Dr Jackie Wright
Fellow ACTRA
Director
Environmental Risk Sciences Pty Ltd
“Health Impact Assessment is both a health protection and health promotion tool. In HIA, health is broadly defined to include assessments of both the health hazards and health benefits of a proposal/project and the potential ways in which health and well being can be protected and promoted within the proposal/project.”

(Harris et al 2007)
Methodology and Guidelines

General guidance from:

• enHealth 2001, *Health Impact Assessment Guidelines*
• Harris et al. 2007, *Health Impact Assessment: A Practical Guide*, CHETRE (Uni NSW)
• enHealth 2012, *Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards*
• NHMRC 2008, *Air Quality in and Around Traffic Tunnels, Systematic Literature Review*

More detailed approach to assessing health impacts from changes in air quality and noise based on approaches developed for major infrastructure projects in NSW (NorthConnex, WestConnex and Moorebank IMT) – developed with NSW Health.
Health Impact Assessment – Desk-top assessment

• Assess all aspects of the project
• Consider stakeholder and community concerns in relation to health
• Assess health impacts (negative) and benefits (positive) using qualitative or quantitative methods
  ▪ Consider the existing environment, population distribution, health behaviours and existing health – includes information on the existing health of the population
  ▪ Evaluate the severity and likelihood of impacts and benefits
  ▪ Assess the distribution of these impacts on the community - particularly important for transport projects as many of the impacts relate to a redistribution of traffic, vehicle emissions and noise in the community
  ▪ Evaluate equity
• Recommend mitigation measures, where relevant
Objectives and Scope of Work

The overarching objective of the HIA is to evaluate how the project may benefit or impact upon the health and wellbeing of the local community, and to facilitate more health conscious planning and development.

Address the scoping requirements for the EES, that specifically requires health and amenity to be addressed in relation to:

- **Air quality** (changes within the local community from emissions to air from tunnel ventilation, and from key local roads)
- **In-tunnel air quality**
- **Noise and vibration** (changes within the local community)
- **Social aspects** (qualitatively address the social aspects that can affect health and wellbeing)
Changes in Air Quality

• Based on Air Quality assessment
• Assessment of changes in air quality associated with the project and impacts on health of community

• Construction impacts:
  • Qualitative assessment
  • Key issues relate to generation of dust, odours and emissions from diesel vehicles and equipment
  • Impacts require management through EPRs (EM2, AQP6, EM3 and EM4)
  • Where managed, impacts to community health are minimised
Changes in Air Quality

- Operations: quantitative assessment of key pollutants from vehicle emissions:
  - **Volatile organic compounds and polycyclic aromatic hydrocarbons (PAHs)** – assessed acute and chronic exposures and compared with health based guidelines. Also assessed carcinogenic risks for benzene, 1,3-butadiene and carcinogenic PAHs
  - **Carbon monoxide** – comparison of total predicted concentrations (background plus project) to health based criteria
  - **Nitrogen dioxide**
  - **Particulates** – as PM$_{2.5}$, but also PM$_{10}$
  - **Diesel particulate matter**
Nitrogen Dioxide and Particulate Matter

- **Cumulative assessment** (background plus project) – review against NEPM
- **Incremental assessment** – project specific and related to the changes in air quality from the project
- No threshold identified for nitrogen dioxide and particulate exposures. So in theory we can calculate an incremental risk from any change in exposure
- HHRA uses **robust** exposure response relationships for key health effects that have been shown to be **caused** by exposures to nitrogen dioxide or particulates
# Nitrogen Dioxide and Particulate Matter

<table>
<thead>
<tr>
<th>Nitrogen dioxide</th>
<th>Particulates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality all causes (ages 30+) (ST)</td>
<td><strong>Primary health effects</strong></td>
</tr>
<tr>
<td>Mortality, respiratory (all ages) (ST)</td>
<td>PM2.5: mortality all causes (ages 30+) (LT)</td>
</tr>
<tr>
<td>Asthma emergency department admissions (1-14 years) (ST)</td>
<td>PM2.5: hospitalisations for respiratory and cardiovascular disease (ages 65+) (ST)</td>
</tr>
<tr>
<td><strong>Secondary health effects</strong></td>
<td></td>
</tr>
<tr>
<td>PM10: mortality all causes (all ages) (ST)</td>
<td></td>
</tr>
<tr>
<td>PM2.5: mortality, cardiopulmonary (ages 30+) (LT)</td>
<td></td>
</tr>
<tr>
<td>PM2.5: mortality, respiratory and cardiovascular (all ages) (ST)</td>
<td></td>
</tr>
<tr>
<td>PM2.5: Asthma emergency department admissions (1-14 years) (ST)</td>
<td></td>
</tr>
<tr>
<td>DPM: lung cancer</td>
<td></td>
</tr>
</tbody>
</table>

**ST** = health effects related to short-term changes in exposure  
**LT** = health effects related to long-term changes in exposure

**Primary health effects** – key effects shown to be causal that include the secondary effects as well as a range of others

**Secondary health effects** – effects that relate to other age groups or specific subsets of effects that may be of particular concern to the community
Nitrogen Dioxide and Particulate Matter

- Calculate an individual risk:
  - Individual community receptors that included sensitive groups
  - Across the whole air modelling grid
  - Adjacent to key roadways
- Assumes exposure occurs to anyone, including sensitive groups, at all these locations 24 hours per day, every day
- Indoor air concentrations = outdoor air concentrations
- Diesel particulate matter = 100% of PM$_{2.5}$
- This calculation is used to identify where risks increase and where they decrease – and if the increase is significant enough to require additional mitigation to lower health impacts
- Acceptability of risk
Risk Levels

**PM$_{2.5}$ Concentration - above Background (µg/m$^3$)**

- **Indoor air (24 hr) (1)**: Risk > 4 x 10$^{-4}$
- **Personal Exposures (24 hr) (4)**: Risk > 2 x 10$^{-4}$
- **Bushfires (24 hr) (5)**: Risk > 2 x 10$^{-3}$
- **Western Distributor (24 hours)**: Risk <= 3 x 10$^{-5}$
- **Vacuuming and dusting indoors (1)**
- **Indoors while cooking (1)**
- **Outdoor dining - with smokers (3)**
- **Indoor air - with smokers (2)**
- **Western Distributor (1 hour)**
### Risk Levels

**Second Sydney Airport** = 1 in 100,000 to 3 in 1,000

**WestGate Tunnel Project** (discussion in Appendix E of HIA):
- Unacceptable > 1 in 10,000 ($1 \times 10^{-4}$)
- Acceptable ≤ 1 in 10,000 ($1 \times 10^{-4}$)

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#### Table E1
Summary and comparison of calculated PM$_{2.5}$ risks in off-site community areas for projects completed, approved or under construction in Australia

<table>
<thead>
<tr>
<th>Max Incremental PM increase from project (µg/m$^3$, annual average)</th>
<th>Max Incremental Individual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 (NorthConnex)</td>
<td>2 x $10^{-5}$, 2 in 100,000</td>
</tr>
<tr>
<td>0.07 (M5 stack and Brisbane Northern Link Project)</td>
<td>1 in 100,000</td>
</tr>
<tr>
<td>0.1 to 1.3 (major roadway widening/upgrade)</td>
<td>2 in 100,000 to 2 in 10,000</td>
</tr>
<tr>
<td>0.2 to 1.4 (thermal desorption remediation projects – Homebush Bay and Villawood)</td>
<td>4 in 100,000 to 3 in 10,000</td>
</tr>
<tr>
<td>0.6 to 1.5 (long-term development/construction)</td>
<td>1 to 3 in 10,000</td>
</tr>
<tr>
<td>Up to 4 (quarry)</td>
<td>7 in 10,000</td>
</tr>
</tbody>
</table>
Nitrogen Dioxide and Particulate Matter

- All calculated risks are very low and not of significance
  - Some relate to increased concentrations/exposure/risk including adjacent to West Gate Freeway, Blackshaws Road, Millers Road, Geelong Road
  - Some relate to decreases – mainly adjacent to key roadways: Francis Street, Williamstown Road, Hyde Street, Whitehall Road, Footscray Road, Dynon Road, Moore Street and Buckley Street
  - Largest changes are adjacent to roadways

- Risks also low and not of significance for the worst-case situation where maximum traffic was in the tunnel at all times of the year
Nitrogen Dioxide and Particulate Matter

• Calculate population incidence:
  • How many additional, or less cases (for the health effects) would occur in the populations evaluated
  • Total change is very small for all health effects considered: 0.0006 to 0.04 cases/year
  • These changes are not measurable
• None of the outcomes for health impacts from changes in air quality change if different (but also robust) published studies are used in the calculations
Impacts to health from changes in air quality

- Construction: management is required to minimise impacts to protect health

- Operations:
  - None of the impacts to health evaluated are considered to be significant or measurable
  - As there are no significant or measurable health impacts there are no trigger to evaluate any mitigation measures
  - This includes tunnel filtration – impacts from tunnel ventilation much smaller than from changes in air quality from surface roads

- Where management measures are implemented all health impacts considered low and acceptable
In-tunnel exposures

- Time spent in the tunnel is short (3 minutes when travelling at 80 km/hr, and 6 minutes at 40 km/hour)
- In-tunnel guidelines for carbon monoxide (EPR AQP3) – these are lower than the WHO air guidelines: no health effects expected
- Nitrogen dioxide – adopting guidelines from NSW tunnels (as recommended by the NSW Advisory Committee on Tunnel Air Quality) (0.5 ppm 15-minute average) which is considered protective of health
- Particulates
  - Tunnel guideline relate to visibility
  - There are no guidelines for very short duration exposures
  - Exposures 80% lower with ventilation on recirculation
  - Should minimise exposures in tunnels
Noise and Vibration

• Based on Noise and Vibration assessment
• Project areas are urbanised environments already impacted by road and other noise
• Assessment of health impacts against current published information on health effects from noise, particularly road traffic noise
• Construction: Without mitigation significant noise impacts are predicted that have the potential to result in adverse health effects in the community – these noise sources require mitigation to protect health and wellbeing (EPRs NVP3 to NVP12)
• EPRs include construction noise targets for sensitive areas and residential homes
Noise and Vibration

- Operational impacts evaluated changes in noise from roadways as well as the operation of ventilation facilities.
- Some areas required noise mitigation/barriers – these have been considered in noise modelling.
- Assessed health impacts in community from changes in noise associated with the project.

(WHO 2011)
## Noise and Vibration

<table>
<thead>
<tr>
<th>Health effect</th>
<th>Noise measure</th>
<th>Threshold for effects</th>
<th>Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension: incidence</td>
<td>Lden</td>
<td>47 dB</td>
<td>Relative risk – calculation of individual risk and change in incidence in population</td>
</tr>
<tr>
<td>Ischaemic heart disease: hospitalisations</td>
<td>Lden</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Stroke: hospital admissions</td>
<td>LAeq,16hour</td>
<td>55-60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;60</td>
<td></td>
</tr>
<tr>
<td>Mortality: all causes</td>
<td>LAeq,16hour</td>
<td>55-60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;60</td>
<td></td>
</tr>
<tr>
<td>Annoyance</td>
<td>Lden</td>
<td>42</td>
<td>% population annoyed, or highly annoyed</td>
</tr>
<tr>
<td>Sleep disturbance</td>
<td>Lnight</td>
<td>&gt;40</td>
<td>% population sleep disturbed or highly sleep disturbed</td>
</tr>
</tbody>
</table>

Assessed health effects where road traffic noise has been shown to be causal and robust studies are available to quantify health impacts – used relationships specific to road-traffic noise
Noise and Vibration

• Calculated individual risk and change in incidence for health effects in the population
• Assessed the maximum changes for residents adjacent to roadways specific to the project and also adjacent to key local roads – assuming residents at home all day, every day
• All calculated risks are low and not significant
  • Some risks relate to increased noise exposures (maximum at Millers Road)
  • Some risks relate to decreased noise exposures (maximum at Francis Street)
• Population incidence showed a very small benefit
  • Maximum change was a decrease in incidence of hypertension of 17 cases
Noise and Vibration

• Calculated change in % population annoyed, highly annoyed, sleep disturbed or highly sleep disturbed
  • Change in % population highly annoyed between -3% and 2%
  • Change in % population highly sleep disturbed between -1% and 0.8%
• These changes not considered significant in population
• Overall: none of the changes in operational noise result in health impacts that are considered significant or measurable in the community. Impacts considered low and acceptable.
• As a result there is no trigger to implement any additional mitigation measures
Social Aspects

- Qualitative assessment of the general impact of the project on the health and wellbeing of the community
- Evaluates more indirect impacts on health and wellbeing
- Evaluates if the impacts of the project are differentially distributed in relation to socioeconomic status – equity
- Assessment relies on other technical studies including Transport, Contamination, Social and Business
- Focus on aspects where changes have the potential to affect health, both negative and positive impacts considered
- Many of the impacts on health relate to changes in levels of stress and anxiety within the community
Evaluating project impacts on more general health and wellbeing in urban areas is highly complex

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Health Impacts</th>
<th>Health Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>Some impacts to businesses from acquisitions and access during construction</td>
<td>Economic benefits of the project including employment, improved access and efficiency gains</td>
</tr>
<tr>
<td>Traffic</td>
<td>Increased congestion during construction – EPRs TP1-TP9</td>
<td>Reduced travel times once completed</td>
</tr>
<tr>
<td>Safety</td>
<td>Construction impacts on road accidents, more traffic on some roads during operation may decrease safety (road, pedestrian, cycle) – EPRs TP1-TP9</td>
<td>Reduced traffic on some roads may improve safety (road, pedestrian, cycle)</td>
</tr>
<tr>
<td>Public transport</td>
<td>Some disruption during construction</td>
<td>May improve travel times for some modes of transport</td>
</tr>
</tbody>
</table>
### Social Aspects

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Health Impacts</th>
<th>Health Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian and cycle</td>
<td>Alternate routes during construction may discourage use or be less safe – EPR TP3</td>
<td>Project will improve pedestrian and cycle access and connectivity – promoting active lifestyles and improved safety</td>
</tr>
<tr>
<td>Contamination</td>
<td>Remediation will require management to ensure no impacts to community – EPRs CSP1-CSP4</td>
<td>Remediation of contamination to prevent future exposures to contamination</td>
</tr>
<tr>
<td>Green space</td>
<td>Temporary use of some greenspace – EPRs EP1-EP7</td>
<td>Project involves landscaping and 89,000 m² new open space areas</td>
</tr>
<tr>
<td></td>
<td>Visual changes</td>
<td></td>
</tr>
<tr>
<td>Equity</td>
<td>No impacts that are unfairly distributed within the community</td>
<td>Some combined benefits to residents adjacent to existing roadways heavily impacted by trucks</td>
</tr>
</tbody>
</table>
Overall conclusions

• Where mitigation and management measures identified in the project are implemented, the health impacts of the project are low and acceptable
• No EPRs identified that are specific to health
• Issues raised in submissions, Preliminary Matters and Additional Information (addressed in Expert Report), within the Expert Conclave and within the report from Dr Lyn Denison do not change the outcomes of the HIA