quality data and meteorological data in the dispersion model. The NorthConnex dispersion model has used three years of background air quality and meteorological data, to provide a more rigorous and comprehensive analysis of potential air dispersion scenarios.

Issue description

Table 14 and Table 15 of the Technical Working Paper: Air Quality refer to “long term (30 year)” meteorological data from Sydney Airport being used, however the tables also indicate in their title “…long term averages (1929-2013)…” which is much longer than 30 years. This needs to be corrected.

Response

Reference to ‘1929-2013’ refers to the entire dataset available from the Bureau of Meteorology at the time of undertaken the air quality impact assessment. It is recognised that a 30 year average would be a subset of this larger dataset.

Issue description

Estimates of the Australian fleet using diesel powered passenger vehicles of eight per cent has been obtained from the motor vehicle census from the Australian Bureau of Statistics (ABS), 2013.

Further information on the exact reference for the figure of eight per cent should be provided as the ABS Census also indicates that "Passenger vehicles consumed 18,510 million litres of fuel in 2012, of which 84.8 per cent (15,696) was petrol". This implies that 15.2 per cent of fuel used was diesel, which is a different proportion to the eight per cent quoted in the environmental impact statement which could affect emissions estimates, as it implies that diesel vehicles use on average more fuel. (9208.0 - Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2012). This should be confirmed.

Comment should be provided on whether there is a breakdown for New South Wales or by capital city.

Response

The Australian Bureau of Statistics (ABS) provides a breakdown of the Australian vehicle fleet by type and fuel, as summarised in **Table 7-32**.

Table 7-32 Summary of fuel type (ABS, 2013)

Vehicle type	Petrol	Diesel	Other
Cars	89.7%	7.7%	2.6%
Light duty vehicles	47.6%	47.5%	5.0%
Heavy vehicles	7.1%	91.7%	1.2%

To align with the emission factors published by the Permanent International Association of Congresses (2012) emission rates, which are based on a petrol and diesel differentiation, 'other' fuelled vehicles (such as liquefied petroleum gas) have been redistributed into 'petrol' or 'diesel' categories according to relative distribution of petrol and diesel for each fuel type. This redistribution is summarised in **Table 7-33**. This is a conservative assumption, noting that 'other' fuelled vehicles are less emissions intensive than petrol or diesel fuelled vehicles.

Table 7-33 Amended summary of fuel type (2013)

Vehicle type	Petrol	Diesel
Cars	92.1%	7.9%
Light duty vehicles	50.1%	49.9%
Heavy vehicles	7.2%	92.8%

The data are for the Australian fleet, rather than for New South Wales (or another state) or Sydney (or another capital city). Further discussion of vehicle fleet and fuel assumptions is provided in **Section 2.8** of this report, including an analysis of Roads and Maritime registration data for the New South Wales fleet.

Issue description

While the number of diesel powered passenger vehicles increased from 2008 by over 100 per cent, the environmental impact statement used the current assumption of eight per cent diesel fleet for both 2019 and 2029 scenarios. Justification for this approach should be provided.

Response

The issue of petrol/ diesel fuel distribution in the vehicle fleet has also been raised by the Environment Protection Authority, and a detailed response is provided in **Section 7.1.1.3** of this report.

It is accepted that the assumption that the petrol/ diesel fuel mix would not change over time is not conservative. Further analysis conducted in response to the submission from the Environment Protection Authority demonstrates that this issue would not significantly affect the outcomes of the air quality impact assessment.

Notwithstanding, updated fuel mix assumptions have been reflected in the additional air dispersion modelling conducted for the five metre increase in southern and northern ventilation outlet heights (refer to **Section 9.2** of this report).

Issue description

The title of Table 18 of the Technical Working Paper: Air Quality could be written more clearly eg “Comparison of PIARC calculations by AECOM (in red) and Pacific Environment (in bold)”.

It is not clear whether the title of Table 19 of the Technical Working Paper: Air Quality is correct, whether it is emission factors that are presented or pollutant concentrations.

Reference to Table 18 and 19 of the Technical Working Paper: Air quality. Could the Pollutant levels in Table 18 and Table 19 of the Technical Working Paper: Air Quality should be presented in units consistent with other tables (eg $\mu g/m^3$ rather than mg/m^3 (albeit for comparative purposes)).

Response

The title of Table 18 of the Technical Working Paper: Air Quality is considered to be appropriate and reflective of its content.

Data presented in Table 19 are in-tunnel pollutant concentrations, although the purpose of the table is to compare the effect of calculating pollutant concentrations using emission factors published by the Permanent International Association of Road Congresses and the New South Wales Environment Protection Authority.

Units of measure have been selected on a case by case basis, depending on the data being presented and the purpose for which it is being presented. Where possible, changes to units of measure throughout the environmental impact statement have been minimised, with a preference for presentation of data units consistent with Le Système International d’Unités (SI Units).

Issue description

The text on page 53 of the Technical Working Paper: Air Quality indicates that nitrogen dioxide concentrations calculated with the two different methodologies in Table 19 are “around the same magnitude”. However, there seem to be quite large differences for the ‘southbound main alignment tunnel at 9am (2019)’ scenario, especially when the concentrations are converted to $\mu g/m^3$.

Comment should be made on whether the use of the lower emissions concentrations in the nitrogen dioxide modelling could be expected to underestimate nitrogen dioxide concentrations from the outlets for that particular scenario.

Response

Reference to in-tunnel air quality concentrations being 'around the same magnitude' refer to the comparison between in-tunnel concentrations calculated using the emission factors published by the Permanent International Association of Road Congresses and the New South Wales Environment Protection Authority. The relative difference between these data would be the same, irrespective of whether the data are presented in mg/m^3 or $\mu g/m^3$.

Further comment and justification for the use of nitrogen dioxide data based on emission factors published by the Permanent International Association of Road Congresses is provided in **Section 2.14.2** of this report.

Issue description

Section 4.2.8.4 of the Technical Working Paper: Air Quality states that that the percentage of heavy vehicles per hour using the tunnel will not vary by hour of day, given that the stated range is 28 per cent to 28.5 per cent. In the same section, reference is also made to "*the predicted percentage of heavy vehicles varied hourly…*", which is expected. This is confusing and needs clarification.

Response

The range within which the percentage of heavy vehicles varied was:

- 28 per cent to 28.5 per cent for the northbound tunnel in 2019.
- 27.8 per cent to 28.6 per cent for the southbound tunnel in 2019.
- 24.5 per cent to 25 per cent for the northbound tunnel in 2029.
- 24.5 per cent to 25.2 per cent for the southbound tunnel in 2029.

The hourly percentage of heavy vehicles using the project varied, but as indicated by the figures above, only slightly. Although the percentage of heavy vehicles is similar over a 24 hour period, the total number of individual heavy vehicles would vary significantly based on changing total traffic volumes over a 24 hour period. These changing traffic volumes are shown in Figure 9 and Figure 10 of the Technical Working Paper: Air Quality.

Issue description

Section 4.2.10.1 of the Technical Working Paper: Air Quality does not adequately explain why the outlet temperatures from the Lane Cove Tunnel outlets were deemed inappropriate for use.

Response

Outlet temperatures from the Lane Cove Tunnel have not been applied to the air quality impact assessment for the NorthConnex project. Rather, the difference between the temperature of air emitted from the Lane Cove Tunnel and the ambient environment has been analysed to determine average hourly temperature differentials (between the tunnel temperature and the environment) on a seasonal basis. These average hourly temperature differentials were then applied to ambient temperatures around the NorthConnex project to determine realistic emissions temperatures for an operational road tunnel.

Issue description

It is not clear whether Table 22 of the Technical Working Paper: Air represents the percentage of volatile organic compounds per litre of fuel or some other measure?

Response

This table provides the speciation profile for volatile organic compounds. This is expressed as a percentage which can be applied to any volume of fuel as required.

Issue description

On page 61, third paragraph, first sentence is incomplete, commencing with "*For CO, the maximum……..*" is incomplete.

Response

This is a typographical error and does not impact the outcomes of the air quality assessment.

Issue description

Meteorological conditions can have a major impact on air pollutant concentrations, even for the same months in different years. Therefore, matching two datasets to the same relative date but from different years, without adjusting for meteorology, may not provide a true picture of relative differences between the datasets. More appropriate analysis would match the project monitoring data from December 2013 to March 2014 to the Office of Environment and Heritage data for the exact same time period. A sensitivity analysis using the project monitoring data for the months available to determine the impact of this should be conducted.

Response

Further analysis of local meteorological conditions and a comparison with CALMET meteorological modelling outputs is provided in **Section 2.10** of this report. A similar analysis has been conducted relative to regional meteorological monitoring data in response to the submission received from the Environment Protection Authority (refer to **Section 7.1.1.3** of this report).

Issue description

If the nitrogen dioxide concentrations measured by the project monitoring were higher than the Office of Environment and Heritage levels, this would be expected to lead to underestimation of actual pollutant concentrations if the Office of Environment and Heritage data was used to estimate background concentrations. The nitrogen dioxide concentrations at the project monitoring sites should be adopted for the background concentrations. Appendix C of the Technical Working Paper: Air Quality states that the average percentage difference between the Office of Environment and Heritage and project data was 0.7 per cent; but it is not clear whether this is the basis for using the Office of Environment and Heritage data.

Response

There are times when the NO_2 data at the project monitoring stations will be higher than the data at the Prospect/ Lindfield monitoring stations. Conversely there will also be times that concentrations will be higher at the Prospect / Lindfield stations than the project monitoring stations. The analysis presented in the Technical Working Paper: Air Quality concludes that

the average difference between the two data sets over the period assessed is only 0.7 percent.

The intent of undertaking the comparison between the project monitoring stations and the Office of Environment and Heritage stations at Prospect and Lindfield was to determine if the overall data sets were similar and therefore appropriate for use in the air quality impact assessment. The average difference between the data sets of 0.7 per cent is considered negligible and, therefore, the data was considered appropriate for use in the assessment. Adjusting the background data by 0.7 per cent would have made an inconsequential change in the data and was not deemed necessary for the air quality impact assessment.

Further consideration of this issue is provided in **Section 2.11** of this report.

Issue description

Comparison of two receiver locations was made against modelled predictions from the CAL3QHCR. It is not clear why the modelled predictions were not compared against the measured data at the five project monitoring sites instead of two?

Response

The CAL3QHCR model is an air dispersion modelling package used to model emissions from roads (as distinct from CALPUFF, which was applied to the project's ventilation outlets).

Of the five monitoring stations that were installed to gather background air quality data, two are located adjacent to Pennant Hills Road to monitor 'roadside air quality', while the remaining three are located away from major roads to monitor 'ambient air quality' (not significantly influenced by roads).

The air quality data from the two roadside monitoring stations is relevant to modelling outputs from the CAL3QHCR model. Data from the ambient monitoring stations, away from major roads, is not relevant (or of very low relevance) to the CAL3QHCR model.

Issue description

With reference to Table 24 of the Technical Working Paper: Air Quality, it is unclear and the title needs to indicate that the data is for $PM_{2.5}$. The table should indicate the time periods relevant to the concentrations (eg maximum concentration over 24 hours).

It is not clear whether the ranks (Column 1) are representative of events (ie days).

It is not clear whether the ranks (ie days?) 1-5 are different for the "Maximum Cumulative Concentrations" (columns 2 to 4) can be compared to the "Maximum Project Contributions" (columns 5 to 7) (ie do they occur at different times/days?). If so, this needs to be made clearer in the table or as footnotes.

The title "Maximum Project Contributions" for columns 5 to 7 is confusing. It is not clear what these columns represent, especially column 7.

Response

Section 4.2.13 of the Technical Working Paper: Air quality provides an explanation of how to read and interpret the contemporaneous assessment tables. Table 24 (titled 'Example contemporaneous assessment table') is an arbitrary example that has been provided as an interpretative example, and does present impact assessment results for the project. As this

table is only an example the averaging period of the ranks and the pollutant itself or not relevant.

In the Table 24 example, the first column represents 'events', which in the case of the air dispersion modelling represents one hour out of the three years of modelling conducted for the project.

(ie Table 24 does not present actual project data; it is an example table with the preceding text explaining the table to help the reader interpret similar tables within the impact assessment section).

Columns 2 to 4 of Table 24 present the outcomes of the air dispersion modelling for the five 'events' (five single hours in the three years of modelling) when background pollutant concentrations were the highest. For each of these 'events', column 2 lists the total cumulative ground level concentration of the relevant pollutant. Columns 3 and 4 list the project contribution and the background contribution during those same 'events'.

Columns 5 to 7 present similar information, except that 'events' are ranked based on the maximum predicted project contributions (rather than maximum background contributions)

Issue description

Section 4.2.13 of the Technical Working Paper: Air Quality indicates that nitrogen dioxide was also assessed contemporaneously, but that it resulted in predicted exceedances, "which were not considered realistic given the background ambient monitoring data". This paragraph does not indicate how this issue was further addressed, but should.

Response

Section 4.2.13 of the Technical Working Paper: Air Quality identifies that nitrogen dioxide was assessed contemporaneously because exceedances were identified. This section forms part of the methodology and is not intended to explain issues such as this in detail. Consideration of nitrogen dioxide is provided in Section 6.1.4 of the Technical Working Paper: Air quality.

Issue description

With respect to Appendix C of the Technical Working Paper: Air Quality, the tables in both locations should be numbered for easy reference, with complete column headings.

It is not clear whether the first two tables and first graph represent data for the two sites combined. If so, the title or a footnote should indicate this. This combined data is not as useful as the data comparing modelled against measured concentration on a site specific basis, as it does not indicate if the variation might be consistent across sites or more specific to a particular site.

Response

It is accepted that numbering the tables in Appendix C of the Technical Working Paper: Air Quality would have assisted readability.

The first two tables in Appendix C show data from PM_{10} and NO_2, respectively, as indicated in the table headings.

Issue description

With reference to Appendix C of the Technical Working Paper: Air Quality, the PM_{10} table indicates that the CAL3QHCR modelled estimates for PM10 were much larger than the concentrations measured by the two project monitors.

For the Brickpit Park site the modelled concentrations were two-fold those of the measured concentrations; for the Observatory Park site, the differences were almost four-fold and the variance in the modelled data fifteen-fold higher than the variance in the measured data.

While, the Woolcock Institute of Medical Research agrees that the choice of the modelled estimates for use in the background concentrations for road receivers is appropriately conservative (ie likely to overestimate concentrations rather than under-estimate concentrations), such differences bring into question the sensitivity, accuracy and representativeness of the modelled roadside data. The data for nitrogen dioxide for the Brickpit Park site are also almost two-fold higher for the modelled data than for the measured data. This means modelled predictions of changes in PM_{10}, $PM_{2.5}$ and nitrogen dioxide along Pennant Hills Road are likely to be over-estimated.

Response

It is recognised that modelled concentrations from the CAL3QHCR model are higher than monitored values at the two roadside monitoring stations installed for the project. Part of the difference in these values may be attributable to the limited dataset obtained from the project monitoring stations for the purpose of comparison with the model. Longer term monitoring may produce values that are closer to CAL3QHCR model outcomes.

Notwithstanding, as highlighted by the Woolcock Institute of Medical Research, a conservative approach has been applied by adopting the CAL3QHCR model outcomes.

Issue description

Reference to In Section 6.1.1 of the Technical Working Paper: Air Quality, the first sentence (first and third paragraphs) are incomplete, while the second sentence (first paragraph) is unclear.

Response

The incomplete sentences are typographical errors (the word ‘to’ after ‘Table 29’ should be deleted) and do not affect the outcomes of the air quality assessment.

The second sentence of the first paragraph states (with reference to Table 29) that ‘predicted exceedances of the applicable air quality criteria are shown in bold text’. This sentence identifies that the bold text in Table 29 shows exceedances of the applicable criteria.

Issue description

The Technical Working Paper: Air Quality (page 72) indicates that as NO_2, CO and PAHs were well below relevant impact assessment criteria, they were not further analysed. This is despite NO_2 peak contributions from the ventilation outlets (one hour maximum) comprising 25-30 per cent of the criterion level of 243 ug/m^3, a much greater proportion than estimated for particulate matter. Given that NO_2 is a good marker of traffic related pollution, and the contradictory nature of this statement, this issue requires clarification.

Response

This issue is discussed and clarified in more detail in response to the submission made by the Environment Protection Authority (refer to **Section 7.1.1.3** of this report).

Section 7.1.1.3 explains the NO_2 peak based on a single hour of meteorological data in three years of modelling. Chart 8 in the Technical Working Paper: Air Quality shows the ranked NO_2 (one hour average) contributions from the project at the most affected receiver location near the northern ventilation outlet in 2019. The data presented in Chart 8 have been summarised in **Section 7.1.1.3** of this report. The data demonstrates that:

- The maximum project contribution of NO_2 (one hour average) at the most affected location near the northern ventilation outlet in 2019 would be an unusual and infrequent event. Only one hour in three years (around 0.004% of the time) is expected to reach this level of project contribution, with all other hours in the three year period predicted to be around no more than half of the maximum (ie less than 35 $\mu g/m^3$).
- Over a three year period, the project is expected to contribute more than 4.1% of the applicable ambient air quality criterion for NO_2 (one hour average) for only three percent of the time. By corollary, this means that for 97% of the time, project contributions to the ambient airshed are less than 4.1%.

This information reinforces the conclusion drawn in the environmental impact statement that project contributions of NO_2 are low relative to applicable ambient air quality criteria, and for the majority of the time are very low.

Issue description

Figure 12 of the Technical Working Paper: Air quality and others do not include the location of the southern ventilation facility. Clarification should be provided as to whether the southern ventilation facility is the “motorway operations complex”.

Response

As identified in Chapter 5 of the environmental impact statement, the southern ventilation facility is located within the motorway operations complex (towards the southern end).

Issue description

With reference to Figure 17 and Figure 18 of the Technical Working Paper: Air Quality, clarification should be provided as to whether the concentration of 0.10 $\mu g/m^3$ attributed to the dark blue box/line is correct, or whether should it read 1.0 $\mu g/m^3$ (as per the legend on top left hand side of figures).

Response

The dark blue line is correctly labelled in the legend Figure 17 and Figure 18 of the Technical Working Paper: Air Quality as 0.10 $\mu g/m^3$.

Issue description

With reference to Table 34, Table 35 and Table 39 of the Technical Working Paper: Air Quality, it is not clear what the column titled “Rank” represents.

These tables are confusing. It is not clear if the ranks (ie days?) 1 to 5 are different for the “Maximum Cumulative Concentrations” (columns 2 to 4) compared to the “Maximum Project Contributions” (columns 5 to 7) (ie do they occur at different times/days?). If so, this needs to be made clearer in the table or as footnotes.

The title “Maximum Project Contributions” for columns 5 to 7 is confusing. It is not clear what these columns represent, especially column 7.

Response

Section 4.2.13 of the Technical Working Paper: Air Quality provides an explanation of how to read and interpret the contemporaneous assessment tables. Table 24 in that section provides an interpretive example.

Columns 2 to 4 of the tables present the outcomes of the air dispersion modelling for the five ‘events’ (five single hours in the three years of modelling) when background pollutant concentrations were the highest. For each of these ‘events’, column 2 lists the total cumulative ground level concentration of the relevant pollutant. Columns 3 and 4 list the project contribution and the background contribution during those same ‘events’.

Columns 5 to 7 present similar information, except that ‘events’ are ranked based on the maximum predicted project contributions (rather than maximum background contributions). Column 7 shows the cumulative concentration (project plus background) for each of the hours during which the time five project contributions have been predicted.

The data in these tables is also presented graphically in the Technical Working Paper: Air Quality to assist in interpretation.

Issue description

Frequency/percentile frequency tables or percentile frequency distributions in Section 6.1.3 of the Technical Working Paper: Air Quality would be useful for some of this data in addition to the graphs to provide more information on frequency of certain concentrations occurring.

Response

These graphs represent the contemporaneous assessment for every hour over a three year period. The relative frequency of concentrations compared to background levels can be visually interpreted from the graphs and are considered a more accessible way to receive this information than more frequency/ percentile tables of data.

Issue description

It is unclear what Chart 8 in Section 6.1.4 of the Technical Working Paper: Air Quality indicates. The text states that “*As shown, the project contributions are at a negligible level for around 70 per cent of the modelling period*”, however the chart does not represent time, it represents a ranking of concentrations, according to the x-axis.

Response

The chart represents the nitrogen dioxide concentrations for all outcomes of the dispersion modelling. The rank shows the approximately 26,280 hours modelled which is a representation of time. Relevant aspects of this data are reproduced in **Section 7.1.1.3**.

Issue description

Reference to Section 6.1.7 of the Technical Working Paper: Air quality. The text in Section 6.1.7 of the Technical Working Paper: Air Quality states that for 24 hour average $PM_{2.5}$, "improvements in air quality are expected to peak at up to 25 percent of the 25 $\mu g/m^3$ ….advisory reporting standard", however Figures 36 and 38 show a 10 per cent improvement at most. This needs to be checked and clarified, as do the statements of a 40 per cent improvement for annual average $PM_{2.5}$, which again Figure 35 and Figure 37 indicate will be a 10 per cent decrease in concentrations.

Response

The text accurately describes the predicted improvements in air quality along Pennant Hills Road. As identified in the text which introduces the figures, due to the scale it is only possible to clearly show changes (graphically) up to ten per cent.

Issue description

Additional dot points should be included in Section 6.1.7 of the Technical Working Paper: Air Quality to indicate that the modelling predicts an overall increase in annual average $PM_{2.5}$ around the northern ventilation outlet of 0.6 per cent of the reporting standard and an overall increase in 24 hour average $PM_{2.5}$ of 1.6 per cent of the reporting standard around both ventilation outlets. Comment should be provided on whether these could also be provided as a percentage of current background concentrations.

Response

This section is intended to discuss the air quality benefits along Pennant Hills Road. The minor increases around the ventilation outlets has been separately assessed and discussed in preceding sections of the environmental impact statement. These were, however, shown on the figures for transparency.

Air quality modelling outcomes are presented in the environmental impact statement and Technical Working Paper: Air Quality as project increments (only) or as a percentage of the applicable criterion/ advisory reporting standard (which is a fixed value). The impacts of the project have not been presented as a percentage of background concentrations, because these background concentrations will vary over time and location. Presentation of project impacts as a percentage of background concentrations could therefore be misinterpreted or being construed as misleading depending on the time and location chosen as a background air quality reference point.

Issue description

It is not clear why the area covered by the increases in annual average $PM_{2.5}$ for the 2029 predictions are smaller than for 2019, when it is expected that there will be greater traffic flows.

While these are very small increases in magnitude, they nevertheless constitute an increase in average $PM_{2.5}$ exposure due to the project. Given that there is currently thought to be no lower threshold for the effects of $PM_{2.5}$, the Woolcock Institute of Medical Research would advocate for the project to result in no estimated increases in average $PM_{2.5}$ concentrations, especially given that the area for increased 24 hour average $PM_{2.5}$ around the northern ventilation outlet is reasonably large.

Response

Comparing Figure 21 (annual average $PM_{2.5}$ concentrations in 2019) with Figure 25 (annual average $PM_{2.5}$ concentrations in 2029) shows that the extent of potential impacts is greater in 2029 than in 2019.

It should be noted that Figure 35 and Figure 37 show annual average $PM_{2.5}$ concentrations that take into account the impacts of the ventilation outlets, as well as the improvements in air quality along surface roads. Because these figures show predicted net changes in air quality, the extent of contributions from only the ventilation outlets may be partially offset by improvements in surface road air quality.

The environmental impact statement accepts that there is no threshold below which exposure to particulate matter ($PM_{2.5}$) would not generate a health effect. Because of this, the environmental impact assessment includes a human health risk assessment that expressly calculates the change in health outcomes associated with predicted exposures to $PM_{2.5}$ (without the application of a dose-response threshold). Further analysis of feasible and reasonable measures to minimise exposures to vehicle emissions, including particulate matter is included in **Section 3.2** of this report. Based on this analysis, an increase in the height of the southern and northern ventilation outlets has been demonstrated as a feasible and reasonable measure to further minimisation ambient air quality impacts and associated human health risks.

Issue description

In Section 6.1.7 of the Technical Working Paper: Air Quality, the same calculations should be provided for the overall effect on NO_2 from the project, especially given that it is a good marker of traffic related air pollution and that the relative contribution of the ventilation outlets to peak NO_2 concentrations was greater than for particulate matter.

Response

Particulate matter has been chosen to represent the predicted air quality benefit along Pennant Hills Road as it is the primary pollutant of concern in relation of human health. It is also the relevant pollutant for the detailed human health risk assessment in order to understand the overall impact (both positive and negative) from the project.

Issue description

With respect to the assumptions in Table 40 of the Technical Working Paper: Air Quality (breakdown scenario), the assumption for “maximum traffic flow” is 1,828 vehicles per hour (2,800 PCU), yet the assumption for “maximum traffic in tunnel during breakdown period” of 55 minutes is only 511 vehicles. Should it not be 1,676 vehicles?

Response

Vehicles contributing emissions during the breakdown scenario would be a combination of:

- Vehicles in the tunnel at the time of the breakdown that are prevented from leaving the tunnel due to the breakdown blockage near the tunnel exit.
- Additional vehicles that enter the tunnel in the ten minutes following the breakdown and before the tunnel is closed to additional traffic.

At the time of the breakdown, it has been assumed that average vehicle speeds drop rapidly from 80 km/h to 20 km/ h until traffic banks back to the maximum traffic throughput capacity of the main alignment tunnel at 20 km/ h. The maximum throughput capacity of a main alignment tunnel is around 2,800 passenger car units (refer to **Section 2.5.1**). Based on the distribution of vehicle types as forecast in 2019:

- Passenger vehicles would comprise 72 per cent of vehicles in the tunnel. Passenger vehicles are one passenger car unit each.
- Heavy vehicles would comprise around 28 per cent of vehicles in the tunnel. Consistent with the assumption made in the traffic impact assessment for the project, heavy vehicles have been assumed to be 2.9 passenger car units each.

Taking this distribution of vehicles into account, 2,800 passenger car units would be around 1,316 passenger vehicles and around 512 heavy vehicles (a total of 1,828 vehicles per hour).

For a nine kilometre long tunnel, 1,828 vehicles per hour would equate to 205.7 vehicles (ie (9km)/(80 km/h) x 1,828 vph = 205.7 vehicles).

For the ten minutes following the breakdown a further 305.7 vehicles would enter the tunnel (ie (1/6) x 1,828 vph = 305.7 vehicles).

Combined, the 205.7 vehicles in the tunnel at the time of the breakdown and the 305.7 vehicles enter in the ten minutes following the breakdown, would sum to 510.4 vehicles. This figure has been rounded to 511 vehicles for the purpose of the air quality impact assessment.

Issue description

It is not intuitive how the concentrations were estimated in Table 41 of the Technical Working Paper: Air Quality as the emission rates are higher when traffic is at low speed. A reference to the methods/equations would be useful. A reference is missing in the text below Table 41.

Response

The data in Table 41 of the Technical Working Paper: Air Quality are mass emission rates at the relevant ventilation outlet, rather than concentrations. These emission rates have been determined by applying the emission factors published by the Permanent International Association of Road Congresses (2012) for the fleet and fuel mix assumed for traffic utilising the project tunnels, and at an average traffic speed of 0 km/h (ie stopped due to a breakdown). Further details of the methodology applied to calculation of emissions from the project are provided in **Section 2.8** of this report.

The reference associated with Table 41 should refer to Section 6.1.1 of the Technical Working Paper: Air Quality.

Issue description

The “emission rates” tables for design analysis A and design analysis B (Appendix H of the Technical Working Paper: Air Quality) have varying titles, even though they both appear to represent emission rates from tunnel ventilation outlets. If this is correct, the title of the table for design analysis A needs to be corrected.

Response

The tables in Appendix G of the Technical Working Paper: Air Quality provide emission rates for different air quality modelling scenarios (design analysis A and design analysis B). The titles for these tables are similar, but appropriate and an accurate description of the contents of the tables.

Issue description

A source for the data in Figure 3.7 of the Technical Working Paper: Human Health Risk Assessment is required.

Response

The relevant reference is NSW Population Health Survey, 2006 – 2006 Report on Child Health published by NSW Health (2008).

Issue description

Table 5.6 of the Technical Working Paper: Human Health Risk Assessment presents estimates of increased population incidence for the outcomes presented due to $PM_{2.5}$ exposures from the ventilation outlets. For instance, it indicates that for all-cause mortality for both the southern and northern suburbs for 2019, that three additional deaths per 100,000 people would be expected per 10 years. This increases for the northern suburbs for the 2019 scenario.

As indicated in Section 5.4.2 of the technical working paper, there is variance in the consideration of what is an “acceptable” and “tolerable” increased risk. Given the current move in Europe towards reduction of population exposures, there needs to be discussion of whether this project should be aiming for no detectable increases in air pollutants attributable to the project. For instance, there is no discussion in the environmental impact statement of how this may be addressed and achieved in terms of additional engineering or ventilation modifications.

Response

Further analysis of feasible and reasonable measures to minimise exposures to vehicle emissions, including particulate matter is included in **Section 3.2**. Based on this analysis, an increase in the height of the southern and northern ventilation outlets has been demonstrated as a feasible and reasonable measure to further minimisation ambient air quality impacts and associated human health risks.

Issue description

Figure 5.4 of the Technical Working Paper: Human Health Risk Assessment shows in-tunnel NO_2 levels during peak periods and at the end of the tunnel runs which are commensurate with overseas studies which have shown an effect of short-term exposures to NO_2 at similar levels after 30 minute exposures. Whilst normal conditions would see shorter in-tunnel exposure periods, congested or breakdown events would add considerably more time for exposure. Further consideration should be given to the potential for reducing NO2 levels in-tunnel.

Response

Further consideration of in-tunnel exposures to NO_2 are presented in response to the NSW Health submission, which is detailed in **Section 7.1.2.3** of this report.

Issue description

The Woolcock Institute of Medical Research understands the need to present data for maximum predicted concentrations, however it would also be useful to present data for average or median (depending on the distribution) concentrations as well as the range of concentrations, especially for annual averaged data. This would provide a better understanding of the data.

Response

The presentation of maximum values provides a conservative assessment in terms of air quality and human health impacts. The contemporaneous assessment and graphs within the Technical Working Paper: Air quality provides a graphically representation of the frequency of the maximum events.

Issue description

It is critical that appropriate and adequate air quality monitoring take place before and after the tunnel is opened. Special project monitoring before and after tunnel operation of finer particulate matter should be considered, for instance project monitoring of PM1, black carbon, and ultrafine particles.

Response

Air quality monitoring during and prior to operation would be conducted to meet the requirements of the conditions of approval that may be applied to the project by the Minister for Planning. These conditions may specify the timing, duration and extent of the air quality monitoring required for the project.

Air quality monitoring during the initial phase after commencement of operation is intended to verify and validate the air quality modelling conducted for the project. By demonstrating that actual air quality is equal to or better than predicted by the air dispersion modelling, then confidence can be gained that predictions made by the modelling into the future are also robust. A period of twelve months of monitoring is proposed within the environmental impact statement because this would provide a whole year of seasonal variations in weather patterns.

In-tunnel air quality monitoring would be undertaken on a continuous basis during operation.

Issue description

The Woolcock Institute of Medical Research would argue against future portal emissions (Section 7.3 of the environmental impact statement), as previous reports have highlighted elevated pollutant levels near portals, and the portals for the NorthConnex project would be in highly populated urban areas.

Response

The project does not propose any emissions from the tunnel portals under normal operating conditions. Air within the section of tunnel beyond the ventilation off-take would be drawn back against the flow of traffic to be emitted and dispersed through the ventilation outlet. As

such, the assessment has not considered portal emissions. If portal emissions are considered in the future, this would be subject to appropriate assessment and approval.

The environmental impact statement includes a statement that the planning application made for the NorthConnex project is not seeking approval for portal emissions. If approved, any approval granted by the Minister for Planning would therefore not authorise portal emissions.

Further details regarding the operation of the project ventilation system is provided in Section 5.2.5 of the environmental impact statement.

Issue description

It is not clear from the environmental impact statement whether tunnel design (design analysis A) which is conducted to ensure the project's ventilation system is adequately sized to cater for tunnels full of traffic, also makes predictions for a third lane in each direction?

Response

The environmental impact statement is seeking approval to operate the tunnel at two lanes only. If three lanes are required in the future, this would be subject to separate assessment and approval.

7.3.4 Asthma Foundation of NSW

Issue description

Ensure mistakes made with the M5 East Motorway tunnels are not repeated, namely:

- Inaccurate assumptions regarding traffic levels. The ventilation system was designed on the assumption that traffic volumes in the tunnel would grow slowly and that improvements in vehicle design and reductions in vehicle emissions would compensate for increases in traffic volumes. Actual levels of traffic growth were much greater than predicted, thereby creating higher concentrations of pollutants than predicted. This was beyond the capacity of the tunnel ventilation system to maintain acceptable conditions and consequently, had greater health impacts for motorists using the tunnel.
- Inappropriate response to community pressure. The Government responded to community pressure around the planned location of the ventilation outlets. This led to replacing the planned three ventilation outlets mainly in elevated locations with a single ventilation outlet located in a valley which exposed motorists and residents to greater amounts of air pollution.
- Filtration was not considered in the planning. Filtration needed to be retrofitted which was expensive and ineffective.
- Lack of independent auditing of the monitoring system. Although there is an extensive and well maintained system of pollution monitoring around the tunnels, there is no publicly accessible monitoring of in-tunnel conditions. Also there is a lack of adequate quality control of the in-stack monitoring system.

Response

For the NorthConnex project, the aim has been to take on board the learnings from the M5 East Motorway tunnels and to effectively manage vehicle emissions through improved tunnel design. This has included:

- A flatter tunnel gradient.
- A large cross-sectional area.
- An efficient ventilation system that does not circulate air from one main alignment tunnel to the other.
- Removal of smoky vehicles through the use of the smoky vehicle camera system.

The lessons learnt as raised by the Asthma Foundation have also been considered by the NorthConnex team:

- The strategic traffic model used to determine the forecast traffic movements on which the NorthConnex environmental impact statement has been based takes into account a suite of factors including motorist behaviour, response to tolling arrangements and anticipated land use changes.

  The air quality impact assessment presented in Section 7.4 and Appendix G of the environmental impact statement has as its principal focus, modelling and assessment of potential air quality impacts under forecast traffic flows in 2019 and 2029 (derived from the Cube model). To provide confidence about the performance of the project's ventilation system in the event that actual traffic demand exceeds traffic forecasts in the future, the air quality impact assessment also considers 'design analysis A'. This design analysis is based on the project operating at its maximum theoretical design throughput capacity during the peak hour (4,000 passenger car units). Design analysis A therefore represents a credible upper limit to the potential operation of the project. Although it is considered unlikely that design analysis A would eventuate in reality, based on traffic forecasting, it provides a 'worst-case' scenario for the purpose of assessment potential air quality impacts. The environmental impact statement demonstrates that design analysis A would meet applicable ambient air quality criteria.
- The NorthConnex project includes a well-designed ventilation system. The air quality impact assessment and the human health risk assessment included in the environmental impact statement demonstrate that the NorthConnex project would comfortably meet ambient air quality criteria and would pose a very low risk to human health. Further details of how the ventilation system has been designed and the criteria applied to that design are provided in **Section 2.5** of this report).

  Consideration has also been given to feasible and reasonable ventilation system design options and alternatives with the aim of minimising in-tunnel and ambient exposures to vehicle emissions. This analysis is provided in **Section 3.2** of this report. Based on this balanced consideration of environmental and land use impacts, engineering feasibility and cost, an increase to the ventilation outlets by five metres has been determined to be feasible and reasonable. As such, the project has been amended to include this increase the height of the ventilation outlets. A revised assessment of this increased ventilation outlet height is provided in **Section 9.2** of this report.
- The environmental impact statement includes an analysis of tunnel filtration systems and explains why such systems are not warranted for the NorthConnex project (refer to Section 7.3.1 of the environmental impact statement). The environmental impact statement demonstrates that the NorthConnex project would meet ambient air quality criteria and would pose a very low risk to human health. In this context, there is no basis to justify installation of filtration systems.

  Further information on the availability and efficacy of in-tunnel air treatment systems (including filtration) is provided in **Section 3.1** of this report. The analysis of ventilation

system design options and alternatives in **Section 3.2** of this report considers the application of in-tunnel air treatment systems to the NorthConnex project and concludes that these systems are feasible but not reasonable.

The use of filtration systems has been proven to be costly and inefficient. Learnings from the M5 East Motorway tunnel filtration trial have demonstrated that greater improvements in air quality can be achieved through investment in programs targeting other emission sources that contribute higher levels of pollution to the surrounding environment. For example, improvements have been demonstrated through the smoky vehicle strategy investigated by Roads and Maritime and the Environment Protection Authority on the M5 East Motorway. Further details of the effectiveness of this strategy are provided in Section 7.3.1 of the environmental impact statement.

For the NorthConnex project, the aim has been to take on board the learnings from the M5 East Motorway tunnels and to mitigate emissions through improved tunnel design. This has included a flatter tunnel gradient, a large cross-sectional area, an efficient ventilation system that does not circulate air from one main alignment tunnel to the other, and the removal of smoky vehicles through the use of the smoky vehicle camera system.

- Air quality monitoring during operation will be conducted to meet the requirements of the conditions of approval that may be applied to the project by the Minister for Planning. These conditions may specify the timing, duration and extent of the air quality monitoring required for the project.

  Air quality monitoring during the initial phase after commencement of operation is intended to verify and validate the air quality modelling conducted for the project. By demonstrating that actual air quality is equal to or better than predicted by the air dispersion modelling, then confidence can be gained that predictions made by the modelling into the future are also robust. A period of twelve months of monitoring is proposed within the environmental impact statement because this would provide a whole year of seasonal variations in weather patterns.

  In-tunnel air quality monitoring would be undertaken on a continuous basis during operation.

  Air quality monitoring data collected for the project would be made publicly available.

Issue description

Whilst car engines and fuels are becoming cleaner, the increase in diesel engines and diesel fuel means an increase in ultrafine particles. These are invisible to the naked eye – unlike the larger particulates which are visible as haze when they are found in high concentrations. These ultrafine particles are also of much greater concern to health as they travel deep into their airways, and cross into the bloodstream, contributing to a range of respiratory and cardiovascular disease.

Response

A detailed discussion of particulate matter, including studies into the health effects of exposures to $PM_{2.5}$ (as well as the ultrafine components of the $PM_{2.5}$ fraction) is provided in Section 4.4.2 of the Technical Working Paper: Human Health Risk Assessment.

When assessing health impacts from fine particulates, the robust associations of effects have been determined on the basis of $PM_{2.5}$, as $PM_{2.5}$ is what is commonly measured in urban air. No robust associations (that can be used in a quantitative assessment) are available for PM_1, although the associations developed for $PM_{2.5}$ will include a significant contribution from PM_1. Hence, health effects observed for PM_1 will be captured in the studies that have been conducted on the basis of $PM_{2.5}$.

The air quality impact assessment and the human health risk assessment presented in the environmental impact statement conservatively assume that there would be no improvement

in fuels or vehicle efficiencies after 2020. This is likely to have led to higher predicted air quality impacts and human health risks after 2020 than would occur in reality, particularly given that fuel standards and vehicle efficiencies are likely to continue to improve over time.

Issue description

Another concern is that monitoring equipment has not kept pace with the decrease in particle sizes or the increased understanding of the mechanisms by which adverse health impacts occur. Some of the current pollutants monitored include: NO_2, CO, PM_{10} and $PM_{2.5}$ particulates ($PM_{2.5}$ only more recently). None of the current tunnel monitoring systems that we are aware of measure and report specifically on ultrafine particles which can be one micrometre in diameter and smaller.

Response

Air quality monitoring during operation would be conducted to meet the requirements of the conditions of approval that may be applied to the project by the Minister for Planning. These conditions may specify the timing, duration and extent of the air quality monitoring required for the project.

Air quality monitoring data collected for the project would be made publicly available.

Monitoring of air pollutants would be carried out to validate the modelling prediction during the environmental impact statement.

It is important that the health outcomes examined as part of the assessment are those where robust correlations exist between the health outcome and the pollutant of concern. The health outcomes examined within the environmental impact statement have been developed based on these robust correlations and in consultation with NSW Health.

When assessing health impacts from fine particulates, the robust associations of effects have been determined on the basis of $PM_{2.5}$, as $PM_{2.5}$ is what is commonly measured in urban air. No robust associations (that can be used in a quantitative assessment) are available for PM_1, although the associations developed for $PM_{2.5}$ will include a significant contribution from PM_1. Hence, health effects observed for PM_1 will be captured in the studies that have been conducted on the basis of $PM_{2.5}$.

As the assessment considers the health effects of $PM_{2.5}$, it is appropriate to also monitor $PM_{2.5}$. Similar to the assessment, monitoring of $PM_{2.5}$ would include all particles 2.5 microns and smaller. Hence, this would include the PM_1 fraction or ultrafine particles.

Further, there is no criterion or standard against which to monitor PM_1. As such, monitoring of this pollutant would not provide information to show compliance with regulatory goals or to inform management of the operational tunnel.

Issue description

National Environment Protection Measures (NEPM) provide guidelines for ambient air quality. There are currently no guidelines for in-tunnel air quality. The National Health and Medical Research report published in 2008 clearly identifies that new tunnel regulations are needed. Some of the recommendations include:

- The need for guideline values or health based exposure limits for priority pollutants. These need to be based on realistic estimates of transit times to capture both normal and congested conditions. They should also take into consideration the total trip of the motorist to assess the total daily exposure to various pollutants.
- The revision of standards to take into account the interaction of various pollutants.

- The monitoring of particulate matter levels should be monitored with a view to reduction, as current levels of particulate matter in some tunnels in Australia are in excess of 1,000 µg/m^3 which is clearly dangerous to health.

The National Health and Medical Research report (2008) also highlighted that further studies are needed on the in tunnel impacts including:

- Experimental studies needed to determine the health effects from exposure to tunnel air and its components at relevant timescales (minutes).
- The relative importance of different indicators of in-tunnel air quality (e.g. NO_2, particulates) in predicting patho-physiological or health effects should be explored.
- A practical and reliable method needs to be developed for monitoring NO_2 concentrations in road tunnels.
- A practical method needs to be developed for predicting tunnel users' exposure to NO_2.

Due to a lack of guidelines and health impact data, the true long term impacts are unknown and there is nothing to hold the tunnel operators accountable to.

It is necessary that in-tunnel conditions be appropriately regulated. Not only is it necessary to specify that the tunnel ventilation and operational systems shall cause no harm but the regulations must specify maximum peak pollutant levels and also the maximum time weighted exposures which are permitted.

Response

The environmental impact statement identifies that there are very few criteria or standards available in relation to short term exposures to pollutants which would be applicable to in-tunnel air quality. Design criteria for in-tunnel air quality have been based on recommendations from international bodies including the World Health Organization and the Permanent International Association of Road Congresses. Despite this, the project has investigated feasible and reasonable ventilation system design options to minimise in-tunnel exposure to particulate matter (refer to **Section 3.2** of this report).

In-tunnel air quality is considered in Section 7.3.4 of the environmental impact statement and the associated potential human health impacts in Section 7.4.5.

This assessment identified that:

- In relation to visibility, the NorthConnex tunnels would be considered 'clear air tunnels' according the Permanent International Association of Road Congress (2012).
- In-tunnel concentrations of nitrogen dioxide are consistent with other tunnels in Sydney and around the world and are below the limits adopted in other countries including Norway, Belgium and France.
- In-tunnel concentrations of particulate matter (PM_{10} and $PM_{2.5}$) are consistent with comparable tunnels around the world.

The human health risk assessment provided in Section 7.4 and Appendix H of the environmental impact statement provides an assessment of potential in-tunnel exposures to pollutants by comparing potential exposures to other tunnels around the world and to adopted standards from around the world where they are available. The assessments found that the predicted concentrations are lower than or comparable to other tunnels around the world, and below guidelines available for the United States and parts of Europe.

Issue description

Tunnels provide critical infrastructure for a growing population and a healthy economy, and if designed well will actually decrease ground concentration of pollutants by effectively dispersing these pollutants into the atmosphere. However there are important considerations in assessing potential health impacts which the Asthma Foundation would like further information on including:

- What assumptions underpin the forecasts for traffic volumes?
- What actions will be taken to control the level of pollution and exposure for motorists and residents?
- What is the predicted mix of vehicles, particularly the percentage of freight?
- What happens if forecasts and assumptions are incorrect?
- What are the standards by which the operator contractor will be held accountable for and are these stringent enough?
- What pollutants will the proposed monitoring report on and will the monitoring be independently audited on a regularly basis to ensure:
    - Real-time data is easily accessible
    - Monitors are placed in the right locations
    - Monitors are working correctly and are regularly calibrated
    - Monitors are measuring relevant air quality data, specifically ultrafine particles, and this is updated as required when new research or technology becomes available
    - Air quality exceedances are accurately and transparently reported.

Response

- The strategic traffic model used to determine the forecast traffic movements on which the NorthConnex environmental impact statement has been based takes into account a suite of factors including motorist behaviour, response to tolling arrangements and anticipated land use changes. Details of the inputs into the strategic traffic model are provided in Section 5.2 of the Technical Working Paper: traffic and transport (Appendix E of the environmental impact statement).

  The air quality impact assessment presented in Section 7.4 and Appendix G of the environmental impact statement has as its principal focus, modelling and assessment of potential air quality impacts under forecast traffic flows in 2019 and 2029 (derived from the Cube model). To provide confidence about the performance of the project in the event that actual traffic demand exceeds traffic forecasts in the future, the air quality impact assessment also considers 'design analysis A'. This design analysis is based on the project operating at its maximum theoretical design capacity during the peak hour (4,000 passenger car units). Design analysis A therefore represents a credible upper limit to the potential operation of the project. Although it is considered unlikely that design analysis A would eventuate in reality, based on traffic forecasting, it provides a 'worst-case' scenario for the purpose of assessment potential air quality impacts. The environmental impact statement demonstrates that design analysis A would meet applicable ambient air quality criteria.
- The NorthConnex project includes a well-designed ventilation system. The environmental impact statement demonstrates that the NorthConnex project would meet ambient air quality criteria and would pose a very low risk to human health. In this context, the design of the project controls the exposure of pollutants to residents and motorists.

- Figures 7-16 and 7-17 of the environmental impact statement provide the hourly traffic flows for 2019 and 2029 which have been used in the air quality assessment. This includes the split of light vehicles and heavy vehicles.
- As noted above, in order to provide confidence about the performance of the project in the event that actual traffic demand exceeds traffic forecasts in the future, the air quality impact assessment also considers 'design analysis A'. This design analysis is based on the project operating at its maximum theoretical design capacity during the peak hour (4,000 passenger car units). Design analysis A therefore represents a credible upper limit to the potential operation of the project. Although it is considered unlikely that design analysis A would eventuate in reality, based on traffic forecasting, it provides a 'worst-case' scenario for the purpose of assessment potential air quality impacts. The environmental impact statement demonstrates that design analysis A would meet applicable ambient air quality criteria.
- The environmental impact statement identifies the likely impacts and pollutant levels as a result of the project. In relation to ambient air quality, the environmental impact statement demonstrates that the NorthConnex project would meet ambient air quality criteria and would pose a very low risk to human health.

  In relation to in-tunnel air quality, the assessments found that the predicted concentrations are lower than or comparable to other tunnels around the world, and below guidelines available for the United States and parts of Europe.
- Air quality monitoring during operation would be conducted to meet the requirements of the conditions of approval that may be applied to the project by the Minister for Planning. These conditions may specify the timing, duration and extent of the air quality monitoring required for the project.

  Air quality monitoring during the initial phase after commencement of operation is intended to verify and validate the air quality modelling conducted for the project. By demonstrating that actual air quality is equal to or better than predicted by the air dispersion modelling, then confidence can be gained that predictions made by the modelling into the future are also robust. A period of twelve months of monitoring is proposed within the environmental impact statement because this would provide a whole year of seasonal variations in weather patterns.

  In-tunnel air quality monitoring would be undertaken on a continuous basis during operation.

  Air quality monitoring data collected for the project would be made publicly available.

7.4 Schools

7.4.1 Abbotsleigh

Issue description

Abbotsleigh is particularly concerned about air quality, namely:

- Emission dispersion from the ventilation outlets in all weather conditions.
- Emissions of exiting cars at the portal on Pearces Corner where no ventilation outlet is planned.
- Emissions in the tunnel for the entire nine kilometre length.

Abbotsleigh seeks assurance that the project complies with all relevant national and international safety and air quality standards; and that there will be no deleterious impact to air quality in our community.

Response

The air quality modelling has been undertaken in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants (Approved Methods) (DEC, 2005a), the National Environmental Protection Measure for Ambient Air Quality (Air NEPM) (National Environment Protection Council, 2003) and the Director-General's environmental assessment requirements. This includes the consideration of a range of meteorological conditions over a three year period.

The air quality impact assessment and the human health risk assessment included in the environmental impact statement demonstrate that the NorthConnex project would meet ambient air quality criteria and would pose a very low risk to human health.

In relation to emissions from the portals near Pearces Corner, the project does not propose any emissions from the tunnel portals under normal operating conditions. The project's ventilation system has been designed to operate with a pressure differential between the ventilation off-take and the portal. This pressure differential will act to draw air close to the tunnel portals back into the tunnel for collection and management with other tunnel air, via the relevant ventilation off-take and associated ventilation facility. This operational principal has been applied to both main alignment tunnel and off-ramp tunnel portals such as the off-ramp at Pearce's corner. Further details regarding the operation of the project ventilation system is provided in Section 5.2.5 of the environmental impact statement.

No criteria or standards are available in relation to short term exposures to pollutants which would be applicable to in-tunnel air quality. Design criteria for in-tunnel air quality have been based on recommendations from international bodies including the World Health Organisation and the Permanent International Association of Road Congress. In-tunnel air quality is considered in Section 7.3.4 of the environmental impact statement and the associated potential human health impacts in Section 7.4.5. This assessment identified that:

- In relation to visibility, the NorthConnex tunnel would be considered a 'clear air tunnel' according the Permanent International Association of Road Congress (2012).
- In-tunnel concentrations of nitrogen dioxide are consistent with other tunnels in Sydney and around the world and are below the limits adopted in other countries including Norway, Belgium and France.
- In-tunnel concentrations of particulate matter ($PM_{2.5}$) are consistent with other tunnels in Sydney and around the world.

The human health risk assessment provided in Section 7.4 of Appendix H of the environmental impact statement provides an assessment of potential in-tunnel exposures to pollutants by comparing potential exposures to other tunnels around the world and to adopted standards from around the world where they are available. The assessments found that the predicted concentrations are lower than or comparable to other tunnels around the world, and below guidelines available for the United States and parts of Europe.

7.4.2 Loreto Normanhurst

Issue description

The school is particularly concerned about any vibration impacts that may occur during the construction of the project tunnels. It is concerned about those impacts interfering with school activities (including sporting and extra-curricular activities) and the effects of those impacts on the education, health and well-being of its students.

The school is opposed to 24 hour, 7 days per week construction as any excessive vibration could interfere with the sleep, health and well-being of our boarders.

The school is also concerned about any property damage to the school's buildings that may be caused by blasting and tunnelling under the site. Any damage to our buildings would greatly impact on the school and its students, particularly if property damage caused any of the school's buildings to be unavailable for use.

It is therefore of the utmost importance to the school that stringent, transparent and accountable conditions in relation to vibration and noise impacts on the school be imposed on any approval of the project.

The school submits that if any approval is granted to the project then conditions should be imposed requiring that a dilapidation survey be carried out by the proponent on all of the school's buildings, not just those within the 50 metres of the proposed tunnel, and that they be carried out before the commencement and after completion of the construction of the tunnel so that a clear before and after picture of the school's buildings are available to the school.

The school notes that in Table 9-1 in Chapter 9 of the environmental impact statement, the proponent agrees to undertake existing condition surveys prior to the commencement of tunnelling. However, as far as the school has been able to ascertain, there is no such commitment to undertake further dilapidation surveys after the completion of construction of the tunnel. This should be required.

The school has reviewed the types of conditions that were imposed on the approval for the North West Rail Link and submits that similar conditions should be imposed on any approval for the project.

Response

Where the tunnel passes under Loreto Normanhurst, it would be around 35 to 45 metres below ground level. Tunnelling vibration maps are provided in Appendix I of the Technical Working Paper: Noise and Vibration (Appendix F of the environmental impact statement). These maps indicate that vibration in the vicinity of Loreto Normanhurst would be below the preferred value for human comfort at all times. Additionally, ground-borne noise maps are provided in Appendix G of the Technical Working Paper: Noise and Vibration. These maps indicate that ground-borne noise levels would be below the relevant night-time criterion of 35 dB(A).

Despite vibration values being below the level at which damage to buildings would be expected to occur, the project would undertake condition surveys on all buildings and structure with the preferred project corridor (a zone on the surface equal to 50 metres from the outer edge of the tunnels) before the commencement of tunnelling works. These condition surveys would be repeated on completion of tunnelling works. Based on the extent of anticipated impacts, there is no justification for extending this zone. It is also noted that, based on the project alignment, the majority of the buildings within Loreto Normanhurst are located within the 50 metre zone and would therefore be subject to dilapidation surveys.

The NorthConnex project team would continue to consult with Loreto Normanhurst in relation to the school's concerns and potential mitigation measures.

Issue description

The School understands that construction traffic will be generated 24 hours a day, 7 days a week along Pennant Hills Road.

It is concerned that noise from night time heavy construction traffic will interfere with the sleep, health and well-being of the school's boarders.

To minimise such disturbance, the school submits that the proponent should be required to consult with the school in the preparation of its Construction Traffic Management Plan for the project.

Response

An assessment of the potential increases in road traffic noise from the introduction of construction heavy vehicles is provided in Section 4.3 of the Technical Working Paper: Noise and Vibration (Appendix F of the environmental impact statement). This identifies that there may be increases in traffic noise of greater than 2 dB(A) during the night time periods. This is considered to represent a worst-case scenario with all trucks either travelling north or south. In reality it is foreseeable that spoil disposal sites would be used in both directions which would limit these potential impacts.

The NorthConnex project team would continue to consult with Loreto Normanhurst in relation to the school's concerns and potential mitigation measures. Issues raised during this consultation would be addressed as relevant in the Construction Traffic Management Plan(s) for the project.

Issue description

The school has a development programme so that current and future students will enjoy a rich learning experience in carefully planned and maintained buildings with the latest technology.

The school has developed a master plan for the future development of the site and has in recent years investigated the potential to use geothermal heating for the heating of new buildings on the site.

Geothermal heating is available from power extracted from heat stored in the earth. The proposed location of the project tunnel under the school's main building complex is likely to restrict the school's ability to provide geothermal heating to its buildings in the future. This would have an adverse financial impact on the school and ultimately, the parents of students attending the school.

The school requests that the location of the tunnel under the site be altered in a minor way such that the tunnel is located either:

- Approximately 100 metres to the north of the tunnel's current proposed location on the site, under Pennant Hills Road.
- Approximately 100 metres to the south of the tunnel's current proposed location, under the Sister Veronica Reid Oval in the southern part of the site.

In addition to the potential future geothermal heating benefits for the school, the relocation of the tunnel 100 metres to the north or south could reduce the potential for property damage adverse to the school's buildings.

Finally, so that there is no confusion, even if a decision is made to relocate the tunnel further south under the Oval, the school still seeks the imposition of conditions of approval requiring the proponent to carry out existing condition surveys of all of the school's buildings before the commencement of and after completion of construction of the tunnel. The school thinks that this requirement is not excessive having regard to the use of the site as a school and the site's listing as a heritage item under *Hornsby Local Environmental Plan 2013*.

Response

Based on the anticipated impacts in relation to vibration, ground-borne noise and settlement to Loreto Normanhurst, there is no justification for relocating the tunnel alignment. Shifting the tunnel alignment by 100 metres in either direction would have flow on effects along the alignment, potentially requiring a significant re-design of the project.

The NorthConnex project team would continue to consult with Loreto Normanhurst in relation to the School’s concerns and potential mitigation measures.

Issue description

The school requests the application of the following conditions of approval to the project if it is approved

- Before the commencement of construction (including demolition and excavation works), the Proponent is to undertake an independent inspection of each building on the School's site in accordance with AS 4349.1 'Inspection of Buildings' or any other applicable Australian Standard.
- The inspection is to be undertaken by appropriately qualified and experienced geotechnical and construction engineering experts.
- The proponent is to advise the school of the scope and methodology for the inspection, and of the process for making a property damage claim.
- A copy of the property inspection report is to be provided by the proponent to the school.
- The proponent is to determine appropriate property vibration criteria, and management and protection measures to ensure that property damage (including cosmetic damage) to buildings on the school's site be avoided.
- The proponent is to consult with the school to ensure that noise and vibration generating construction works in the vicinity of the school are not proposed to be carried out during sensitive periods (included but not limited to examination periods), unless other appropriate arrangements are made with the school.
- The proponent should be required to monitor noise and vibration during the construction of the tunnel and if monitoring indicates exceedance of the criteria, then the work should be required to stop immediately and should not recommence until a revised work method has been established that will ensure compliance with the noise and vibration criteria.
- The proponent should be required to establish an Independent Property Impact Assessment Panel before commencing the excavation, demolition and construction works. The Panel's members should be independent geotechnical and engineering experts not involved in the project. The Panel would independently verify the property inspection reports undertaken, the resolution of property damage disputes and the establishment of ongoing monitoring requirements. If there is a dispute between the school and the proponent about any potential or actual property damage either party could refer the unresolved dispute to the Panel for resolution. The Proponent would be responsible for all costs incurred in establishing and implementing the Panel.
- Any damage caused to any of the school's buildings or grounds as a result of the Project is to be rectified by the proponent or the school compensated, within a reasonable timeframe, with the costs borne by the proponent. A condition of this type should not limit any claims that the school may have against the proponent.
- The Construction Environmental Management Plan for the project should include a Construction Noise and Vibration Management Plan setting out how construction noise and vibration impacts will be minimised and managed, including but not be limited to:
    - Identifying construction noise and vibration goals applicable to the project and prescribed by the approval.
    - Details of the proposed construction activities and an indicative schedule for construction.
    - Identification of feasible and reasonable procedures and mitigation measures to ensure relevant vibration and blasting criteria are achieved.
    - Details of tunnelling activities including impacts, management and mitigation measures.

- If blasting is required, an assessment of the potential noise and vibration impacts, and a strategy to minimise and manage those impacts, including preparation of an appropriate community information program.
- A description of how the effectiveness of mitigation and management measures would be monitored during the proposed works, indicating how often the monitoring would be conducted, the locations where monitoring would take place, how the results of the monitoring would be recorded and reported, and, if any exceedance is detected, how any noncompliance would be rectified.
- Mechanisms for monitoring, reviewing and amending the Construction Noise and Vibration Plan.

- Construction hours, including activities associated with tunnelling to be limited to:
  - Monday to Friday 7am to 6pm.
  - Saturday 8 am to 1 pm.
  - No works permissible on Sundays or public holidays.

  No permission should be provided for 24 hour construction works, including tunnelling.
- The proponent should be required to consult with the school in relation to the preparation of the Construction Traffic Management Plan so as to minimise noise from heavy construction traffic at night time along Pennant Hills Road causing disturbance to the school's boarders.

Response

Loreto Normanhurst's suggested conditions of approval are noted. While the genera; intent of most of these suggested conditions is similar to commitments made in the environmental impact statement, restrictions on the hours of certain construction activities cannot be accepted.

There are three types of construction activities that cannot be feasibly or reasonably restricted to standard construction hours:

1. Underground tunnelling activities.
2. Surface activities supporting underground tunnelling activities.
3. Activities conducted within active road reserves.

Once commenced, it is not practical to start and stop tunnelling activities. The project tunnels would be constructed with principally with roadheaders with construction in some areas also employing surface miners. Significant time and resources are required to start-up and shut-down this equipment, which would introduce avoidable inefficiencies into the construction methodology and program if the project were limited to standard construction activities for tunnelling activities. Further, the current construction program which involves tunnelling activities over slightly less than three years (refer to Table 5-5 in the environmental impact statement) could be extended to include up to around eight to nine years of tunnelling works if standard construction hours were required for underground tunnelling. The environmental impact statement has demonstrated that, with some limited exceptions around tunnel portals, surface impacts as a result of underground tunnelling activities would be negligible.

Jack hammering underground may be required during tunnelling activities. Because this activity is noise intensity and poses an elevated risk of ground-borne noise and vibration, particularly around portal locations, a commitment has been made to avoid jack hammering

at night. For the same reasons as outlined above in relation to tunnelling, further restrictions on rock hammering in the tunnel would not be practical.

Because tunnel works would be undertaken continuously, 24 hours per day and seven days per week,, tunnel support activities at the southern interchange compound (C5), the Wilson Road compound (C6), the Trelawney Street compound (C7) and the northern interchange compound (C9) are also likely to be required up to 24 hours per day and seven days per week. This is principally because of three factors:

- The total extent of land acquisition and surface disturbance required for the project has been minimised. As a consequence, there is limited space to stockpile spoil and a need to regularly remove spoil from tunnel support sites.
- Spreading traffic movements over a 24 hour period reduces peak impacts, with lower impacts on average for most receivers.
- The highly congested traffic situation along Pennant Hills Road during and around peak hours, and high traffic volumes at other times of the day limit the ability to remove spoil for large periods during day time hours.

Some of the Hills M2 Motorway integration works are also required to be conducted outside of standard construction hours. This is principally driven by the need to ensure construction safety and the continued operation of the Hills M2 Motorway with minimal disruption during construction works affecting or in proximity to live road carriageways.

The need to conduct construction works within road reserves outside of standard construction hours, such as for the Hills M2 Motorway integrations works, is different to conducting construction works on a 24 hour/ seven day basis. There is no suggestion in the environmental impact statement that construction activities associated with the Hills M2 Motorway would be required on a 24 hour/ seven day basis (only outside of standard construction hours). This approach is consistent with construction scheduling for the M2 Motorway Upgrade project, and for other major road and rail infrastructure projects where construction safety is an issue.

As outlined in the environmental impact statement, other construction activities may be conducted outside of standard construction hours where the works in question are minor/ low impact, required for emergency response or under statutory direction, or for which agreement has been reached with the affected receiver(s). These works, if required, would include:

- Construction activities that do not exceed the applicable Noise Management Level at the nearest sensitive receiver.
- Activities that required by the Police or other authorities for safety reasons.
- Activities that are required to avoid the loss of life, property and/ or to prevent environmental harm in the event of an emergency.
- Construction activities for which negotiated agreements are in place with the affected receivers.
- Construction activities otherwise authorised by an environment protection licence.

7.4.3 Knox Grammar School

Issue description

Knox Grammar School respectfully requests that serious consideration be given to the filtering of exhaust outlets in the interest of public safety.

Response

Further information on the availability and efficacy of in-tunnel air treatment systems (including filtration) is provided in **Section 3.1** of this report. The analysis of ventilation system design options and alternatives in **Section 3.2** of this report considers the application of in-tunnel air treatment systems to the NorthConnex project and concludes that these systems are not feasible and reasonable.

Issue description

Knox Grammar has followed with great interest the reports from experts in the community on a range of health and safety issues and we concur with those concerns and ask that these be considered as a matter of urgency.

We attach a copy of a letter titled "Letter of Medical Evidence opposing NorthConnex tunnel portal and outlet placement in residential suburb" which we believe best summarises those health and safety concerns.

Response

The letter attached to the submission by Knox Grammar School provides information relating to the impacts of air pollution on human health. The letter also makes reference to the recent study by Cowie regarding the health effects of Lane Cove Tunnel.

The human health risk assessment presented in the environmental impact statement has been carried out in accordance with the Director-General's environmental assessment requirements and the requirements of EnHealth Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards: 2012 (enHealth 2012a). Section 4.2 of the human health risk assessment (Appendix H of the environmental impact statement) discusses the potential human health impacts associated with air pollutants.

It is important that the health outcomes examined as part of the assessment are those where robust correlations exist between the health outcome and the pollutant of concern. The health outcomes examined within the environmental impact statement have been developed based on these robust correlations and in consultation with NSW Health.

The Woolcock Report (or Cowie study) recently undertaken to investigate the effect of tunnel emissions from the Lane Cove Tunnel on respiratory health found that tunnel emissions had minimal impact on the respiratory heath of residents living near the ventilation outlets and in the surrounding areas. NSW Health's independent Air Pollution Expert Advisory Committee has reviewed the findings of this study and has advised that no changes to the operation or management of the Lane Cove Tunnel are needed and no further health studies are required at this time.

7.5 Churches and places of worship

7.5.1 Chinese and Australian Baptist Church

On behalf of our church members and visitors, the Chinese and Australian Baptist Church puts forward this submission as we have significant concerns with the proposed use of Loch Maree Avenue for heavy vehicle movements to and from the Trelawney Street support facility.

Our church premises are located on the corner of Pennant Hills Road and Loch Maree Avenue and used for regular activities and public events seven days a week. These include playgroups for parents and their children aged 0-5 on Wednesday and Friday mornings, Thursday morning meetings for about 60 elderlies and women as well as numerous group meetings and events on Saturdays from morning till evening.

Although we have sufficient parking facilities on-site for the above activities and events, we wish to alert you that we have over 100 participants of youth activities on Friday evenings 7 pm to 11 pm as well as a total of 500+ (including elderly people and young children) attending five services and related activities on Sundays between 8 am and 9 pm. Many of them require parking on nearby streets or access to public transport by foot.

While the proposed standard construction hours exclude week nights after 6 pm, Saturdays after 1 pm and all Sundays and public holidays, we note that they will be up to 24 hours per day and seven days per week during peak construction periods of tunnelling for the proposed 33 months (from the third quarter in 2016 to the first quarter of 2019), and that 1,140 heavy vehicles and 200 light vehicles will turn into Loch Maree from Pennant Hills Road. This translates into roughly one construction vehicle movement per minute up or down Loch Maree Avenue.

Issue description

The proposed inbound heavy vehicle route coming from the north and the south both turn into Loch Maree Avenue. For the size and length of these heavy vehicles, their drivers not only need to make the turn on the outer lanes of Pennant Hills Road, they will also need to negotiate downslope into a much narrower two lane Loch Maree Avenue to turn left into the support facility. Frequent congestions and / or collisions caused by these heavy vehicles will be very likely.

One suggested alternative to reduce the concentration of construction vehicles using Loch Maree Avenue will be for the southbound heavy vehicles to instead turn left into Trelawney Street and then right into the support facility site.

Given the undesirable confusion caused by the frequent traffic gridlock, safety to our participants especially our young children, youths and elderlies may be jeopardized when many need to walk across both Loch Maree Avenue and Pennant Hills Road at the traffic lights to / from the train stations, bus stops and street parking off-site.

Drivers entering/ exiting our church car park on Loch Maree Avenue will also be endangered among the constant stream of heavy vehicles. In addition, it will be difficult for cars to turn left into Loch Maree Avenue from Pennant Hills Road and right from Loch Maree Avenue into Pennant Hills Road due to the expected frequency of trucks making these turns as well.

The Chinese and Australian Baptist Church would therefore seek your traffic control management plan and ask that your management team works closely with ours in order to alleviate the foreseeable danger, traffic jam and street parking problems caused to our members and the public.

Response

Based on concerns raised in public submissions, including from the Chinese and Australian Baptist Church, and through other community and stakeholder engagement mechanisms (refer to **Chapter 5** of this report), access arrangements to several construction compounds have been reviewed. This has included a review of heavy vehicle access arrangements to the Trelawney Street compound (C7). Changes made to access arrangements at the Trelawney Street compound are detailed and assessed in **Section 9.4** of this report.

The access arrangements would still need to utilise a small section of Loch Maree Avenue. It is acknowledged that the access and egress point to and from construction compounds and worksites would introduce an interface between construction traffic, local traffic, pedestrians and potentially cyclists. Site specific traffic management plans and traffic controls plans would be developed in order to effectively manage this interface. This may include measure such as temporary diversions for pedestrians and cyclists, and traffic controllers at access / egress points.

The NorthConex project team would continue to consult with the Chinese and Australian Baptist Church in relation to potential impacts to the church from works in the vicinity.

Issue description

The proposed volumes of heavy vehicle traffic especially during the 33-month tunnelling works, which would concentrates on the corner of Pennant Hills Road and Loch Maree Avenue, would generate endless and loud engine noise that would in turn render all activities in our premises (meeting rooms, halls and courtyard) impossible. We therefore request your temporary installation of effective sound-proofing barriers around our church boundary on the affected corner.

Response

A construction traffic noise assessment has been undertaken and is provided in Section 4.3 of the Technical Working Paper: noise and vibration (Appendix F of the environmental impact statement). This shows that, during the daytime period, the introduction of construction traffic would not result in significant increases in road traffic noise around Trelawney Street.

Based on concerns raised in public submissions and through other community and stakeholder engagement mechanisms (refer to **Chapter 5** of this report), access arrangements to several construction compounds have been reviewed. This has included a review of heavy vehicle access arrangements to the Trelawney Street compound (C7). Changes made to access arrangements at the Trelawney Street compound are detailed and assessed in **Section 9.4** of this report. This includes further consideration of the potential noise impacts from construction traffic.

Issue description

The large amount of dust and fumes emitted daily from these extra 1,340 construction vehicles that travel only one to two metres away from our premises would adversely impact on the health of our young children and elderly people as well as those who have existing respiratory illnesses. We seek input on how this concern can be addressed by your air quality experts.

Response

Section 7.3.4 of the environmental impact statement provides an assessment of potential air quality impacts during construction, including dust and vehicle emissions.

Construction air quality management measures are identified in Section 7.3.5 of the environmental impact statement. In relation to dust generation, these include measures such as:

- Water carts, sprinklers, sprays and dust screens to control dust emissions.
- Modifying construction activities during high or unfavourable wind conditions.
- A proactive dust observation program would be implemented involving daily reviews of weather forecasts, observations of meteorological conditions and on site dust generation. This would inform mitigation measures or alterations to construction activities to be implemented during unfavourable weather conditions.

Emissions from plant and equipment during construction are anticipated to be minor compared to the emissions from the surrounding road network. Additionally, plant and equipment used during construction would comply with the emissions concentration limits outlined in the *Protection of the Environment Operations (Clean Air) Regulation 2010*.

Issue description

In order that the wider community may enjoy improved infrastructure for the future, we accept that a certain level of inconvenience to us is inevitable. However, the concerns that we have raised, if left unaddressed, would have adverse or irreversible consequences not only to the health and safety of our members and the public but also to the viability of our church operations.

We therefore look forward to cooperating with the NorthConnex project team so that the project may go ahead with proper management and/or mitigation of these foreseeable problems.

Response

Construction works would result in impacts to the local community. These impacts, potentially including noise and vibration; air quality (particularly dust); visual impacts; and construction traffic, are identified and assessed within the relevant sections of the environmental impact statement. The environmental impact statement demonstrates that these impacts can be managed within acceptable limits with the application of a suite of mitigation and management measures. Construction works would be limited in duration and any construction-related impacts on surrounding receivers would be temporary.

The environmental impact statement identifies feasible and reasonable management and mitigation measures in order to avoid or minimise these potential impacts.

The NorthConnex project team would continue to consult with the Chinese and Australian Baptist Church in relation to potential impacts to the church from works in the vicinity, and the proposed mitigation and management measures to reduce these impacts as far as feasible and reasonable.

7.5.2 St Paul's Anglican Church

Issue description

An additional right turn lane northbound on Pennant Hills Road is proposed to be installed at Pearces Corner (due to anticipated increases in traffic volume once the tunnel is in place). It is requested that Roads and Maritime determines an appropriate way that parishioners, preschool parents and other users of the church facilities are able to safely exit the church grounds onto the Pacific Highway in a timely manner (noting that this is already a problem under current traffic volumes).

Measures may include one or more of the following:

- The construction of a new entrance / exit directly into the Church car park from Ingram Rd / the Pacific Highway.
- "Keep clear" markings (which would need to be installed and maintained by Roads and Maritime) on the Pacific Highway on the road at the point of exit.
- Appropriate traffic light phasing.

Response

The Pearces Corner intersection would be upgraded as part of the NorthConnex project. This would include the provision of an additional right-turn lane to the Pacific Highway.

The provision of this new right-turn lane would not alter the existing access or egress arrangements to and from St Pauls Anglican Church. Alterations to the access and egress arrangements to and from St Paul's Anglican Church are outside the scope of the NorthConnex project.

Issue description

Construction of the additional right turn lane at Pearces Corner and any movement of spoil from the tunnel drilling via Pearces Corner must not occur on a Sunday noting that we have services at 8am, 9:45am and 7pm.

The church and church hall is also used by various church and community groups at various times during the week both day and night and any noise generated by the construction of the NorthConnex project should not affect the ability of worshippers at church and hall users to participate in the services/ communicate with each other. The amenity of the staff, parents and children at the Peter Rabbit Community Preschool on the church premises should also not be affected by construction/ construction related activities.

Response

Spoil haulage is proposed to occur 24 hours per day and seven days per week. This is principally because of three factors:

- The total extent of land acquisition and surface disturbance required for the project has been minimised. As a consequence, there is limited space to stockpile spoil and a need to regularly remove spoil from tunnel support sites.
- Spreading traffic movements over a 24 hour period reduces peak impacts, with lower impacts on average for most receivers.
- The highly congested traffic situation along Pennant Hills Road during and around peak hours, and high traffic volumes at other times of the day limit the ability to remove spoil for large periods during day time hours.

In relation to the Pennant Hills Road/ Pacific Highway intersection, this spoil haulage is not anticipated to result in a significant deterioration in intersection performance (refer to Table 7-19 and Table 7-21 of the environmental impact statement).

The environmental impact statement provides an assessment of construction noise in Section 7.2.4 and Appendix F. This assessment has been undertaken in accordance with the relevant guidelines including the Interim Construction Noise Guidelines (DECCW, 2009).

Where the assessment indicates that relevant noise management levels are predicted to be exceeded, consideration has been given to feasible and reasonable mitigation and management measures. Further information on construction noise mitigation and management measures is provided in **Section 4.5** of this report.

Issue description

Due to adverse health effects associated with air pollution from car/truck exhausts, that further consideration be given to the use of filtration and/or moving the northern ventilation outlet northbound into an industrial or forested area rather than concentrating it in a residential area in close proximity to the Rectory, Assistant Minister's residence, parishioners homes, nursing homes, schools, preschools and child care centres.

Response

The air quality impact assessment and the human health risk assessment included in the environmental impact statement demonstrate that the NorthConnex project would meet ambient air quality criteria and would pose a very low risk to human health. In this context, there is no technical basis to justify relocation of the northern portals and/ or northern ventilation facility to an alternative location.

The most efficient location for ventilation outlets is close to the main alignment tunnel exit portals. This is because vehicles travelling through the tunnels create a piston effect, which draws air into the tunnel and pushes it forward in the direction of traffic flow. Locating the ventilation outlets near the main alignment tunnel exit portals maximises the benefit of the piston effect and minimises the need for additional energy consumption to operate tunnel jet fans and to transport the exhaust air from the tunnel to the outlet. This approach provides environmental benefits through the reduction in energy consumption and greenhouse gas emissions from the project.

The locations of ventilation outlets for the project have been determined based on proximity to the main alignment tunnel exit portals, as well as consideration of other factors including land access and acquisition requirements, geology, engineering and construction constraints, potential landscape and visual impacts, and the location of other major infrastructure.

Section 3.2 of this report includes consideration of options and alternatives for the design and configuration of the northern ventilation outlet into the Asquith Industrial Estate. This assessment demonstrates that the relocation of the northern ventilation outlet would not achieve any appreciable improvement in air quality impacts, but would introduce greater environmental and land use impacts, engineering complexities and project costs. On this basis, relocation of the northern ventilation outlet is not considered feasible or reasonable, and would produce a superior outcome to the northern ventilation outlet in the location identified in environmental impact statement.

7.6 Hospitals and aged care facilities

7.6.1 Sydney Adventist Hospital

Issue description

The Sydney Adventist Hospital is opposed to the current design of the NorthConnex project due to concerns that we have regarding the health of local residents living around the proposed tunnel ventilation outlets and portals. We also have concerns for our staff, both at the San Day Surgery (600 metres from proposed northern ventilation outlet) and at the Sydney Adventist Hospital (Main campus, two kilometres from proposed northern ventilation outlet). We feel it is our duty of care to our community (for which we have cared for over a century) and our staff, to have their wellbeing and health seen as the overall priority insight of major infrastructure projects.

Response

Section 7.4 and Appendix H of the environmental impact statement presented a human health risk assessment, which demonstrates that the project would a very low impact on human health risks for populations around the project's ventilation outlets. The human health risk assessment has considered more vulnerable members of the community, including children, the elderly and people with existing respiratory issues.

Based on the air dispersion modelling presented in the environmental impact statement, the San Day Surgery is on the boundary of where air quality impacts from the northern ventilation outlet have been predicted under some meteorological conditions. Maximum impacts at this location are expected to be very low and below detection levels in most cases. The Sydney Adventist Hospital lies well beyond the extent of measurable air quality impacts from the project.

Issue description

A local study by Cowie et al looking at health effects of the Lane Cove tunnel in Sydney, NSW, studied participants before and after the opening of the tunnel. The study found that residents living within 650 metres of the tunnel ventilation outlet reported more upper and lower respiratory symptoms and had lower lung volumes in the first two years after the tunnel opened. There was also, unfortunately, no consistent evidence of improvement in respiratory health in residents living along the bypassed main road, despite a reduction in traffic from 90,000 to 45,000 vehicles per day. Gauderman et al followed school children from the age of 10 for eight years to observe the effects of air pollution on lung development. He showed that lung development is significantly affected through reductions in lung volumes such as FVC, FEV1 and MMEF, as would be expected if the children had been exposed to maternal smoking.

Exposure to particulate pollution is associated with reduced lung function growth in children, and even children relocating from high to low pollution areas (or vice versa) were shown to experience changes in lung function growth that mirrored changes in exposure to particulate matter (i.e. the changes in their lung function growth was permanent).

Our concerns regarding the current proposal are based on the following facts regarding air pollution which are researched and documented in scientific literature:

- There is an increased risk of death in people exposed to particulate matter, even when exposure is within concentration ranges well below the present European standards.
- Air pollution causes lung cancer and is associated with bladder cancer.
- In 2010, 223,000 deaths from lung cancer worldwide resulted from air pollution, according to the World Health Organisation (WHO).

- WHO classifies diesel exhaust fumes as a carcinogen (cancer causing).
- Ultrafine particles (median diameter <0·1 micrometres) are more toxic when inhaled than other measurable particles. They are greatly absorbed into tissues and the circulation and are important factors in determining cardiopulmonary toxicity.
- Both short- and long-term exposures to particulate matter are associated with a host of cardiovascular diseases, including heart attacks, arrhythmias, strokes and increased risk of death from the above cardiovascular causes.
- Children show reduced lung function growth which persists later into life, even when exposure stops, i.e. the damage for growing lungs is permanent.
- Children have been found to suffer from symptoms of bronchitis following exposure.
- Residents living around tunnel ventilation outlets report more upper and lower respiratory symptoms and have lower lung volumes.
- Low birth weights are more common in pregnant women exposed to traffic pollution.
- Exposure to traffic-related air pollution during pregnancy and during the first year of life is associated with autism.
- Higher levels of long-term pollution are associated with significantly faster cognitive decline, ie development of dementia.
- Outdoor pollutant levels correlate with those measured indoors in houses exposed to air traffic pollution.

We are concerned that any modelling of air quality and drawing conclusions on their resultant health impacts drawn from this modelling prior to construction will be inaccurate, as little scientific evidence exists for long term health impacts of unmeasured particles.

Our concerns are therefore validated by the existing medical data which suggests that lung damage to children is permanent when due to air pollution. We have seen this happen locally by Cowie, and even though measurable particles did not significantly increase in the studied areas, health impacts occurred. This heightens our concerns that it is unmeasured particles, such as ultrafine particulate matter, which contribute to these adverse health impacts.

Response

The human health risk assessment presented in the environmental impact statement has been carried out in accordance with the Director-General's environmental assessment requirements and the requirements of EnHealth Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards: 2012 (enHealth 2012a). Section 4.2 of the human health risk assessment (Appendix H of the environmental impact statement) discusses the potential human health impacts associated with air pollutants.

The environmental impact statement accepts that there is no threshold below which exposure to particulate matter ($PM_{2.5}$) would not generate a health effect. Because of this, the environmental impact assessment includes a human health risk assessment that expressly calculates the change in health outcomes associated with predicted exposures to $PM_{2.5}$ (without the application of a dose-response threshold). Further analysis of feasible and reasonable measures to minimise exposures to vehicle emissions, including particulate matter is included in **Section 3.2**. Based on this analysis, an increase in the height of the southern and northern ventilation outlets has been demonstrated as a feasible and reasonable measure to further minimisation ambient air quality impacts and associated human health risks.

It is important that the health outcomes examined as part of the assessment are those where robust correlations exist between the health outcome and the pollutant of concern. The health outcomes examined within the environmental impact statement have been developed based on these robust correlations and in consultation with NSW Health.

The Woolcock Report (or Cowie study) recently undertaken to investigate the effect of tunnel emissions form the Lane Cove Tunnel on respiratory health found that tunnel emissions had minimal impact on the respiratory heath of residents living near the ventilation outlets and in the surrounding areas. NSW Health's independent Air Pollution Expert Advisory Committee has reviewed the findings of this study and has advised that no changes to the operation or management of the Lane Cove Tunnel are needed and no further health studies are required at this time.

Issue description

The NorthConnex environmental impact statement includes a human health risk assessment.

The impacts outlined in this section of the environmental impact statement are directly calculated from the air quality data derived from the air quality section of the environmental impact statement. Hence, the health impacts are directly linked to the air quality calculations.

We are of the opinion that the air quality calculations in the environmental impact statement show major flaws and hence the health impacts thus derived are subject to questionable validity. It is our understanding that the environmental impact statement contains some major flaws which will have a negative impact on pollution dispersion calculations, and hence, on health impact assessments:

- Meteorology:
  - We are aware that meteorological data for the ventilation outlet locations was gathered from remote sites around greater Sydney. These locations include Sydney Airport, Terrey Hills and Penrith.
  - No local weather data was collected from West Pennant Hills or Wahroonga for dispersion calculations.
  - We feel that the proposed ventilation outlet locations have their own climatic conditions, especially with regard to average wind speeds, and that these differ from those found at the measured locations.

  This will have effects on dispersion calculations.

- Topography:
  - Local topography was measured using software accurate to 250 metres.
  - Please refer to independent air quality assessment by Jacobs Group (Australia) Pty Ltd as per Ku-ring-gai Council submission.
  - The true valley contours are different to "measured" contours by five to 10 metres in parts.

- Background air quality data:
  - PM_1 are not measured.
  - There is a total failure to collect site specific ambient air quality data and meteorological data. No local area data has been collected for more than few months.
  - Background air quality was measured distant from Wahroonga, at Lindfield (10 kilometres away) and Prospect (20 kilometres away). Lindfield monitoring station does not comply with Australian Standards and does not measure $PM_{2.5}$.

- In tunnel air quality:
  - Failure to consider and include the polluted intake of air from the busy Hills M2 Motorway / Pennant Hills Road interchange as part of contribution to air quality at Wahroonga.
  - Levels of toxins such as $PM_{2.5}$ reaching very high levels (500 μ/m^3) at the ends of the tunnels with potential health impacts on commuters and residents.

- Current practice and recommendations:
  - The National Health and Medical Research Council states that the great advantage of tunnels is that their portals and outlets can be deliberately sited away from residential areas. These recommendations are also found internationally.
  - There are no other tunnels of this length in Australia.
  - Of the tunnels that do exist on our continent, there are none that have ventilation outlets sited in comparable areas.
  - We are concerned that as a result of the magnitude and length of this tunnel, there will be greater than estimated pollution levels ejected out of single ventilation outlets at either ends of this tunnel.

- Solution:
  - As the medical and scientific knowledge of these toxins is evolving, we urge the approach of using precautionary principles to avoid long term harm to the affected community.
  - Application of the precautionary principle is best achieved by relocation of the ventilation outlets away from densely populated areas.
  - Any ventilation outlet sited within metropolitan Sydney needs to be filtered with the utilisation of the filtration systems being enforced by an independent overseer.
  - Repeat the air quality assessment and recalculate the resultant health impacts, taking into account the local topography, ventilation outlet height, local meteorology and true total emission values in various traffic situations.
  - The project, if approved, must take into consideration the above elements.

Response

Specific responses to each of the issues raised by the Sydney Adventist Hospital are as follows:

- Meteorology:
  - **Section 2.10** of this report provides further information and discussion of meteorological data and modelling conducted as part of the air quality impact assessment for the project. It takes into account data available from project monitoring stations along the Pennant Hills Road corridor, and demonstrates that the meteorological data used in the modelling is conservative and is likely to have led to an overestimate of conditions under which peak air quality impacts would occur.

- Topography:
  - Further discussion and analysis of terrain data and assumptions is provided in **Section 2.12** of this report. As part of this analysis, additional screening level modelling has been conducted using SRTM data at 250 metre resolution, and LiDAR data at one metre resolution. The additional modelling demonstrates that the SRTM data at 250 metre resolution tends to lead to overestimates of ground level impacts relative to the modelling predictions using more accurate LiDAR terrain data.

- Background air quality data:
  - PM_1 concentrations are measured as part of the $PM_{2.5}$ fraction.
  - **Section 2.10** and **Section 2.11** of this report provide further information and discussion of meteorological and background air quality data used as part of the air quality impact assessment for the project. It takes into account data available from project monitoring stations along the Pennant Hills Road corridor, and demonstrates that the meteorological and background air quality data used in the modelling is conservative.

- In tunnel air quality:
  - Further discussion and analysis of pollutant loads drawn into the project tunnels through entry portals is provided in **Section 2.8.2** of this report. This analysis includes additional screening level modelling which demonstrates that this additional pollutant load would not significantly affected modelled ambient air quality outcomes.
  - Discussion of in-tunnel pollutant concentrations and exposure levels, including in relation to $PM_{2.5}$ concentrations (with reference to a quoted of 500 μ/m^3), are provided in response to issues raised by NSW Health (refer to **Section 7.1.2.3** of this report).

- Current practice and recommendations:
  - There is limited potential for feasibly and reasonably locating the project's ventilation outlets along the Pennant Hills Road corridor in an area that is entirely removed from residential areas.
  - The environmental impact statement demonstrates that the project's ventilation outlets in their proposed locations would lead to very low air quality impacts, which are within acceptable ambient air quality criteria and advisory reporting

standards. It also demonstrates that the project would generate a very low human health risk.

- Further analysis of feasible and reasonable measures to minimise exposures to vehicle emissions, including particulate matter is included in **Section 3.2**. This analysis has included consideration of options such as increased ventilation heights, alternative ventilation outlet locations, provision of additional ventilation outlets, changes in tunnel ventilation rate and application of in-tunnel air treatment (such as filtration). Based on this analysis, an increase in the height of the southern and northern ventilation outlets has been demonstrated as a feasible and reasonable measure to further minimisation ambient air quality impacts and associated human health risks. Further details of the five metre increase in ventilation outlet heights are provided in **Section 9.2** of this report.
- Concentrations of vehicle emissions in the project tunnels (and ultimately the concentration of emissions from the project's ventilation outlets) have been calculated using conservative, internationally recognised emission factors published by the Permanent International Association of Road Congresses (2012). Further details of these calculations are provided in **Section 2.8** of this report.

- Solution:
  - Further analysis of feasible and reasonable measures to minimise exposures to vehicle emissions, including particulate matter is included in **Section 3.2**. This analysis has included consideration of options such as increased ventilation heights, alternative ventilation outlet locations, provision of additional ventilation outlets, changes in tunnel ventilation rate and application of in-tunnel air treatment (such as filtration).

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7.7 Elected representatives

7.7.1 The Hon Barry O'Farrell MP – State Member for Ku-ring-gai

At the outset I want to reiterate my longstanding support for the much sought after link between the M1 Pacific Motorway and the M2 Hills Motorway and to note that, in all my dealings with local residents and groups about the proposed NorthConnex project, all have expressed support for such a link.

Local residents understand the benefits the proposed link will deliver through reduced traffic on both Pennant Hills Road and the Pacific Highway.

However, as highlighted at a number of public forums and meetings – and undoubtedly in submissions to this environmental impact statement process – there are a number of issues and concerns held about the current plans for the link.

Issue description

In relation to air quality:

- Residents are concerned about the accuracy of data used in modelling the likely air quality impact of the proposed tunnel, pointing to the fact that it is based upon data derived from monitoring stations at Prospect and Lindfield rather than locations along the proposed NorthConnex project corridor.
- Residents have expressed concern that air quality modelling for the northern ventilation outlet appears to fail to take into account the topography of the proposed location and are based on meteorological data that doesn't reflect 'normal' local weather conditions.
- Residents have also raised questions about whether pollution emissions from heavy vehicles have been underestimated and raised similar concerns about estimates made about likely emissions from diesel vehicles.

Response

Chapter 2 of this report provides further information on the inputs and assumptions that have been applied to the air quality impact assessment for the project, including in relation to background air quality data, topography and meteorological conditions. This information demonstrates that the assumptions and inputs into the air quality impact assessment are reasonable and conservative.

Section 2.8 of this report provides further information on how the emissions from vehicles using the project have been calculated. Further, the Environment Protection Authority has raised several queries relating to vehicle emission assumptions. Detailed responses to these queries are provided in **Section 7.1.1.3** of this report.

Issue description

With respect to the northern ventilation outlet:

- Residents are strongly concerned about the plan to locate the northern ventilation outlet close to homes and in the vicinity of a number of schools. This is a concern I share and, as with the Lane Cove Tunnel, my preferred option is to locate the outlet within the Hornsby industrial estate [Asquith Industrial Estate].

Response

Section 3.2 of this report includes consideration of options and alternatives for the design and configuration of the northern ventilation outlet into the Asquith Industrial Estate. This assessment demonstrates that the relocation of the northern ventilation outlet would not achieve any appreciable improvement in air quality impacts, but would introduce greater environmental and land use impacts, engineering complexities and project costs. On this basis, relocation of the northern ventilation outlet is not considered feasible or reasonable, and would produce a superior outcome to the northern ventilation outlet in the location identified in environmental impact statement.

Issue description

In relation to filtration:

- The strongest concern raised by residents has related to potential harm caused by the ventilation outlets and the demand to include filters in the northern and southern ventilation outlets. I understand the retro fitting of filters on the M5 Motorway had a negligible impact on air quality. But given the increasing use of road tunnels to overcome congestion caused by under investment in road and public transport by previous governments, a case can be made for the inclusion of filters in the NorthConnex project to determine their effectiveness. Obviously such a decision would have to consider any impact upon the project's financial viability.

Response

Further information on the availability and efficacy of in-tunnel air treatment systems (including filtration) is provided in **Section 3.1** of this report. The analysis of ventilation system design options and alternatives in **Section 3.2** of this report considers the application of in-tunnel air treatment systems to the NorthConnex project and concludes that these systems are not feasible and reasonable.

Issue description

With respect to the location of the northern portal:

- Residents have expressed a view that the portal should be located two kilometres further north of the currently proposed location. Understanding that this would have an impact on the cost of the project – and presumably the level of the tolls – I have previously asked the Minister for Roads on whether such a change could be made without threatening the financial viability of the proposed link.
- Residents are also concerned that, while current plans rule out portal emissions, the issue of such emissions in the future is not addressed. Even though I understand that, was such a change to be proposed in future it would require an environmental impact statement to be undertaken, it would seem prudent to ensure the current project was designed to avoid this possibility.

Response

The northern portals and northern ventilation outlet have been located taking into account a balance of relevant issues, including the performance of the surrounding road network, engineering practicality and constructability, cost efficiency, the desire to minimise land take and disturbance of existing development patterns, and minimisation of environmental impacts. Taking all of these factors into account, the proposed location for the northern portals and northern ventilation outlet represent an optimised outcome that meets the needs and objectives of the NorthConnex project.

The air quality impact assessment and the human health risk assessment included in the environmental impact statement demonstrate that the NorthConnex project in its current form would meet air quality criteria at external receivers and would pose a very low risk to human health. In this context, there is no basis to justify relocation of the northern portals and/ or northern ventilation facility to an alternative location.

Section 3.2 of this report includes consideration of options and alternatives for the design and configuration of the northern ventilation outlet into the Asquith Industrial Estate. This assessment demonstrates that the relocation of the northern ventilation outlet would not achieve any appreciable improvement in air quality impacts, but would introduce greater environmental and land use impacts, engineering complexities and project costs. On this basis, relocation of the northern ventilation outlet is not considered feasible or reasonable, and would produce a superior outcome to the northern ventilation outlet in the location identified in environmental impact statement.

The project does not propose any emissions from the tunnel portals under normal operating conditions. Air within the section of tunnel beyond the ventilation off-take would be drawn back against the flow of traffic to be emitted and dispersed through the ventilation outlet. As such, the assessment has not considered portal emissions. If portal emissions are considered in the future, this would be subject to appropriate assessment and approval.

The environmental impact statement includes a statement that the planning application made for the NorthConnex project is not seeking approval for portal emissions. If approved, any approval granted by the Minister for Planning would therefore not authorise portal emissions.

Issue description

In relation to groundwater:

- Residents have raised questions about whether the environmental impact statement adequately addresses the impact of the proposed tunnel on groundwater, whether along the tunnel route or adjacent to the portals where the impact could adversely affect homes.

Response

The groundwater impact assessment in Section 7.8 of the environmental impact statement provides consideration of potential impacts to groundwater and settlement related to groundwater drawdown which has the potential to result in property damage.

The assessment found that, in all cases, settlement due to groundwater drawdown would be less than three millimetres, which is considered negligible. Settlement of three millimetres would only result in potential minor cosmetic damage such as hairline cracking.

Prior to the commencement of tunnelling works, condition surveys would be undertaken on properties and structures within the preferred project corridor (the zone on the surface equal

to 50 metres from the outer edge of the tunnels) and within 50 metres of surface works. In the unlikely event of damage caused by the construction of the NorthConnex project, this would be rectified by the contractor at no cost to the property owner.

Issue description

In relation to traffic:

- Besides concerns about traffic management during the construction of the proposed links, residents have also worried about possible adverse impact on Pennant Hills Road of northbound traffic trying to leave Sydney if current plans for a single northbound lane on the M1 Pacific Motorway at Wahroonga remain unchanged.
- The chief benefit advanced for the NorthConnex project is the removal of heavy vehicles from Pennant Hills Road. In my view, this outcome—and additional the benefit of removing similar vehicles from the Pacific Highway and Ryde Road—can only be guaranteed if eligible heavy vehicles are required to use the proposed tunnel.

Response

Traffic northbound on the M1 Pacific Motorway north from Pennant Hills Road is predicted to be around 970 vehicles per hour in the AM peak and 1,760 vehicles per hour in the PM peak by 2029. The capacity of the M1 Pacific Motorway at this location is 2,200 vehicles per hour per lane. As such, a single lane in this location is sufficient for the predicted volume of traffic into the foreseeable future.

Because a key function of the NorthConnex project would be to provide an alternative to Pennant Hills Road for the movement of heavy vehicles, the NSW Government will be introducing regulatory measures to ensure heavy vehicles (other than dangerous goods vehicles or those with a genuine origin or destination along Pennant Hills Road) use the NorthConnex project rather than surface roads. These measures may include introducing, or changing the operation of existing, traffic control facilities, advisory and / or regulatory signage, route designations, notices, application of permits, or other traffic measures. Any regulatory measures that have the effect of regulating heavy vehicles would need to be consistent with the objectives of the National Heavy Vehicle Law, where applicable.

Regulatory measures under consideration also include a potential penalty for non-compliance, for certain classes of heavy vehicles using the surrounding road network. Enforcement measures might include structures, upon which equipment associated with enforcement may need to be mounted (such as cameras or other equipment).

Issue description

With respect to the M1 Pacific Motorway / Pacific Highway interchange:

- I am also aware that, as part of this environmental impact statement process, one resident has submitted a proposal to eliminate the need for traffic lights at the Pacific Highway / M1 Pacific Motorway overpass at Wahroonga. Removal of these lights would improve local traffic flow after the Northconnex project is completed.

Response

The re-configuration of the M1 Pacific Motorway/ Pacific Highway interchange, the Pacific Highway/ Pennant Hills Road intersection and the M1 Pacific Motorway/ Pennant Hills Road intersection arrangements as suggested is beyond the scope of the NorthConnex project.

This suggestion would require a significant change to intersection layouts. For example, the provision of continuous straight through movements uncontrolled by traffic lights with opposing right hand turn movements at some intersections as suggested is potentially dangerous without physical separation between these movements.

The removal of the right hand turn from the Pacific Highway to the M1 Pacific Motorway northbound is also suggested. This would require all these northbound vehicles to travel south on Pennant Hills Road to join the M1 Pacific Motorway. This could result in significant traffic issues and increases to road traffic noise along this section of Pennant Hills Road.

7.7.2 Mr Matt Kean MP – State Member for Hornsby

I would like to place on the record my strong support for the proposed tunnel linking the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at West Pennant Hills.

The proposed route has been studied extensively commencing in 2003 with the F3 to Sydney Orbital link study (SKM, 2004) and confirmed in the 2007 review by the Honourable Mahla Pearlman AO.

Pennant Hills Road is one of the worst roads in Sydney. It suffers from chronic congestion, high crash rates as well as causing severe local amenity impacts for local residents.

The project is needed to provide a safer and more efficient link between the M1 and M2 that would better service current and future road users.

Notwithstanding my support for the project, I would like to raise a number of questions and concerns which need to be addressed in relation to the air quality assessment contained in the EIS.

Issue description

What assurance can be provided that data used to develop the Digital Elevation Model (DEM) was sufficiently accurate to be used in air quality modelling around the ventilation outlets. Has the DEM considered the terrain around the outlets and the site specific meteorological conditions?

Response

Chapter 2 of this report provides further information on the inputs and assumptions that have been applied to the air quality impact assessment for the project, including in relation to topography. Through a comparison of topographic data used in the air quality impact assessment for the project, and higher resolution LiDAR collected along the project corridor,

the analysis in **Section 2.12** has demonstrated that the air quality impact assessment was conservative and may in fact have over-predicted air quality impacts.

Issue description

What assurance can be provided that the background air quality estimates especially at the northern portal and outlet are representative of the air quality in the Wahroonga/Hornsby area given that the two air quality monitoring stations used to establish ambient air quality were located at Lindfield and Prospect? Can sufficient site specific ambient air quality information be used as the basis of background air quality estimates?

Response

Chapter 2 of this report provides further information on the inputs and assumptions that have been applied to the air quality impact assessment for the project, including in relation to background air quality data, topography and meteorological conditions. This information demonstrates that the assumptions and inputs into the air quality impact assessment are reasonable and conservative.

Issue description

What confidence can I have regarding the assessment of the quality of "fresh" air entering the northbound entry tunnel portals at the Pennant Hills/M2 interchange when it unclear what data or assumptions have been used for the quality of the "fresh air" entering the tunnel. If the quality of "fresh air" entering the northbound tunnel at the Pennant Hills Road and M2 Interchange entry portals has been based purely on the air quality monitoring undertaken in residential areas in Prospect and Lindfield, then I am not sure that this is reflective of reality. The "fresh air" quality at Pennant Hills/ Hills M2 Motorway interchange needs to be remodelled to include emissions from the southern vent outlet and surface emissions from the M2 and Pennant Hills Road.

Response

Chapter 2 of this report provides further information on the inputs and assumptions, including further analysis of the implications of drawing polluted air from the road corridor into the project's entry portals. This analysis has demonstrated that drawing this air into the project tunnels would have a negligible impact on predicted ambient air quality impacts from the project.

Issue description

There appears to be no modelling or assessment of air quality impacts from discharges from the portals, outlets and emergency discharge locations for emergency situations. Can the NorthConnex project provide modelling of a variety of emergency situations including an assessment of the resultant air quality and human impacts under the various scenarios?

Response

Section 2.7.2 of this report provides further discussion of tunnel incidents that may lead to emergency emissions from the project tunnels (principally fire related incidents). The discussion demonstrates that a combination of a very low probability of such events, and the design of the project to minimise potential consequences, would result in a very low risk of significant impacts to the surrounding environment and communities in the unlikely event of a tunnel incident.

Issue description

The environmental impact claims that there will be no portal emissions from the project. A review of the ventilation design should be undertaken to verify the claim that there will be no portal emissions.

Response

The project does not propose any emissions from the tunnel portals under normal operating conditions.

The project's ventilation system has been designed to operate with a pressure differential between the ventilation off-take and the portal. This pressure differential will act to draw air close to the tunnel portals back into the tunnel for collection and management with other tunnel air, via the relevant ventilation off-take and associated ventilation facility. This operational principal has been applied to both main alignment tunnel and off-ramp tunnel portals.

Further details regarding the operation of the project ventilation system is provided in Section 5.2.5 of the environmental impact statement.

Issue description

The current NorthConnex air quality and meteorological monitoring stations are not in appropriate locations to assess the impacts of ventilation and portal discharges. In the area around the proposed northern ventilation outlet, one monitoring station has been located at James Park which is 1.2 kilometres distant from the proposed northern ventilation outlet. There should be appropriately located monitoring stations installed as soon as possible to enable the validation of the air quality modelling.

Response

Chapter 2 of this report provides further information on the inputs and assumptions that have been applied to the air quality impact assessment for the project, including in relation to background air quality data, topography and meteorological conditions. This information demonstrates that the assumptions and inputs into the air quality impact assessment are reasonable and conservative. **Section 2.10** also explains the appropriateness of the meteorological data and modelling conducted for the project

Ambient air quality and meteorological monitoring stations would be installed and operated for a period following opening of the project, to verify predictions made in the environmental

impact statement and to provide confidence about the very low air quality impacts of the project.

Issue description

I am concerned that the NorthConnex project has not proposed community involvement in the development of appropriate monitoring programs. To address community concerns about air quality and human health impacts, the community should be involved in the development of monitoring programs for these aspects. This has been successfully undertaken on other Sydney tunnel projects via an Air Quality Consultative Group. An Air Quality Consultative Group should be formed consisting of representatives from the community (including schools and health professionals). The consultative group should be involved in the developing the long term monitoring program as well as assessing the results of monitoring.

Response

Air quality monitoring during operation will be conducted to meet the requirements of the conditions of approval that may be applied to the project by the Minister for Planning. These conditions may specify the timing, duration and extent of the air quality monitoring required for the project.

Air quality monitoring during the initial phase after commencement of operation is intended to verify and validate the air quality modelling conducted for the project. By demonstrating that actual air quality is equal to or better than predicted by the air dispersion modelling, then confidence can be gained that predictions made by the modelling into the future are also robust. A period of twelve months of monitoring is proposed within the environmental impact statement because this would provide a whole year of seasonal variations in weather patterns. For the same reasons, and as the air quality modelling predicts outdoor ground level concentrations, monitoring of indoor air is not considered appropriate.

In-tunnel air quality monitoring would be undertaken on a continuous basis during operation.

7.7.3 Dr Mehreen Faruqi MLC – Member of the NSW Legislative Council

I am making this submission in my capacity as a Greens Member of Parliament and spokesperson for Transport, Roads and Freight.

The NorthConnex project is a $3 billion unsolicited proposal from the private toll-road company Transurban that purports to reduce congestion on Pennant Hills Rd by moving freight trucks and cars into 9 km of tollway tunnels linking the M1 Pacific Motorway (F3 Sydney-Newcastle) at Wahroonga and Hills M2 Motorway at West Pennant Hills.

Constructing a road tunnel will not achieve the objectives of reducing congestion or improving transport in the future. Funding must be diverted to improving public transport and rail-freight as alternatives to unnecessary toll-roads such as the NorthConnex project.

Many communities connected by Pennant Hills Road have expressed concerns regarding the impacts of this project and the lack of meaningful community information and engagement.

Specific issues regarding the environmental impact statement and the broader project are highlighted in more detail below.

Issue description

The justification for NorthConnex does not stack up.

Travel times on Pennant Hills Road will still increase if NorthConnex is built. Drivers unable to pay the toll will still be forced to travel on congested roads even though a key objective of the NorthConnex project is to assist in the reduction of traffic congestion.

Toll roads with similar lack of justification (eg the Lane Cove Tunnel) have failed to meet traffic volumes to be economically viable, a trend repeated globally. Historical preferences for road infrastructure projects in Sydney have not reduced the rising cost of congestion, and NorthConnex is no different as it does not provide a solution to the predicted increases in congestion on Pennant Hills Road. Alternatives to toll roads can provide the road traffic reductions necessary to alleviate congestion. However, the environmental impact statement does not consider alternatives adequately.

The government's stated primary purpose for NorthConnex is to get freight trucks off Pennant Hills Road and into the tunnel underneath. While the government has plans to use point-to-point camera systems to analyse the pace at which trucks use Pennant Hills Road and force the trucks that are not making deliveries in the region to pay, the ability of this system to be implemented efficiently in practice is questionable. For example, the environmental impact statement does not provide information about the details of this regulatory scheme or any information on what proportion of trucks and heavy vehicles may be exempt from using the tunnel.

Response

The strategic justification for the NorthConnex project is provided in Chapter 3 of the environmental impact statement. This justification is based on the relationship with State and national strategic planning documents, and the need for the project considering the existing road network, traffic and safety conditions.

The 2004 report and the 2007 Pearlman Review provided a robust process for the assessment of alternatives and options. The 2004 report concluded that a tunnel road connection between the M1 Pacific Motorway and the Sydney Orbital Road Network within the purple corridor (generally following the alignment of Pennant Hills Road) best satisfied the planning and project objectives. It was also concluded that the purple corridor alignment option performed best in terms of the technical criteria considered in the assessment and that the purple corridor alignment performed better than the other corridor alignment options in terms of social and environmental impacts based on the assessment conducted. The 2007 Pearlman Review found that there was no case for altering the conclusions reached in the 2004 report and that a road link based on the purple corridor alignment option was preferred.

At opening, the NorthConnex project would provide capacity for an additional two lanes of traffic in each direction between the Hills M2 Motorway and the M1 Pacific Motorway in addition to the existing three lanes in each direction on Pennant Hills Road. The capacity of Pennant Hills Road will not be altered as part of the NorthConnex project.

Section 7.1 of the environmental impact statement and the Technical Working Paper: Traffic and Transport demonstrate that in 2029 most intersections along Pennant Hills Road would operate beyond their design capacity (level of service F and average delays in excess of 100 seconds) if the NorthConnex project is not constructed. With the implementation of the NorthConnex project, mid-block traffic volumes along Pennant Hills Road and volume to capacity (V/C) ratios are expected to improve in most cases (for both 2019 and 2029 scenarios). Improvements, particularly reductions in anticipated delays, are also anticipated at several intersections along Pennant Hills Road in 2019 and 2029.

The project would also:

- Deliver significant travel time savings during peak hour. Table 7-36 of the environmental impact statement provides predictions of future travel times on Pennant Hills Road with and without the project. This identifies that travel time savings in 2029 would be around nine minutes southbound in the AM peak and 21 minutes northbound in the PM peak.
- Reduce truck movements along Pennant Hills Road.
- Bypass 21 sets of traffic lights east and westbound along Pennant Hills Road, providing more reliable and safer travel conditions.
- Improve air quality, reduce traffic noise and traffic congestion along Pennant Hills Road.
- Create opportunities for improving public transport.

Because a key function of the NorthConnex project would be to provide an alternative to Pennant Hills Road for the movement of heavy vehicles, the NSW Government will be introducing regulatory measures to ensure heavy vehicles (other than dangerous goods vehicles or those with a genuine origin or destination along Pennant Hills Road) use the NorthConnex project rather than surface roads. These measures may include introducing, or changing the operation of existing, traffic control facilities, advisory and / or regulatory signage, route designations, notices, application of permits, or other traffic measures. Any regulatory measures that have the effect of regulating heavy vehicles would need to be consistent with the objectives of the National Heavy Vehicle Law, where applicable.

Issue description

The NorthConnex project would increase local air pollution and would not work to reduce the greenhouse gas emissions of New South Wales.

Polluting emissions from trucks can be reduced inexpensively at the source and generate significant returns in community health. If the successfully trialled Diesel Retrofit Program were applied to 5,000 of the dirtiest trucks travelling on Pennant Hills Road, pollution could be reduced for a fraction of the $3 billion cost of the NorthConnex project.

The potentially devastating impact of the tunnels on local communities is perhaps being most strongly felt through the proposed locations of the unfiltered polluting ventilation outlets. Both the northern and southern outlets are located in a valley. The northern outlet has been slated for the middle of a residential area in Wahroonga; it will require the demolition of one house, and will be installed just metres away from the homes of other residents and young families. Areas around the outlets also include many schools.

Deaths from air pollution have been rising in Australia. The cost of these pollution-related deaths was $5.8 billion in 2010 and it was estimated that the effects of road- generated air pollution are far greater than previously thought.

Given this significant impact of air pollution and risks to on human health, the environmental impact statement does not comprehensively address these impacts, consider mitigation measures or alternatives.

Finally, the project does not recognise or work to reduce the high levels of transport-related greenhouse gas (GHG) emissions in NSW.

Response

The NorthConnex project would not produce new emissions or new pollution. The NorthConnex project would collect vehicle emissions that are currently released in an uncontrolled manner at ground level, adjacent to residential and other sensitive receivers, and effectively disperse those emissions in a controlled manner high in the atmosphere. The net effect would be a reduction in the concentration of vehicle pollution at ground level where it may affect the local community.

The data presented in Section 7.3.3 of the environmental impact statement supports the need for ongoing programs targeting air quality improvements across the Sydney region. These actions, in which Roads and Maritime is an active participant with the NSW EPA, are identified in Action for Air (EPA, 1998) and the most recent update of that strategy (DECCW, 2009).

Action for Air (EPA, 1998) – the Government's 25 year air quality management plan – and the updates to that strategy in 2002, 2006 and 2009, recognise that managing and improving air quality in New South Wales requires a multi-layered approach and an 'integrated attack on air pollution'. Action for Air recognises that all stakeholders and pollution sources need to play a role in maintaining and managing air quality.

In the spirit of Action for Air, it is appropriate to focus the broader task of air quality management and improvement over time on those areas where the greatest benefit could be feasibly and reasonably achieved through the most cost effective means. Action for Air includes a series of targets and focus areas, including the transport, commercial and industrial and domestic sectors, through which improvements in air quality could be achieved.

The environmental impact statement for the NorthConnex project, including Table 7-89 and the discussion of filtration technology, is consistent with and reinforces the underlying focus of Action for Air. That is, there are several opportunities that have been identified which have the potential to significantly reduce particulate matter loads in the Sydney airshed at much less cost per tonne of reduction than would be achieved through road tunnel filtration. If the focus is to be on improving air quality in Sydney as a whole, then these opportunities would provide a more efficient and cost effective means to do so than road tunnel filtration. By comparison, road tunnel filtration is a relatively expensive means to remove a comparatively small mass of particulate matter from the Sydney airshed.

Further information on the availability and efficacy of in-tunnel air treatment systems (including filtration) is provided in **Section 3.1** of this report. The analysis of ventilation system design options and alternatives in **Section 3.2** of this report considers the application of in-tunnel air treatment systems to the NorthConnex project and concludes that these systems are not feasible and reasonable.

The air quality impact assessment and the human health risk assessment included in the environmental impact statement demonstrate that the NorthConnex project in its current form would comfortably meet ambient air quality criteria and would pose a very low risk to human health.

Section 8.4 of the environmental impact statement provides a comprehensive assessment of greenhouse gas emissions during construction and operation. As the project would provide a more efficient route between the M1 Pacific Motorway and the Hills M2 Motorway, it would result in savings of greenhouse gas emissions of around 47,000 t $CO_{2\text{-}e}$ in the year of opening (2019). By 2027 the projected saving would have offset the construction emissions. Therefore, the project does assist in reducing transport-related greenhouse gas (GHG) emissions in NSW.

Issue description

Alternatives to the NorthConnex project have not been adequately considered.

Shift from road-freight to rail freight

Although, NSW has a plan to move freight off our roads and onto rail, but funding of road-freight projects is consistently prioritised over rail-freight projects and only 14 per cent of the total freight moved in the Sydney to Newcastle corridor is moved by rail (SKM 2004).

Funding and approving the NorthConnex project conflicts with the government's commitment to increasing the proportion of freight carried by rail.

Further, two-thirds of the projects in the NSW Freight and Ports Strategy (Nov 2013) Infrastructure Program are road-freight projects, with 73 per cent of the fully-funded projects being road freight. However, the benefits of these improvements or increased funding towards further improvements on the number of trucks using Pennant Hills Road have not been investigated in the environmental impact statement.

Upgrade public transport options especially Sydney-Newcastle passenger rail services

A small mode-shift to public transport can have large impacts on traffic congestion. NSW has a goal to increase the patronage, frequency and reliability of public transport (see NSW 2021 goals 7, 8, 20) yet public funds are being directed towards toll roads such as NorthConnex. Sixty per cent of the total daily traffic on the F3 is made of traffic to and from the Central Coast with rail currently only having a 43 per cent share of all peak period trips between the Central Coast and Sydney (SMK 2004). This indicates that there are significant opportunities to encourage a mode-shift to passenger rail from private cars.

Upgrades of public transport should include:

- Improving express train services between Sydney and Newcastle.
- Introducing tilt-train technology to speed up services, used in Queensland since 1998 (and upgraded in 2010 for $190 million).
- Separating freight traffic from passenger traffic would improve reliability of services and thus increase patronage.

- Integrating timetables and fares of connecting passenger services in both the Central Coast and the Sydney Metro area. Also include connections for active transport.
- Grade separation of local bus services (bus lanes) along Pennant Hills Road could help to increase the reliability of services in the region, encouraging a mode shift and reducing congestion.
- Connecting the Central Coast to Parramatta by building the Parramatta to Epping Rail Link.

Response

Prior to the NorthConnex project being proposed, an alternatives and options assessment including rail upgrades and consideration of various potential road alignments was undertaken by SKM in 2004 (the 2004 report). Specifically, the 2004 report considered a number of strategic alternatives. This included a 'do nothing / do minimum' alternative which involved upgrades to the existing road corridor, a rail and public transport upgrade alternative, and a road link between the M1 Pacific Motorway and the Sydney Orbital Road Network.

This investigation found that:

- The 'do nothing / do minimum' alternative would not provide a suitable long term solution from a strategic, regional, local planning or transport perspective.
- The rail and public transport upgrade alternative alone would not be unlikely to satisfy future growth in transport demand.

In recent years significant investments in rail-based freight and passenger transport have been committed and the Epping to Thornleigh Third Track project and the North West Rail Link are currently under construction.

Although these improvements will play an important role in servicing the region, public transport alone and in particular rail transport, is unlikely to completely satisfy future growth in transport demand. As traffic volumes grow, there will be greater pressure to improve the efficiency of the National Road Network to service expanding commercial centres and to cater for local and district freight transport demands and in doing so, support the State's economy.

Based on the above, a road link between the M1 Pacific Motorway and the Sydney Orbital Road Network was identified as the preferred solution from a strategic, regional, local planning and transport perspective.

The long term strategic vision for Sydney and NSW is outlined in the NSW State Infrastructure Strategy (NSW Department of Premier and Cabinet, 2012), the NSW Long Term Transport Master Plan (Transport for NSW, 2012), the Metropolitan Plan for Sydney to 2036 (Department of Planning, 2010) and the draft Metropolitan Strategy for Sydney to 2031 (Department of Planning and Infrastructure, 2013). A link between the M1 Pacific Motorway and the Hills M2 Motorway (NorthConnex) is identified in these long term planning documents.

These documents also identify a range of public transport and rail freight initiatives which are being progressed by the NSW Government. In the region of the NorthConnex project, this includes a significant investment by the State Government in projects such as the North West Rail Link and the Epping to Thornleigh Third Track.

Issue description

The NorthConnex project does not meet the principles of Ecologically Sustainable Development as its impacts (air pollution, greenhouse gas emissions, human health etc) on the environment and the community will have a long-term negative effect on our communities and the environment.

The NorthConnex project is not the solution to Sydney's traffic congestion and should be firmly opposed. The government needs to invest in real integrated public transport to promote a mode-shift from private cars and in necessary rail-freight infrastructure to reduce congestion and increase road safety in our communities.

Response

Section 11.1.4 of the environmental impact statement provides consideration of the project against the principles of ecologically sustainable development. A summary is provided below.

In relation to the specific issues raised in the submission, the environmental impacts statement has shown that the project would:

- Meet ambient air quality criteria and would pose a very low risk to human health in the areas around the ventilation outlets.
- Result in an overall improvement in air quality across the regional airshed.
- Result in overall benefits to human health associated with the reduction in air pollution across the regional airshed.
- Provide long term reductions in greenhouse gas emissions.
- Provide long term benefits to the communities along Pennant Hills Road associated with the reduction in heavy vehicles and associated improvement in amenity.

As such, the project would provide for long term benefits to the community and the environment.

<u>The Precautionary Principle</u>

The precautionary principle has been applied throughout the design and development of the project. The alternatives and options analysis as part of the 2004 report considered environmental impacts, including the minimisation of surface disturbance and potential impacts to National Parks and other ecologically sensitive areas.

The design aimed to avoid known areas or items of environmental value. Where avoidance was not possible, mitigation measures were identified to manage these risks.

<u>Intergenerational equity</u>

One of the key objectives of the project is to assist in a reduction in traffic congestion along Pennant Hills Road and provide shorter travel times for road users. The project would provide an alternative travel route between the M1 Pacific Motorway and the Sydney orbital road network increasing the capacity of the road network. The project is also being future proofed with the ability to be retro-fitted to three lanes in each direction if required in the future.

The project would also provide the following benefits for today's generations and future generations:

- Provide a reduction in air quality emissions along the Pennant Hills Road corridor.
- Improve noise amenity along the Pennant Hills Road corridor through the reduction in heavy vehicle use.
- Improve road safety through the provision of a motorway standard connection.
- Result in improvements to local amenity.
- Result in reduced operational greenhouse gas emissions when compared to the project not being built.

Conservation of biological diversity and ecological integrity

Conservation of biological diversity and ecological integrity is a fundamental consideration of the project. The alternatives and options analysis as part of the 2004 report considered ecological integrity, evident through the selection of an option which minimised potential impacts to National Parks and other ecologically sensitive areas. The current project design avoids impacts to areas of high ecological value as far as practical.

Improved valuation and pricing of environmental resources

The value placed on the environment is evident in the development of design features and also in the extent of environmental investigations for the project. In addition the costs associated with the planning and design of measures to avoid / minimise adverse environmental impacts and the costs to implement them have been built into the overall project costs.

A target rating of 'excellent' has been set for the NorthConnex project under the Infrastructure Sustainability Council of Australia's Infrastructure Sustainability (IS) Framework. Feasible and reasonable measures to pursue this target rating will be identified and developed during detailed design of the project.

The provision of a toll on the project supports the concept of users of goods and services paying prices based on the full life cycle of costs of providing the goods. Whilst the upfront capital costs would be provided by a combination of private funding and a contribution from the NSW and Australian Governments, this funding would be recouped through a toll to cover the upfront construction, and ongoing operation and maintenance costs.

7.7.4 The Hon Philip Ruddock MP – Federal Member for Berowra

Issue description

The single point on which all would agree is that an answer needed to be found to the ongoing congestion and traffic safety issues on Pennant Hills Road along the section known commonly as the `missing link'. This is the section of Pennant Hills Road linking the Hills M2 Motorway with the beginning of the M1 Pacific Motorway.

I have been lobbying for the construction of the `missing link' for many years and am certainly gratified that the Abbott Federal Government, together with the NSW Government, is making the plan a reality.

As the Federal representative for the people of the Berowra electorate, my primary concern is for the project to provide the best possible results for the area through the use of best practice policy. While the general consensus of residents throughout local suburbs is

favourable to the overall project, I am aware of and sympathetic to, a number of concerns which have been raised.

The most often heard are the concerns people have regarding tunnel filtration.

The point of my submission is to remind NorthConnex and the Governments involved of the words issued in a joint statement by the Deputy Prime Minister at the time, the Hon John Anderson MP and Senator the Hon Ian Campbell: -

> *"While the Australian Government endorsed the preferred corridor it will insist on the following in three key areas:*
>
> - *The Government has a strong preference for a fully tunnelled link and will ensure that there is no opening in Brickyard Park,*
> - *The Government will ensure the ventilation stacks use the world's best practice filtration suitable to Australian conditions, and*
> - *The Government rejects the concept of intermediate access points from the link."*

It is my belief that the conditions referred to in this statement, released on 6 May 2004 remain as valid now as they were then.

Response

The Honourable Member for Berowra's comments regarding the need for the project are noted.

The NorthConnex project provides the following response to the key issues identified:

- The design of the NorthConnex project provides a fully tunnelled link and has avoided the need for an open cut section around Kenley Park and Brickpit Park. The avoidance of this open cut section has avoided direct impacts Blue Gum High Forest and Sydney Turpentine-Ironbark Forest communities (both listed as critically endangered ecological communities), unnecessary impacts to important community facilities and the disturbance of a contaminated site.
- The environmental impact statement includes an analysis of tunnel filtration systems and explains why such systems are not warranted for the NorthConnex project (refer to Section 7.3.1 of the environmental impact statement). The environmental impact statement demonstrates that the NorthConnex project would meet ambient air quality criteria and would pose a very low risk to human health. In this context, there is no basis to justify installation of filtration systems.
- Further information on the availability and efficacy of in-tunnel air treatment systems (including filtration) is provided in **Section 3.1** of this report. The analysis of ventilation system design options and alternatives in **Section 3.2** of this report considers the application of in-tunnel air treatment systems to the NorthConnex project and concludes that these systems are not feasible and reasonable.
- The use of filtration systems within the tunnel ventilation outlets has been proven to be costly and inefficient. Learnings from the M5 East Motorway tunnel filtration trial have demonstrated that greater improvements in air quality can be achieved through investment in programs targeting other emission sources that contribute higher levels of pollution to the surrounding environment. For example, improvements have been demonstrated through the smoky vehicle strategy investigated by Roads and Maritime and the Environment Protection Authority on the M5 East Motorway. Further details of the effectiveness of this strategy are provided in Section 7.3.1 of the environmental impact statement.

- For the NorthConnex project, the aim has been to take on board the learnings from the M5 East Motorway tunnel and mitigate emissions through improved tunnel design. This has included:
  - A flatter tunnel gradient.
  - A large cross-sectional area.
  - An efficient ventilation system that does not circulate air from one main alignment tunnel to the other.
  - Removal of smoky vehicles through the use of the smoky vehicle camera system.
- The potential for an intermediate interchange was contemplated in the 2004 report, The preliminary design of and need for an intermediate interchange was reviewed as part of the Stage 2 unsolicited proposal process. This review identified that:
  - The difference in grade between the surface and the main alignment tunnels would likely result in environmental costs associated with significant additional lengths of tunnelling works to implement the intermediate interchange, or steep grades on the ramps resulting in operational inefficiencies and potential air quality impacts.
  - Additional property acquisition would likely be required to facilitate the traffic arrangements around the interchange.
  - The proximity of the works to the Northern Railway Line would introduce additional constructability challenges, engineering risks and project costs.

  Further, a consideration of local and regional traffic conditions and forecast patronage of an intermediate interchange indicated there would only be limited traffic benefits associated with an interchange at this location.

  On balance it was concluded that, although an intermediate interchange would provide some limited traffic benefits, these benefits were not sufficient to outweigh the additional impacts, the significant risks and the additional cost associated with constructing the intermediate interchange. The intermediate interchange was therefore not included in the scope of the project.

  Further details are provided in Section 4.3.2 of the environmental impact statement.

7.7.5 Mr Paul Fletcher MP – Federal Member for Bradfield

As the Member for Bradfield, I seek a decision concerning the NorthConnex environmental impact statement which best meets the needs of my constituents. I support the NorthConnex project proceeding because I believe there is a need to reduce congestion on Pennant Hills Road; the NorthConnex project will deliver that outcome, and it is the only realistic option that will. I also believe the project should only proceed if it meets appropriate health and safety standards, and this should be assessed by the Department of Planning and Environment drawing on advice from appropriately qualified independent experts.

There is a clear need to reduce congestion on Pennant Hills Road and provide an alternative route for through traffic which presently travels along it.

Pennant Hills Road is highly congested. It carries large volumes of traffic, with two-way average annual daily traffic in 2011 of about 80,000 vehicles per day, average speeds of 31 kilometres per hour during morning peak, and large numbers of heavy vehicles. In addition, the road carries a mix of different types of traffic, including through commercial traffic, local traffic, bicycles and pedestrians. This makes it difficult to configure the route to best serve its users.

This level of congestion has a detrimental effect on communities along its route, including Thornleigh, Normanhurst, Waitara and Wahroonga. Pollution, noise and vibration impact in these areas.

There are several ways that the construction of the NorthConnex project will benefit my constituents.

- The NorthConnex project will deliver improved community amenity for communities along Pennant Hills Road, due to reduced traffic and congestion and in turn reduced emissions, noise and vibration along the route. Reduced traffic volumes and a higher proportion of local traffic will also result in improved land use.
- The NorthConnex project is expected to reduce travel time along the route by as much as 21 minutes, as well as improving speeds along Pennant Hills Road.
- The completion of the NorthConnex project will see a significant volume of traffic shift from Pennant Hills Road to the NorthConnex project, and in particular there will be a marked reduction in the number of trucks travelling on Pennant Hills Road compared to the scenario in which the NorthConnex project is not built.
- By shifting a significant volume of traffic from Pennant Hills Road to a grade and carriage separated motorway there will be a reduction in the number of motor vehicle accidents and in turn the number of fatalities and injuries.

If reducing congestion on Pennant Hills Road is a desirable public policy objective, the only realistic option to achieve this objective in the foreseeable future is the NorthConnex project.

It has taken a ten year planning and consultation process to reach this point with the NorthConnex project, including the F3 to Sydney Orbital Link Study, published in 2004, the Pearlman report in 2007 and now the current process. To bring any alternative proposal to fruition would be likely to involve a lead time of at least ten years.

The NorthConnex project would not be viable if it were not for the proposal by Transurban, and its willingness to take the commercial risk that the cost of construction will be recouped through tolls charged to users. The total capital cost of the project is around $3 billion; with a little over $800 million having been contributed by the State and Federal Governments. It is my judgement that there is little prospect of government having the capacity to fund the total cost of this project. In other words, the Transurban unsolicited proposal offers a specific (and in my view unlikely-to-be-repeated) opportunity to relieve congestion on Pennant Hills Road at a cost to government which is affordable.

Notwithstanding the benefits of the NorthConnex project, the project should only proceed if it meets appropriate health and safety standards.

Issue description

Concerns have been raised with me, particularly by residents of Wahroonga, about the proposed location and design of the ventilation outlet at the northern exit of the tunnel.

These concerns include:

- That the ventilation outlet's emissions will concentrate chemicals and particulate matter from the length of the tunnel in to a small area.
- That the ventilation outlet will fail to adequately disperse emissions.
- That the surrounding area is largely residential in nature, and includes schools, medical facilities and a large elderly population.
- That the air quality inside the tunnel will be poor.

- That the data on which the modelling was based was insufficient, in that it uses wind and climate data from locations removed from the location of the outlet, and uses terrain data that is not of sufficient resolution.
- That certain scenarios have not been examined in the environmental impact statement which, if they were to occur, could lead to emissions exceeding safe levels.

Response

The environmental impact statement provides an assessment of potential changes to air quality and the potential human health impacts from the introduction of the ventilation outlet in Wahroonga.

These assessments demonstrate that the NorthConnex project would meet ambient air quality criteria and would pose a very low risk to human health.

Section 2.5 of this report provides further information on the inputs and assumptions that have been applied to the air quality impact assessment for the project, including in relation to background air quality data, topography and meteorological conditions. This information demonstrates that the assumptions and inputs into the air quality impact assessment are reasonable and conservative.

No criteria or standards are available in relation to short term exposures to pollutants which would be applicable to in-tunnel air quality. Design criteria for in-tunnel air quality have been based on recommendations from international bodies including the World Health Organisation and the Permanent International Association of Road Congresses.

In-tunnel air quality is considered in Section 7.3.4 of the environmental impact statement and the associated potential human health impacts in Section 7.4.5.

This assessment identified that:

- In relation to visibility, the NorthConnex tunnel would be considered a 'clear air tunnel' according the Permanent International Association of Road Congress (2012).
- In-tunnel concentrations of nitrogen dioxide are consistent with other tunnels in Sydney and around the world and are below the limits adopted in other countries including Norway, Belgium and France.
- In-tunnel concentrations of particulate matter ($PM_{2.5}$) are consistent with other tunnels in Sydney and around the world.

The human health risk assessment provided in Section 7.4 of Appendix H of the environmental impact statement provides an assessment of potential in-tunnel exposures to pollutants by comparing potential exposures to other tunnels around the world and to adopted standards from around the world where they are available. The assessments found that the predicted concentrations are lower than or comparable to other tunnels around the world, and below guidelines available for the United States and parts of Europe.

Issue description

The arguments based on the health impacts of the NorthConnex project involve complex medical and scientific issues. While I personally am not qualified to assess them, I want to be satisfied that in its assessment of the environmental impact statement, the Department of Planning and Environment is advised by experts with appropriate scientific and medical qualifications, and that these experts have a full and unconstrained ability to examine the evidence and draw their own conclusions.

The evidence in the environmental impact statement suggests that the health impacts of the ventilation outlet are modest (around a one percent increase in the level of $PM_{2.5}$). However, the environmental impact statement has been prepared by the project proponents. It is important that these claims are independently assessed by appropriately qualified experts.

I therefore urge that:

- The analysis and assumptions in the environmental impact statement be subject to rigorous examination by the Department of Planning and Environment, advised by appropriately qualified experts.
- Concerns raised by community members be given serious consideration and addressed in detail.
- The project should only proceed if it meets appropriate health and safety standards.

It will also be important that the Department of Planning and Environment is in a position to impose conditions or changes to the design, should these be required in the opinion of independent appropriately qualified experts – for example regarding such matters as the height of the ventilation outlets.

Response

The environmental impact statement has been prepared in accordance with the Director-General's environmental assessment requirements and relevant guidelines developed by regulatory agencies. Additionally the environmental impact statement has been certified by the authors as neither false nor misleading.

The Department of Planning and Environment will undertake an independent assessment of the NorthConnex project, consistent with the requirements of the *Environmental Planning and Assessment Act 1979*. As part of this the Department of Planning and Environment considers the content of the environmental impact statement, the submissions received and the proponent's response to those submissions. As part of this process, the Department of Planning and Environment receives specialist input and advice from other agencies, such as the Environment Protection Authority, and may engage specialists to undertake independent reviews and to provide technical advice as deemed appropriate by the Department.

Following the preparation of this report, the Secretary of the Department of Planning and Environment will prepare and provide to the Minister for Planning, a report detailing the Secretary's assessment of the NorthConnex project. This report will include consideration of issues raised in public submissions, and Roads and Maritime's response to those issues (as detailed in this report).

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