1 August 2017 Project No. 1521107-9002-R-Rev0

WEST GATE TUNNEL PROJECT INQUIRY & ADVISORY COMMITTEE

REPORT OF FRANK EDWARD FLEER

1 INTRODUCTION

Golder Associates Pty. Ltd. (Golder) prepared:

- Report No. 1521107-6002-R-Rev0 (dated 9 May 2017) titled *West Gate Tunnel Project – Air Quality Impact Assessment Report*, included as Technical Report G to the West Gate Tunnel Project Environment Effects Statement (EES)
- Documentation in support of the application to the Environment Protection Authority (EPA) Victoria for Works Approval (dated 11 May 2017) to install the West Gate Tunnel Project road tunnel ventilation systems, included as Attachment V to the West Gate Tunnel Project EES.

My involvement in preparing Technical Report G and supporting documentation for the application for Works Approval included:

- defining the scope of the air quality impact assessment, based on:
  - meetings with representatives of EPA Victoria to discuss the proposed approach to modelling of tunnel ventilation structures and surface roads, including selection of background air quality data and vehicle emission factors and criteria for assessing model outputs
  - workshops with members of the Technical Reference Group
  - feedback obtained through participation in community consultation sessions
- overall responsibility for preparation of the air quality impact assessment, in my role as Project Director for this component of work
- peer review of documentation.

Other significant contributors to Technical Report G were as follows:

- Mark Tulau - BSc Chemistry/Physics 1984, GradDip Computer Programming 1992
- John Conway BSc Chemistry (Honours) 1991, MSc Atmospheric Sciences 1992
- Jason Shepherd - BSc Physics 1998, MSc Atmos. Physics 1999, PhD Atmos. Physics 2004.

I adopt Technical Report G, in combination with this document, as my written expert evidence for the purposes of the West Gate Tunnel Project Inquiry and Advisory Committee's (IAC's) review of the EES, draft planning scheme amendment and Works Approval application.

2 QUALIFICATIONS AND EXPERIENCE

Appendix A contains a statement setting out the qualifications and experience of myself, Mark Tulau, John Conway and Jason Shepherd, together with other matters raised by Planning Panels Victoria *Guide to Expert Evidence*. A copy of my curriculum vitae is provided in Appendix B.

3 FURTHER WORK SINCE PREPARATION OF THE TECHNICAL REPORT

Following publication of Technical Report G, data entry errors were identified in Tables 101, 102 and 103. The corrected tables are provided in Appendix C. In addition Table 36 row 5, column 5 (Scenario A, inbound, inter-peak, all vehicles) has a typographical error. The number of vehicles should be 11,000 not 1,100. In neither instance has this resulted in a significant change to the outcomes of the air quality impact assessment, consequently my opinion on the matters expressed in Technical Report G remains unchanged.Other work conducted on the West Gate Tunnel Project since finalisation of Technical Report G and the application for Works Approval has included auditing of monitoring conducted by Ecotech Pty. Ltd. at the five ambient air quality monitoring stations operated by Western Distributor Authority and preparation of a report providing a statistical analysis of validated air quality data to 30 June 2017. A copy of the report will be provided to the West Gate Tunnel Project IAC upon completion.

In addition consideration has been given to issues raised in public submissions to the EES and to the key issues and requests for information noted in Appendix D of the *Preliminary Matters and Further Information Request* issued by the West Gate Tunnel Project IAC (dated 18 July 2017) and responses prepared.

At this time the further work noted above has not caused me to change my opinion on the matters expressed in Technical Report G and the Works Approval application.

4 WRITTEN SUBMISSIONS

4.1 Submissions Received

Golder has reviewed the 260 submissions identified by Western Distributor Authority as being of relevance to Technical Report G, the Works Approval application and my area of expertise. These include submission numbers:

3, 4, 7, 10, 14, 17, 18, 19, 21, 24, 29, 33, 40, 57, 61, 62, 63, 65, 71, 72, 73, 78, 79, 80, 81, 83, 86, 88, 92, 93, 94, 95, 96, 98, 100, 101, 103, 104, 105, 106, 107, 108, 109, 113, 114, 115, 116, 118, 119, 123, 125, 128, 129, 130, 132, 133, 134, 136, 137, 140, 143, 144, 145, 151, 152, 155, 158, 160, 162, 164, 165, 168, 169, 170, 171, 175, 177, 178, 179, 180, 182, 183, 184, 187, 189, 192, 194, 195, 196, 198, 200, 201, 202, 203, 205, 206, 209, 211, 212, 213, 214, 215, 217, 218, 220, 221, 225, 228, 229, 230, 233, 243, 249, 250, 251, 254, 256, 270, 272, 274, 275, 278, 279, 280, 281, 282, 283, 284, 285, 286, 288, 289, 290, 293, 296, 297, 298, 299, 300, 301, 303, 305, 307, 309, 314, 316, 319, 322, 323, 324, 326, 329, 330, 331, 333, 334, 335, 336, 337, 339, 340, 342, 343, 344, 345, 346, 348, 349, 351, 352, 353, 354, 355, 357, 358, 359, 362, 363, 364, 365, 366, 368, 369, 371, 372, 373, 374, 375, 378, 382, 383, 384, 385, 387, 390, 399, 400, 401, 403, 404, 405, 406, 407, 408, 409, 411, 412, 413, 414, 417, 418, 419, 421, 422, 427, 428, 429, 430, 431, 432, 434, 437, 439, 443, 444, 445, 446, 449, 450, 454, 457, 458, 460, 462, 464, 465, 467, 470, 474, 475, 477, 478, 480, 481, 482, 483, 484, 485, 486, 487, 488, 490, 491, 492, 493, 494, 496, 499, 502, 504.

4.2 Issues Raised

Issues raised in the public submissions to the EES relevant to my area of expertise are summarised in Table 1, together with my responses.

Table 1: Public Submission Issues and Responses

No.	Issue	Response
1	Deterioration in air quality due to ventilation structure emissions	The predicted impacts of pollutants emitted from the West Gate Tunnel Project road tunnel ventilation structures are low, consistent with the outcomes of modelling assessments previously conducted for East West Link, EastLink and CityLink. The predicted project contributions relative to the State Environment Protection Policy (Air Quality Management) [SEPP(AQM)] Schedule A design criteria range from less than 0.1 per cent for carbon monoxide (CO), ethybenzene and polycyclic aromatic

No.	Issue	Response
		hydrocarbons (PAH) in 2022 and 2031 to 14 per cent for particulate matter with an equivalent aerodynamic diameter less than 2.5 microns ($PM_{2.5}$) in 2022 and 18 per cent for $PM_{2.5}$ in 2031. Modelling assumes that vehicle emission factors remain the same as in 2020. This is a conservative assumption as pollutant emissions from the vehicle fleet are anticipated to decrease with time due to continued advances in engine technology and an increased percentage of electric vehicles.
2	Deterioration in air quality during construction	There is the potential for local, short term air quality impacts during construction, primarily due to particulate matter (deposited dust, TSP, PM_{10} and $PM_{2.5}$), possibly odour and, to a lesser extent, products of combustion. Technical Report G identifies a range of engineering, planning and operational controls that could be implemented and notes that a Construction Environmental Management Plan should be implemented, taking into account the requirements of EPA Victoria *Environmental Guidelines for Major Construction Sites*. Section 11.3 of Technical Report G and Environmental Performance Requirement AQP6 refer to the development of an Air Quality Management and Monitoring Plan to minimise impacts during construction. This would include an ambient air quality monitoring programme to assess particulate matter impacts.
3	Deterioration in air quality during operation	The combined impact of emissions from the road tunnel ventilation structures and surface roads were predicted for 2022 and 2031,based on 2012 background data. The year 2012 was selected from the period 2009 to 2013 as it represented the worst case for the modelling of surface roads. Modelling predictions were compared with State Environment Protection Policy (Ambient Air Quality) [SEPP(AAQ)] and National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) criteria (although neither have any regulatory status for a modelling assessment as they apply to the assessment of air quality monitoring data only), with all pollutants complying, except for PM_{10} and $PM_{2.5}$. The 24 hour average PM_{10} background concentrations exceed the SEPP(AAQ) objective on two occasions, with no additional exceedances resulting from the relatively small project contribution. The 24 hour average $PM_{2.5}$ background concentrations exceed the objective on one occasion, again with no additional exceedances due to the project. The maximum annual average $PM_{2.5}$ concentration predicted for 2031 exceeds the revised SEPP(AAQ) (2025) objective, principally due to the background concentration and surface road contribution. The $PM_{2.5}$ revised objective assumes that air quality will improve with time, which has not been allowed for in the modelling assessment. The modelling has a number of conservative elements, with vehicle emission factors assumed to remain at 2020 levels and pollutant background concentrations to remain at 2009 to 2013 levels for both the 2022 and 2031 scenarios.
4	Deterioration in air quality from surface road emissions	There are no regulatory criteria specifically applicable to the modelling of roads, however predictions were compared with SEPP(AQM) Schedule B intervention levels, in accordance with previous EPA Victoria directions for assessing the impacts of major road projects. With the exception of 24 hour average PM_{10} concentrations, there were no exceedance of intervention levels for any pollutant on any modelled road at the maximum impacted receptor. PM_{10} exceedances occur with and without the project, with a predicted reduction in the number of roads exceeding the intervention level should the project proceed. For the 12 roads evaluated, nine show a decrease or no change in maximum $PM_{2.5}$ concentrations, for the project over the no project scenario. For maximum PM_{10} concentrations nine of the 12 roads show a decrease or no change in 2022 for the project scenario and ten in 2031. The roads where increases in particulate matter concentrations were predicted for the 'with project' over the 'without project' scenario were as follows: PM_{10} (2022) - West Gate Freeway, Millers Road and Geelong Road

No.	Issue	Response
		PM_{10} (2031) – Blackshaws Road and Millers Road $PM_{2.5}$ (2022 and 2031) – Blackshaws Road, Millers Road and Geelong Road.
5	Deterioration in air quality in public open spaces	The air quality impact assessment considered air quality in public open spaces. Modelling of ventilation structure emissions was conducted over a 10 km by 10 km grid, with an inner grid (4.25 km by 2.5 km with receptors located on a 25 m grid spacing) centred on the project. In addition a selection of discrete sensitive receptors such as public open spaces, schools, kindergartens, hospitals and aged care facilities were included. Except for one hour average PM_{10} concentrations, there were no exceedances of SEPP(AQM) Schedule A design criteria at any receptor, including public open spaces. PM_{10} background concentrations exceed the one hour average criterion on 130 occasions (i.e. approximately 1.5 per cent of hours) during the worst case year (2009), with the project only predicted to result in an additional six exceedances (0.07 per cent of hours) in 2022 and nine (0.1 per cent of hours) in 2031.
6	Exceedances of air quality standards	Victorian legislation requires the West Gate Tunnel Project to comply with the requirements of SEPP(AQM) for the modelling of ventilation structure emissions. As noted above the PM_{10} one hour average design criterion was exceeded due to background concentrations alone. In accordance with the requirements of SEPP(AQM), exceedance resulted in the conduct of a human health risk assessment. It should be emphasised that SEPP(AQM) Schedule A design criteria are for modelling purposes only and are not human health based air quality standards. In addition, air quality standards (environmental quality objectives) described in SEPP(AAQ) apply to the assessment of ambient air quality monitoring conducted at performance monitoring stations representative of the general population, not to air quality modelling assessments. Comparisons with SEPP(AAQ) environmental quality objectives provided in Technical Report G are for information purposes only.
7	Existing air quality	Compared with international cities of similar size, Melbourne's air quality is relatively good (EPA Victoria http://www.epa.vic.gov.au/your-environment/air/melbournes-air-quality). There are however periodic exceedances of air quality standards, principally PM_{10} and $PM_{2.5}$, mainly due to the impact of wood heaters, dust storms, bushfires and fuel reduction burns.
8	In-tunnel air quality	Road tunnel ventilation systems are designed to achieve compliance with in-tunnel air quality criteria for CO, nitrogen dioxide and visibility. This is achieved through the use of conservative World Road Association (PIARC) vehicle emission factors and the control of tunnel ventilation flowrates based on monitoring conducted for these parameters utilising in-tunnel air quality monitoring equipment. EPA Victoria's submission suggested that an in-tunnel air quality criterion of 0.5 ppm NO_2 apply to the tunnel. Section 6.2.2.12.2 of the air quality impact assessment suggested this criterion when conducting a sensitivity analysis to evaluate the impact of tunnel ventilation structure emissions at the in-tunnel air quality limits, noting that CO limits alone may no longer be considered adequate to protect human health.
9	Lack of filtration system proposed in ventilation system design	As noted in the response to Item 1, the predicted impacts of pollutants emitted from the West Gate Tunnel Project road tunnel ventilation structures are low. Section 9 of Technical Report G provides a detailed examination of whether air pollution control technology should be installed to control emissions to air from the West Gate Tunnel Project ventilation structures. The conclusion, based on both Australian and international experience, is that air pollution control technology is not considered best practice on the basis of either health, environmental or cost considerations.
10	Concern about ultrafine particles	Background data from existing EPA Victoria monitoring stations are key inputs to the West Gate Tunnel Project air quality impact assessment, with

No.	Issue	Response
	emitted from vehicles and/or the lack of monitoring for this particle size fraction	none measuring ultrafine particles. There are no air quality standards for PM_1 or $PM_{0.1}$ (the definition for ultrafine particles remains unclear with both particle size fractions referred to in the literature and public submissions) in either Australia or, to my knowledge, internationally. Ultrafine particles do however represent a sub-fraction of $PM_{2.5}$, which is monitored. The World Health Organization recommends criteria for $PM_{2.5}$ and PM_{10}, not PM_1 or $PM_{0.1}$, noting that "*while there is considerable toxicological evidence of potential detrimental effects of ultrafine particles on human health, the existing body of epidemiological evidence is insufficient to reach a conclusion on the exposure-response relationship to ultrafine particles. Therefore no recommendations can be provided at present as to guideline concentrations of ultrafine particles*". In addition there are no recognised standard methods for measuring ultrafine particles in ambient air in either Australia or overseas.
11	No reference to monitoring during construction	As noted in Section 11.3 of Technical Report G, an Air Quality Management and Monitoring Plan will be developed to minimise impacts during construction. Minimum monitoring requirements for road construction projects are typically based on existing VicRoads contracts documentation.
12	Adequacy of air quality impact assessment	The air quality impact assessment is the most comprehensive assessment yet undertaken for a road or road tunnel project in Australia. It includes consideration of a network of surface roads and an evaluation of the combined impact of emissions from both the road tunnel ventilation structures and surface roads, neither of which is normally assessed. The assessment was conducted in accordance with EPA Victoria guidance and has been the subject of independent peer review, which concluded that the methodology and findings were appropriate.
13	Air quality impact on Maribyrnong River	The assessment of air quality impacts is in accordance with the requirements of SEPP(AQM). The principal beneficial use impacted by a road project is the life, health and well-being of humans, which is the focus of the air quality impact assessment. Other impacts on beneficial uses would be expected to be minor by comparison, in particular those relating to wet and dry deposition of pollutants on a river.
14	Background air quality data used	Available sources of ambient air quality data were considered in Technical Report G, with EPA Victoria Footscray data considered representative of background air quality over the region impacted by the West Gate Tunnel Project. The Footscray ambient air quality monitoring station is only approximately 2.4 km north-west of the project boundary. The predicted impacts of emissions to air from the road tunnel ventilation structures and surface roads were added to the background concentrations to estimate local impacts in the project vicinity.
15	Lack of detail on ambient air quality monitoring	There are currently five ambient air quality monitoring stations operated by Western Distributor Authority collecting air quality data in the vicinity of the project alignment (Francis Street, Barbara Beyer Reserve, Donald McLean Reserve, Primula Avenue and Woods Street). An Air Quality Monitoring Plan is provided in Section 7 of Attachment V to the EES. At a minimum, one ambient air quality monitoring station will be located adjacent to each road tunnel ventilation structure to assess the impact of emissions on nearby sensitive receptors during the operational phase of the West Gate Tunnel Project. The location of each station will be agreed through consultation with EPA Victoria and other external stakeholders. Table 106 of Technical Report G also refers to the Environmental Performance Requirement that ambient air quality monitoring will be conducted for at least one year prior to operation and five years post opening, or as agreed with EPA Victoria.
16	Concern regarding vehicle emission standards and compliance with air	Vehicle emission standards are set by the Australian Government. The Government's Ministerial Forum on Vehicle Emissions is currently undertaking a review to consider whether Australia will adopt Euro 6 standards for light vehicles and Euro VI standards for heavy vehicles.

No.	Issue	Response
	quality standards and legislation	Compliance with applicable air quality standards and legislation in Victoria was the topic addressed by Technical Report G.
17	Veracity of air quality model	AERMOD and AUSROADS were used to predict air quality impacts from the road tunnel ventilation structures and surface roads respectively. AERMOD is the Victorian regulatory model and a USEPA regulatory model. AUSROADS is the Victorian regulatory model and was based on the CALINE series of models originally developed by the California Department of Transportation. Both models have been the subject of validation studies. Regulatory models are approved by EPA Victoria for use in assessing emissions to air. EPA Victoria will only approve an alternative to the regulatory model in circumstances where the proponent has demonstrated in a written submission that the alternative model is appropriate for the circumstances.
18	Request that air quality monitoring be conducted during construction and operation	As noted in Section 11.3 of Technical Report G, an Air Quality Management and Monitoring Plan will be developed to minimise impacts during construction. The Air Quality Monitoring Plan provided in Section 7 of Attachment V to the EES describes the parameters to be monitored at ambient air quality monitoring stations following completion of the project. At a minimum, one ambient air quality monitoring station will be located adjacent to each ventilation structure to assess the impact of emissions on nearby sensitive receptors during the operational phase of the West Gate Tunnel Project.

5 RESPONSE TO THE PRELIMINARY MATTERS AND FURTHER INFORMATION REQUEST ISSUED BY THE WEST GATE TUNNEL PROJECT INQUIRY AND ADVISORY COMMITTEE

Requests for information relevant to my area of expertise noted in Appendix D of the *Preliminary Matters and Further Information Request* issued by the West Gate Tunnel Project IAC are reproduced in Table 2, together with my responses.

Table 2: IAC Requests for Information

No.	Request	Response
LD2-K	Further discussion on the selection of background data is required. As with $PM_{2.5}$ a sensitivity analysis with the 2015 should be provided for both tunnel and surface roads. A sensitivity analysis for the Brooklyn area including Millers Road should be done using the Brooklyn PM data.	Background air quality data selected for the road tunnel ventilation structure modelling was defined by the availability of $PM_{2.5}$ data. Prior to 12 October 2014 $PM_{2.5}$ was monitored at the EPA Victoria Footscray ambient air quality monitoring station by low volume sampler on a one in three day basis, producing 24 hour average concentrations. Subsequently continuous monitoring instrumentation was introduced. Therefore, in order to provide five years of consistent $PM_{2.5}$ data (in accordance with EPA Victoria modelling guidance) the period 1 January 2009 to 31 December 2013 was used. This period was also used for the remaining pollutants evaluated. It was however agreed with EPA Victoria to perform an additional year of modelling using 2015 $PM_{2.5}$ time varying background concentrations. The worst case year (2012) from 2009 to 2013 was selected for the purposes of surface road modelling. In addition the 2010 meteorological data set comprised only 73 per

No.	Request	Response
		cent valid data compared to 99 per cent for 2012. Low volume sampler $PM_{2.5}$ monitoring data from the Brooklyn ambient air quality station was only available from July 2010 to July 2011 and therefore did not comply with the requirement for five years of data.
LD2-L	The modelling of two lanes as normal operation needs to be reconciled with the SEPP(AQM) requirement for modelling of worst case emissions. It is accepted that it is unlikely that the tunnel will operate 24 hours a day at full capacity however as with CityLink it is likely that there will be hours in the day that the tunnel is at full capacity under normal operating conditions. This scenario needs to be assessed to show compliance with SEPP(AQM) for the tunnel operation.	Traffic data was provided by GHD and included morning (7am to 9am) and afternoon (4pm to 6pm) peak traffic volumes. As the ventilation structure dispersion modelling is dependent on total pollutant emission rates it is immaterial whether traffic is distributed over two or three lanes. The modelling assessment is therefore consistent with the requirements of SEPP(AQM). A sensitivity analysis was however conducted at maximum lane capacity (three lanes), for 24 hours a day 365 days a year. The results indicated that, whilst there were PM_{10} and $PM_{2.5}$ exceedances due to elevated background concentrations, the maximum tunnel contribution to 1 hour average PM_{10} and $PM_{2.5}$ concentrations were 1.4 per cent and 0.8 per cent respectively (Table 47 of Technical Report G).
LD2-M	Further information on the rationale and justification of the 1 km impact zone for the emissions from the ventilation stack is required.	The 1 km zone refers to the area within which a selection of discrete sensitive receptors were identified, not the area over which modelling was conducted. The actual assessment area was 100 square kilometres centred on the project (approx. half way between the north and south ventilation stacks) as noted in Section 6.2.2.1 of Technical Report G.
LD2-N	Further discussion on the use of the NPI and PIARC data and how that has taken into account changes in Australian Design Rules and fuel quality is required. The impact of any changes that are not reflected in the emission factors used needs to be discussed.	As noted above vehicle emission standards are set by the Australian Government. The Government's Ministerial Forum on Vehicle Emissions is currently undertaking a review to consider whether Australia will adopt Euro 6 standards for light vehicles and Euro VI standards for heavy vehicles. Future changes to Australian Design Rules dealing with vehicle emissions or changes in fuel quality would primarily be aimed at reducing tailpipe emissions. This would effectively increase the conservatism of the emission factors used in the assessment.
LD2-O	Further discussion on the ratio of $PM_{2.5}$ to PM_{10} in the predicted ground level concentrations is required as they do not reflect the high percentage of $PM_{2.5}$ from motor vehicle exhausts.	Predicted maximum PM_{10} ground level concentrations are strongly influenced by the time varying background concentration. The corresponding $PM_{2.5}$ predictions use a constant 70^{th} percentile background concentration, as described in Technical Report G, and are therefore not directly comparable. Examination of the emission rates used (Appendix C, Table 3 onwards) shows that $PM_{2.5}$ emission rates are in general approximately 70 per cent of the PM_{10} rate.

No.	Request	Response
		These emission rates include non-tailpipe emissions which influence PM_{10} rates more strongly than $PM_{2.5}$. Without non-tailpipe emissions, $PM_{2.5}$ emission rates would be approximately 95% of the PM_{10} rate.
LD2-P	The traffic data in Tables 36 needs to be checked and clarification as to what has actually been used in the air quality modelling provided.	A typographical error is present in Technical Report G Table 36 row 5, column 5 (Scenario A, inbound, inter-peak, all vehicles). The number of vehicles should be 11,000, not 1,100. The value was not however used in the modelling assessment as emission rates were determined for each hour of the day. Other minor inconsistencies are principally due to rounding errors.
LD2-Q	Further information on the validity of the 2012 census data is required. Comparison with data from the most recent Commonwealth reports on changes to the Australian Design Rules and Fuel Quality Act should be included where possible.	The Australian Bureau of Statistics 2016 Motor Vehicle Census (93090DO001, 31 January 2016) reports national diesel passenger vehicles as comprising 11 per cent of total passenger vehicles. As noted in Technical Report G the modelling assumption of 15 per cent diesel passenger vehicles is therefore considered conservative.
LD2-R	Further modelling of the surface roads including non-tailpipe emissions should be undertaken. If modelling is not undertaken then an assessment of the potential impact on predicted concentration of PM_{10} should be included.	The major objective of the surface road modelling was to provide a comparison between the 'with project' and 'without project' scenarios. Previous modelling for major road projects, for example CityLink Tulla widening, have used EPA Victoria vehicle emission factors which do not include non-tailpipe emissions. However, modelling predictions for West Gate Freeway and Francis Street will be provided to the IAC including tyre and brake wear emission factors.
LD2-S	The surface road modelling for Hyde Street for PM_{10} and $PM_{2.5}$ needs to be clarified as to why a 100 per cent increase in HCV leads to a decrease in predicted PM_{10} and $PM_{2.5}$ concentrations. Further discussion is required.	Hyde Street triggered the road selection criteria with a 100 per cent increase in HCVs from West Gate Freeway to Francis Street (1,100 HCVs). However, there was a larger decrease in HCVs on Francis Street between Williamstown Road and Hyde Street (4,200 HCVs) resulting in a decrease in the maximum predicted PM_{10} and $PM_{2.5}$ concentrations on Hyde Street (corner of Hyde Street and Francis Street).
LD2-T	Modelling should be conducted for the increase in construction vehicles using the local roads in particular Hyde Street and Francis Street. If this is not possible then the potential impacts of this traffic needs to be discussed in detail and mitigation measures proposed.	Due to the lack of detailed information regarding the construction schedule (e.g. the number of vehicles, duration and trip frequency) it was not possible to include construction traffic in Hyde Street and Francis Street modelling. The major impact of construction activity would be expected to be dust emissions associated with earthmoving activities, not the movement of construction vehicles. Appropriate mitigation measures for earthmoving and other construction activities were proposed for the project which will be

No.	Request	Response
		incorporated within the Construction Environmental Management Plan (CEMP).

6 DECLARATION

I have made all enquiries that I believe are desirable and appropriate and that no matters of significance which I regard as relevant have to my knowledge been withheld from the West Gate Tunnel Project IAC.

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Signed

Date: 1 August 2017

Attachments: Appendix A - Matters Raised by PPV Guide to Expert Evidence
Appendix B – Curriculum Vitae – Frank Fleer
Appendix C – Technical Report G Corrections

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APPENDIX A

MATTERS RAISED BY PPV GUIDE TO EXPERT EVIDENCE

Expert's Name and Address
Frank Edward Fleer
Principal Air & Noise Group
Golder Associates Pty. Ltd.
570 – 588 Swan Street
Richmond 3121

Expert's Qualifications and Experience
Honours Degree in Chemical Engineering 1977. Forty years' experience in environmental science/environmental engineering consulting including two years with GHD Pty. Ltd., three years with ACI Environics, 26 years with AWN (Air Water Noise) Consultants Pty. Ltd. as founder and Managing Director, and nine years with Golder as Principal Air & Noise Group (refer to Appendix B for curriculum vitae).

Expert's Area of Expertise
My areas of expertise include environmental management, environmental auditing, environmental engineering, workplace exposure assessment and control procedures, industrial source emission monitoring and control, ambient air quality monitoring, soil vapour monitoring, indoor air quality monitoring, air quality impact assessment, mathematical modelling, environmental noise monitoring and noise impact assessment (refer to Appendix B for a number of project examples).

I was Project Director for the preparation of Technical Report G (*West Gate Tunnel Project – Air Quality Impact Assessment Report*) and participated in discussions with EPA Victoria and the Technical Reference Group during scoping of modelling to assess surface road and road tunnel ventilation structure impacts.

Other Significant Contributors to the Report
Mark Tulau - BSc Chemistry/Physics 1984, GradDip Computer Programming 1992

Mark has 30 years of experience in the fields of environmental management, workplace exposure assessment, industrial source emission monitoring, ambient air quality monitoring and mathematical modelling, including the past 24 years as an environmental consultant with AWN (Air Water Noise) Consultants and, following their merger, Golder.

His work has involved the conduct and co-ordination of environmental monitoring, impact assessment and modelling projects in the fields of air quality and environmental noise.

Mark is a technical assessor in the field of air quality monitoring for the National Association of Testing Authorities and International Accreditation New Zealand.

John Conway BSc Chemistry (Honours) 1991, MSc Atmospheric Sciences 1992

John has 23 years of experience in air quality gained in Australia, the UK and Ireland, of which three years were spent in research.

His areas of expertise include air quality impact assessments, dispersion modelling, ambient air quality studies, occupational hygiene, indoor air quality, odour assessments, stack emission testing management and greenhouse gas assessments.

John has been an active member of the Clean Air Society of Australia and New Zealand since 2008 and is current Treasurer of the Victoria/Tasmania Branch.

Jason Shepherd - BSc Physics 1998, MSc Atmos. Physics 1999, PhD Atmos. Physics 2004

A background in atmospheric physics research led Jason into environmental consulting.

He has 11 years of experience co-ordinating and conducting source emission testing, ambient air quality monitoring and noise monitoring programmes and delivering numerous air quality modelling and noise modelling studies for transport, mining, landfill, recycling, port and manufacturing facilities.

Instructions that Define the Scope of the Report
Golder was instructed by Transurban to prepare reports that assessed the air quality impacts of the proposed West Gate Tunnel Project in accordance with the relevant requirements of the Department of Environment, Land, Water and Planning document titled *Scoping Requirements for Western Distributor Project* (dated April 2016) and EPA Victoria Works Approval application guidelines.

Further to the above, I received a letter of instructions dated 11 July 2017 from Clayton Utz, acting on behalf of the Western Distributor Authority. The letter requested that I undertake the following work:

- Review the public submissions and identify those relevant to your area of expertise
- Review your previous reports and identify whether there are any changes to the conclusions of the reports arising out of the issues raised by the public submissions or as a consequence of any other relevant matter
- Prepare an expert report that:
  - Responds to the public submissions relevant to your area of expertise
  - Addresses your previous reports and any changes to the conclusions reached
  - Any other matter that you consider relevant to your area of expertise.

A subsequent email from Clayton Utz dated 18 July 2017 requested a review of Appendix D of the Preliminary Matters and Further Information Request issued by the West Gate Tunnel Project IAC and the preparation of an expert report responding to the matters raised.

Identity and Qualifications of Person Responsible for Tests or Experiments used by Expert in Making the Report
Not applicable.

Report that the Expert Relies on
My evidence relies on the traffic volume and fleet mix projections for surface roads and the West Gate Tunnel Project provided in Technical Report A titled *Transport (West Gate Freeway Upgrade and Road Tunnel).*

Facts, Matters and Assumptions upon which the Report Proceeds
My evidence, Technical Report G and Attachment V rely on the traffic volume and fleet mix projections for surface roads and the West Gate Tunnel Project provided in Technical Report A titled *Transport (West Gate Freeway Upgrade and Road Tunnel).*

Summary of Opinions of Expert
Based on the evidence presented in Technical Report G, it is my opinion that the air quality impacts associated with the West Gate Tunnel Project are minor, with road tunnel ventilation structure emissions to air complying with the requirements of SEPP(AQM), with the exception of one hour average PM_{10} concentrations. Background one hour average PM_{10} concentrations exceed the SEPP(AQM) Schedule A design criterion without the project.

Professional Opinions not Fully Researched
None.

Questions Outside Expert's Expertise
None.

Report Incompleteness or Inaccuracies
Following publication of Technical Report G, data entry errors were identified in Tables 101, 102 and 103 (refer to Appendix C). In addition Table 36 row 5, column 5 (Scenario A, inbound, inter-peak, all vehicles) has a typographical error. The number of vehicles should be 11,000 not 1,100. These corrections have not caused me to change my opinion on the matters expressed in Technical Report G.

APPENDIX B

CURRICULUM VITAE – FRANK FLEER

Education

BEng Chemical (Honours), Monash University, Melbourne, Australia 1977

Golder Associates Pty Ltd – Melbourne

Principal Air and Noise Group

Mr. Frank Fleer has 40 years' experience in the fields of environmental management, environmental auditing, environmental engineering, workplace exposure assessment and control procedures, industrial source emission monitoring and control, ambient air quality monitoring, soil vapour monitoring, indoor air quality monitoring, air quality impact assessment, mathematical modelling, environmental noise monitoring and noise impact assessment. Two years were spent with GHD, three years with ACI Environics and 26 years with AWN (Air Water Noise) Consultants, as founder and Managing Director, prior to joining Golder Associates in 2008.

Frank has published over 50 papers/chapters on air quality issues and is a Past Federal President and Fellow of the Clean Air Society of Australia and New Zealand (CASANZ). He is also a Past Chairperson of both the CASANZ Measurement Special Interest Group (SIG) and Odour SIG and a member of the NEPC Advisory Group during the development of the *National Environment Protection (Ambient Air Quality) Measure* and *$PM_{2.5}$ Advisory Reporting Standard*.

As Chairperson of Standards Australia/Standards New Zealand Committees EV-007 *Methods for Examination of Air*, EV-007-1 *Stationary Source Emission Testing* and EV-007-3-1 *Odour Measurement Test Method*, substantial input has been made into establishing suitable methods for air quality monitoring. Frank was solely responsible for drafting a substantial number of Australian/New Zealand Standards dealing with air emission and ambient air quality monitoring, including the current draft DR AS/NZS 3580.18 *Measurement of Road Tunnel Air* Quality, dealing with the measurement of CO, NO, NO_2, visibility and air velocity in road tunnels.

As a Technical Expert and Co-Chair of the National Association of Testing Authorities (NATA) Life Sciences Accreditation Advisory Committee (LSAAC), he reviews the test methods, laboratory procedures and quality systems management of laboratories that have applied for accreditation in the field of environmental monitoring and assists in establishing requirements for NATA accreditation. He is also a Technical Expert for International Accreditation New Zealand and Hong Kong Accreditation Service and a Technical Advisor to Proficiency Testing Australia.

Frank is a certified Environmental Auditor under the Victorian *Environment Protection Act 1970* and has conducted numerous statutory and company initiated audits of industrial facilities to assess environmental performance, including a large number of audits associated with road tunnels (West Gate Tunnel Project – Melbourne; CityLink - Melbourne; Cross City Tunnel – Sydney; Lane Cove Tunnel – Sydney; Legacy Way – Brisbane).

Significant appointments have been as follows:

- 1991 to present – Environmental Auditor (Industrial Facilities), appointed by EPAV pursuant to the Victorian *Environment Protection Act 1970*
- 1992 to 1996 – CASANZ Federal President
- 2005 to 2011 - Planning Panels Victoria Sessional Member

- 2006 to 2009 - Victorian Government Waste Management Advisory Committee Member
- 2007 to present – Standards Australia/Standards New Zealand Committee EV007 Chairperson
- 2010 to present - Victorian Civil and Administrative Tribunal Planning and Environment List Sessional Member
- 2012 - Commissioner of Environmental Sustainability Atmosphere Expert Reference Group Member, assisting with preparation of the 2013 Victorian State of the Environment Report
- 2014 to present – NATA LSAAC Chairperson
- 2014 to 2015 - Department of Health and Emergency Management Victoria Expert Panel Member, examining air quality criteria and responses for CO and $PM_{2.5}$ exposure under fire conditions, following the 2014 Hazelwood Mine fire.
- 2016 - World Road Association (PIARC) Technical Committee 3.2 *Environmental Considerations in Road Projects and Operations* Member.

Awards have included:

- 2000 – CASANZ Distinguished Service Medal and Society Life Membership
- 2002 - Clean Air Medal, based on his efforts in increasing standards within the consulting industry. The Medal is the highest air quality honour awarded in Australia and New Zealand
- 2011 - Werner Strauss Achievement Award for outstanding contributions to improving air quality measurements, in part through his involvement with Standards Australia, NATA and Proficiency Testing Australia.

Internationally he has worked on air quality issues in New Zealand, Taiwan, Hong Kong, Papua New Guinea, Fiji, Yemen, Indonesia, Solomon Islands and Malaysia.

Employment History

Golder Associates *Principal Air & Noise Group (2008 to present)*

AWN (Air Water Noise) Consultants *Managing Director (1982 to 2008)*

ACI Environics *Chemical Engineer (1980 to 1982)*

GHD *Chemical Engineer (1978 to 1980)*

Australian Paper Manufacturers *Technical Officer Paper (1977 to 1978)*

PROJECT EXPERIENCE – ROAD TUNNELS AND ROAD CONSTRUCTION

CityLink
Victoria, Australia

A large number of projects were conducted for Transfield Obayashi Joint Venture during CityLink construction, and, subsequent to tunnel opening, for Translink Operations.

These include the establishment of baseline PM_{10}, lead and TSP concentrations, statutory environmental audits of ambient, tunnel and ventilation stack air quality monitoring during the period 2000 to 2008, NO_x, CO, PM_{10}, $PM_{2.5}$, benzene and lead verification emission tests on the tunnel ventilation stacks and the assessment of occupational exposure to noise and airborne contaminants for tunnel maintenance workers.

In addition, dispersion modelling was conducted to assess air quality impacts on proposed high rise residential developments due to emissions to air from the Domain tunnel ventilation stack.

Cross City Tunnel
New South Wales, Australia

Appointed by various Cross City Tunnel operators (Baulderstone Hornibrook, Leighton Contractors and Ventia) to conduct statutory environmental audits of ambient air quality monitoring conducted at two ground level and two elevated stations, together with in-tunnel CO monitoring.

Audits assessing data handling and validation protocols, maintenance procedures and equipment calibration procedures have been conducted on a six monthly basis since the tunnel opened in 2005, in accordance with Planning Minister Conditions of Approval.

Lane Cove Tunnel
New South Wales, Australia

Assessed suitability of various sites for monitoring ambient air quality impacts associated with Lane Cove Tunnel ventilation stack emissions to air, on behalf of Thiess John Holland.

Commissioned by Transurban to conduct six monthly in-tunnel air quality, ambient air quality and ventilation stack emission test audits to comply with Planning Minister Conditions of Approval.

Eastern Distributor
New South Wales, Australia

Commissioned by Ventia to review the methods and procedures used to conduct in-tunnel air quality monitoring for the Eastern Distributor.

Geelong Ring Road,
Victoria, Australia

Section 4B of the Geelong Ring Road, VicRoads included duplication of Anglesea Road, immediately adjacent to a proposed quarrying operation.

Commissioned by VicRoads to evaluate the impact of reducing the Anglesea Road buffer distance from the quarry site boundary to the road. A dispersion modelling assessment was conducted, taking into account the changes in road elevation with distance.

Acoustic Barrier Study
Victoria, Australia

Commissioned by VicRoads to study the effect of acoustic barriers on motor vehicle exhaust emission dispersal. Various configurations representing barrier height, wind speed and wind direction (relative to the roadway and acoustic barrier) were assessed to provide data on predicted NO_x ground level concentrations downwind of the roadway, utilising both a 3D empirical-diagnostic dispersion model [Quick Urban & Industrial Complex (QUIC)] and a computational fluid dynamics (CFD) model.

West Gate Tunnel Project
Victoria, Australia

The West Gate Tunnel Project is a proposed road, road tunnel and elevated motorway project that connects the West Gate Freeway with the Port of Melbourne, CityLink and Melbourne's central business district, providing an alternate river crossing and reducing traffic volumes on the West Gate Bridge. Appointed by Transurban as the air quality lead; Environmental Effects Statement preparation and provision of expert advice.

EastLink
Victoria, Australia

EastLink is a $2.5 billion, 39 kilometre motorway running between Donvale in Melbourne's north-east to Frankston in Melbourne's south-east, incorporating two tunnels under the Mullum Mullum Valley. The motorway was one of Australia's largest road construction projects, opening in June 2008.

Prior to opening, conducted ambient air quality monitoring for benzene, toluene, ethyl benzene and xylene isomers (BTEX) and 1,3-butadiene concentrations in the valley to establish background concentrations, initially on behalf of VicRoads and subsequently for Transfield Services.

Other projects included peer review of the project works approval application, together with assisting Thiess John Holland in evaluating possible ambient air quality monitoring sites and to negotiate appropriate works approval conditions with EPA Victoria.

Following EastLink's opening, monitoring of environmental impacts of road traffic emissions by ambient air quality stations located along the length of the motorway, in addition to atmospheric contaminant emission rate measurements utilising continuous emission monitoring systems located in the tunnel ventilation exhaust stacks.

Parameters measured continuously, in both ambient air and ventilation stack exhausts, included PM_{10}, $PM_{2.5}$, CO and NO_x. Meteorological parameters (wind speed, wind direction, temperature, solar radiation and relative humidity) were also measured at a number of the ambient air quality stations. In addition, monitoring for a range of air toxics (PAHs, BTEX and formaldehyde) was conducted on a 1 in 6 day basis at one of the ambient stations.

Commissioned by Transfield Services to operate and maintain the five ambient air quality stations (including data validation and reporting) for the first two years of motorway operation and continue to be contracted to operate and maintain the ventilation stack CEMS, and conduct air toxics (PAHs, BTEX, 1,3-butadiene and formaldehyde) emission tests and manual PM_{10}, $PM_{2.5}$, NO_x and CO verification emission tests on the ventilation stack exhausts.

Project Manager of a statutory audit conducted of the EastLink Wastewater Management Plan, with the objective of assessing all tunnel wastewater system inputs, together with identifying opportunities to reduce the total dissolved solids load.

Conduct of study into the viability of restricted emissions from the exit portals of the EastLink road tunnels under all operating hours, using GRAL, a Lagrangian particle model with a specific 'tunnel module'. A closed loop control system is proposed to control ventilation exhaust fan speeds throughout the day, permitting tunnel emissions to be split between the exhaust stacks and the portals, whilst maintaining minimal impact on ambient air quality.

VicRoads
Victoria, Australia

Commissioned by VicRoads to prepare the air quality section of their Sustainable Roads Assessment Tool, INVEST. The tool aims to deliver sustainable road projects and provide momentum for continual improvement. The air quality section describes various elements associated with dust control and suppression; maintenance of equipment and machinery; dust monitoring; other air quality issues.

Legacy Way
Brisbane, Australia

Golder Associates were the Environmental Management Representative (EMR) for Brisbane City Council (BCC) during construction of the Legacy Way road tunnel project. Legacy Way is a major road tunnel project connecting the Western Freeway at Toowong with the Inner City Bypass (ICB) at Kelvin Grove.

Provision of on-going air quality consultancy services as part of the Golder EMR team for BCC, involving auditing of monitoring conducted by the contractor and review of the Construction Air Quality EMP Sub-plan with respect to the Coordinator General's Conditions and BCC specifications.

Gungahlin Drive Extension
ACT, Australia

The ACT Department of Urban Services proposed the construction of a major roadway immediately adjacent to the Australian Sports Commission's Australian Institute of Sport (AIS) complex in Leverrier Crescent, Bruce, ACT. The Gungahlin Drive Extension is part of Canberra's transport network, linking the Barton Highway at Gungahlin Drive with the Tuggeranong Parkway at the Glenloch Interchange. Stage 1 of the project consisted of a 2 lane highway and Stage 2 a 4 lane highway.

Commissioned by the Australian Sports Commission to review the road project air quality modelling, with the objective of establishing if potential air quality impacts on the AIS facilities and athletes had been adequately addressed.

VicRoads
Victoria, Australia

Commissioned by VicRoads to create an Air Quality Screening Tool (AQST), based on AUSROADS, modelling evaluations of various project scenarios.

New road projects, major realignments or modifications to existing roads have the potential to cause adverse air quality impacts. Increased traffic volumes and changes to road alignment which result in decreased separation distances between vehicle emissions and sensitive uses, can create increased air pollution at residential dwellings and other sensitive uses. However, adverse air quality impacts are not anticipated where the road project involves low traffic volumes and a suitable separation distance.

The purpose of the VicRoads AQST is to enable Planners and Project Engineers to assess compliance against *State Environment Protection Policy (Air Quality Management)* criteria using a worst case approach.

VicRoads
Victoria, Australia

Commissioned by VicRoads to develop and present a number of training courses dealing with air quality monitoring, modelling and management for road projects.

Hallam ByPass
Victoria, Australia

Commissioned by Transfield Construction to periodically audit compliance with the Hallam Bypass Environment Management Plan.

Ambient Air Quality Monitoring

Conduct of dust deposition and directional dust monitoring for various road construction projects (Monash Freeway upgrade; Goulburn Valley Highway upgrade; Vineyard Road duplication; Nagambie Bypass; Hallam Bypass) on behalf of both VicRoads and construction contractors.

PROJECT EXPERIENCE – AMBIENT AIR QUALITY MONITORING

John Brown Engineering Papua New Guinea	Ambient sulphur dioxide ambient air quality monitoring programme during gas turbine installation commissioning trials, Bougainville, Papua New Guinea.
Brick Industry Victoria, Australia	Monitoring of particulate and gaseous ambient fluoride concentrations using active sampling techniques and development of a passive sampling/analysis technique for gaseous ambient fluoride monitoring utilising calcium oxide exposure plates. Forage and foliage sampling to determine fluoride contents and visual effects vegetation surveys to assess fluoride impacts on foliage and plant growth.
Queensland Health Queensland, Australia	The Narangba Industrial Estate, located approximately 35 km north of Brisbane, was established for noxious, hazardous and offensive industries, including fish meal production, fertilizer manufacture, composting and waste treatment. Initially a desk top study was conducted to identify all facilities and potential sources. Subsequently commissioned to conduct an ambient air quality monitoring programme at seven sites to establish community exposure to VOCs (including benzene, toluene, ethyl benzene and styrene), organochlorine and organophosphate pesticides, PCBs and glyphosate under summer and winter conditions.
Dept. of Administrative Services Victoria, Australia	During the Sydenham rehabilitation project, conduct of an extensive ambient air quality monitoring programme for the determination of TSP and lead.
Municipal Councils Victoria, Australia	Ambient air quality monitoring programmes to determine the concentrations of lead and TSP for a number of municipal councils located in the Melbourne metropolitan area.
Abigroup NSW, Australia	Operation of nine ambient air monitoring stations for the determination of TSP and lead during sand blasting and repainting of State Rail Authority railway bridges.
City of Greater Dandenong Victoria, Australia	Measurement of ambient air toxics using multisorbent tubes (USEPA Method TO17), together with the determination of flux chamber emission rates, for the largest municipal solid waste landfill in Victoria.
Portland Aluminium Victoria, Australia	Plume tracking conducted at sea, for the first time in Australia, using ambient SO_2 measurement techniques to enable the measurement of plume centre line concentrations of SO_2, odour and VOCs.
Caltex Pacific Indonesia Indonesia	Conduct of ambient air quality monitoring programme in the Duri Steam Flood Oil Field, Sumatra. Tests included TSP, lead, PAHs, alkanes, alkenes, alkynes and air toxics.
Comalco Aluminium Tasmania, Australia	Conduct of ambient air quality monitoring programme at Bell Bay, Tasmania, to assess the impact of SO_2 emissions from the aluminium smelter.
Thiess Services Western Australia, Australia	Conduct of ambient air quality monitoring programme for the Omex site remediation, Bellevue, Western Australia. Monitoring was conducted at five locations over a two month period for PAHs (PUF LVS), benzene (GC/PID), PM_{10}, lead and SO_2.

Hazelwood Power Victoria, Australia	Ambient air quality monitoring programme to assess the contribution of Morwell open-cut mining activities on $PM_{2.5}$, PM_{10} and TSP concentrations.
Total Waste Management WA, Australia	Ambient air quality monitoring for VOCs (USEPA Method TO-17), odour, TSP, metals and semi-volatile organics by PUF HVS (dioxins/furans, PCBs and PAHs).
Yallourn Energy Victoria, Australia	Conduct of PM_{10} and insoluble solids dust deposition ambient air quality monitoring programme for the Maryvale Coal Field Development Project. PM_{10} monitoring was conducted by both LVS and laser light scattering instruments, in order to assess the suitability of the latter technique.
Shell Victoria, Australia	Benzene ambient air quality monitoring using passive adsorption and SUMMA canister sampling techniques. SO_2 ambient air quality monitoring by pulse fluorescence analyser with remote data download and validation. Gaseous and particulate fluorides in ambient air utilising double filter paper sampling, in accordance with AS/NZS 3580.13.2.
Terminals Victoria, Australia	SUMMA canister monitoring to determine VOCs and acrylic monomer concentrations in residential communities abutting Coode Island. "Real time" mathematical modelling of benzene emission sources over a seven month period, aimed at determining maximum predicted benzene concentration sites beyond the site boundary, together with ambient air quality monitoring utilising SUMMA canisters, to verify model predictions (Coode Island). SUMMA canister monitoring to establish 1,3 butadiene concentrations at five locations in Corio, prior to and immediately following the construction and commissioning of a 1,3 butadiene storage facility.
Boral Victoria, Australia	Ambient air quality monitoring programme to assess the contribution of quarrying activities to respirable crystalline silica, $PM_{2.5}$ and PM_{10} concentrations in the region. Comparative data was obtained between co-located HVS, laser light scattering instruments and LVS. The study was the first in Australia to confirm the suitability of LVS for PM_{10} monitoring.
Commercial Client Victoria, Australia	A proposed development site was contaminated with PCBs resulting from a previous use. An ambient air quality monitoring programme was conducted to determine dust deposition rates and PCBs deposition rates and concentrations at the site boundary, during soil remediation by direct fired thermal desorption.
SP AusNet Victoria, Australia	Conduct of ambient air quality monitoring programme to assess the impact of soil remediation activities at a contaminated site, including the determination of phenol, cresol, VOCs, PAHs and PM_{10} concentrations and dust deposition rates.
VicTrack Victoria, Australia	Conduct of ambient air quality monitoring programme to assess TSP and arsenic concentrations at the Spotswood material handling depot.
Various Australia	Dust deposition and directional dust monitoring programmes in accordance with Australian Standards AS 3580.10.1 and AS 3580.10.2 for foundries, steelworks, bulk commodity loading/unloading at ports, grain handling operations, brickworks, road construction, oilseed processing, landfills, recycling, chemical storage and handling, tyre manufacture and mining activities.

PROJECT EXPERIENCE – INDUSTRIAL SOURCE EMISSION MONITORING

Caltex Pacific Indonesia Indonesia	Point source emission monitoring programme for NO_x, SO_2, NMHC, CH_4, H_2S, CO, lead, particulate matter, PAHs, air toxics; area/fugitive source monitoring programme for hydrocarbons and air toxics. Conduct of source emission monitoring training programme for Caltex staff.
Sydney Water Board NSW, Australia	Five month monitoring programme to determine emissions to air of dioxins/furans, PAHs, PCBs, pesticides, particulate matter, sulphur trioxide, fluorides, acid gases, heavy metals, BTEX, NO_x, SO_2, H_2S, CO, CO_2 and O_2 from five sewage sludge incinerators. The project was reported to be the largest project of its type undertaken in Australia.
Animal By-Products Victoria, Australia	Review and measurement of odour emissions to air from an animal by-products plant, environmental impact assessment, pilot scale control equipment trials, preparation of control equipment process design specification and equipment commissioning.
Fonterra Victoria, Australia	Odour audit and odour emission monitoring study of wastewater treatment plant located at Dennington milk processing facility, Warrnambool.
Portland Aluminium Victoria, Australia	Monitoring of anode bake furnace emissions to air to determine the emissions of PAHs, BTX, VOCs, hydrogen fluoride, SO_2 and particulate matter. Evaluation of the effect of spent potliner re-use on phosphine, cyanide, fluoride, chloride, SO_2 and ammonia emissions to air from various processes. This involved the completion of approximately 100 tests during a four-day trial period. Monitoring of cathode bake oven afterburner inlet and outlet to determine VOCs removal efficiency (utilising the USEPA VOST train and PID continuous monitoring) and PAHs formation.
Nylex Victoria, Australia	Commissioned to co-ordinate, monitor and report on emissions to air from 31 discharges serving various unit operations located at five sites throughout Victoria. This involved the completion of approximately 800 emission tests for contaminants which included VCM, particulate matter, acrylonitrile, ethyl acrylate, 1, 3-butadiene, methyl methacrylate, formaldehyde, MIBK, acrolein, toluene, styrene, cyclohexanone, odour, MEK, plasticiser aerosol and TDI.
Plasterboard Industry Victoria, Australia	Commissioned by Boral Plasterboard, CSR Plasterboard and Lafarge Plasterboard to conduct an extensive stack emission monitoring programme at three manufacturing sites, to establish emission factors for subsequent NPI use. Emission tests conducted on dryer, oven, mill and calciner exhausts included ammonia, BTEX, CO, chlorine, hydrogen chloride, dioxins/furans, formaldehyde, metals, methane, NO_x, TSP, PM_{10}, PAHs, SO_2, SO_3 and VOCs.
Department of Environment Queensland, Australia	Prepared the Queensland Department of Environment Air Quality Sampling Manual for subsequent publication.
Aluminium Development Council NSW, Australia	Project management of study to evaluate laser instrument for measuring HF emissions in primary aluminium smelting potroom roof ridge vents, including field trials to determine characteristics of individual pot plumes and compare results against a cassette sampling method over a 400m path length.

PROJECT EXPERIENCE – AIR POLLUTION CONTROL EQUIPMENT

Nuplex Industries Victoria, Australia	Pilot scale control equipment trials, specification of wet chemical packed bed scrubbing system for the control of odorous emissions to air from various sources in the alkyd resin manufacturing process.
Dynamic Fertilisers Victoria, Australia	Pilot scale control equipment trials, process design, specification and commissioning of incineration system for the control of odorous emissions to air from the poultry manure dryer.
Aspen ByProducts Victoria, Australia	Pilot scale control equipment trials, process design, specification and commissioning of wet chemical packed bed scrubbing system for the control of odorous emissions to air from various sources in the sausage casings manufacturing process.
Philip Morris Victoria, Australia	Pilot scale control equipment trials, process design and commissioning of wet chemical packed bed scrubbing system for the control of odorous emissions to air from various sources in the cigarette manufacturing process.
Riverland Oilseed Processors Victoria, Australia	Pilot scale control equipment trials, process design and specification of wet chemical packed bed scrubbing system for the control of hydrogen sulphide emissions to air from the oilseed solvent extraction process.
Nylex Victoria, Australia	Process design and specification of incineration system for the control of odorous emissions to air from the polypropylene/wood flour extrusion process. Conduct of pilot scale Odorgard scrubbing trials on a process exhaust serving PVC calendering equipment.
Bridgestone Australia Victoria, Australia	Pilot scale control equipment trials, process design and specification of wet chemical packed bed scrubbing system for the control of odorous emissions to air from the rubber underlay Banbury mixing and curing processes.
Horizon APC Victoria, Australia	Conducted pilot scale wet chemical packed bed scrubbing trials designed to evaluate the performance of two mass transfer packing materials in removing SO_2 from an air stream, utilising a number of scrubbing liquors.

PROJECT EXPERIENCE – INDOOR AIR QUALITY MONITORING

Dept. of Environment and Heritage Australia	Conducted the largest indoor air quality study undertaken in Australia, evaluating the impact of unflued gas appliances in domestic residences located in Sydney, Melbourne, country Victoria and Canberra. Indoor air quality was determined through measurement of; indoor concentrations of NO_2, NO, CO, CO_2 and formaldehyde, outdoor concentrations of NO_2 and NO; indoor temperature and relative humidity; ventilation rate and ambient meteorological parameters.
Manufacturer Victoria, Australia	Assessment of general indoor air quality in office space through monitoring of CO_2, ozone, total colony forming units (TCFU) and formaldehyde concentrations.
Government Dept. Victoria, Australia	Indoor air quality assessment at two Victorian Government offices to determine employee exposure to TCFU, MEK, MIBK, toluene, formaldehyde and CO.
Municipal Council Victoria, Australia	Monitoring of airborne asbestos fibre levels in public swimming pool area, with assessment of health risk and control strategies.
Municipal Council Victoria, Australia	Monitoring of airborne asbestos fibre levels in Council office buildings and airborne fungal spore contamination of a public building. Assessment of health risk and control strategies.

Municipal Council Victoria, Australia	Indoor air quality assessment to determine public exposure to Legionella sp., TCFU and TSP.
Shopping Centre Victoria, Australia	Monitoring of CO concentrations in a car park to assess public and employee health risk.
Municipal Council Victoria, Australia	Assessment of employee exposure to airborne asbestos fibres and TSP. Identification of particulate matter chemical composition.
Employee Union Victoria, Australia	Monitoring of CO_2, CO, TSP, formaldehyde and TCFU concentrations in an office building to assess employee health risk.

PROJECT EXPERIENCE – WORKPLACE EXPOSURE ASSESSMENTS

Manufacturer Victoria, Australia	Monitoring and health risk assessment of electroplating plant operator exposure to chromic acid mist.
ANL Australia	Identification, monitoring and assessment of employee exposure to airborne asbestos fibres on all ships working in Australian waters. Recommendations for handling procedures.
	Assessment of heat stress potential for employees located in a ship's engine room.
Closure Manufacturer Victoria, Australia	Workplace noise survey to determine employee noise exposure. Recommendations for equipment noise control and employee hearing protection.
	Monitoring and health risk assessment of employees exposed to organic solvents in the lithographic metal printing process.
Container Glass Manufacturer Victoria, Australia	Workplace noise survey to determine employee noise exposure. Recommendations for equipment noise control and employee hearing protection.
	Monitoring and risk assessment of employees exposed to sodium hydroxide mist during caustic cleaning operations.
Phenolic Resin Manufacturer Victoria, Australia	Monitoring and health risk assessment of employees exposed to phenol and formaldehyde. Recommendations for modified handling procedures, installation of an exhaust ventilation system and air pollution control equipment.
Grain Shipping Terminal Victoria, Australia	Assessment of airborne concentrations of crystalline silica, respirable dust and inhalable dust, together with recommendations for control and medical surveillance.
Paint and Allied Coating Manufacturer Victoria, Australia	Monitoring and health risk assessment of employees exposed to organic solvents. Review of materials handling procedures and employee work practices.
	Detailed design of exhaust ventilation systems for powder and solvent handling throughout the manufacturing process.
Chemical Manufacturer Victoria, Australia	Monitoring and assessment of employee exposure to acrylamide dust. Recommendations for modified handling procedures.
	Monitoring and assessment of employee exposure to acrylonitrile.
Chemical Manufacturer Victoria, Australia	Monitoring and health risk assessment of employee exposure to organic and inorganic pigment dust and aromatic amines. Detailed design of exhaust ventilation system to minimise employee exposure to airborne dust.

Pharmaceutical Manufacturer Victoria, Australia	Workplace noise survey to determine employee noise exposure.
Electronic Circuit Board Manufacturer ACT, Australia	Assessment of employee exposure to ammonia, ozone, sulphuric acid mist, copper mist, synthetic mineral fibres, cyanide, potassium hydroxide mist, nickel mist and tin.
Powder Coatings Manufacturer Victoria, Australia	Workplace noise and inhalable dust survey.
Automotive Component Manufacturer Victoria, Australia	Monitoring of employee exposure to styrene monomer, xylene isomers, toluene, 1, 3-butadiene, particulate fluorides, hydrogen fluoride, refined mineral oil mist, inhalable dust, sodium hydroxide mist, methyl ethyl ketone, methyl isobutyl ketone, chromic acid mist, zirconium compounds, aluminium welding fume, nitric acid and phosphoric acid mist
Valspar Australia & New Zealand	Monitoring of employee exposure to noise and workplace atmospheric contaminants [respirable dust, inhalable dust, crystalline silica (α-quartz and cristobalite), metals, formaldehyde, isocyanates, ammonia and VOCs] at five manufacturing sites located throughout Australia and New Zealand.

PROJECT EXPERIENCE – ENVIRONMENTAL AND WASTE AUDITS

Akzo Nobel Victoria, Australia	Environmental Audit of resin, industrial coatings and powder coating manufacturing facility as supporting documentation for an Accredited Licensee application.
Australian Jockey Club NSW, Australia	Environmental Audit and Waste Audit of AJC activities at Randwick Racecourse. Preparation of Waste Management Plan to establish future policy and waste minimisation initiatives.
Terminals Victoria, Australia	Statutory Environmental Audits of the Coode Island bulk liquid storage facility during the period 2004 to the present, as one of the cornerstones of maintaining Accredited Licensee status. Conduct of Waste Audits and Bunding Audit and preparation of Waste Management and Stormwater Management Plans.
Orica Australia NSW, Australia	Mandatory Environmental Audit of the Orica Kooragang Island facility, under the requirements of the NSW *Protection of the Environment Operations Act 1997*. The Audit was considered to be the largest undertaken in Australia, with audit reports produced covering the Ammonia Plant, Nitric Acid Plants, Ammonium Nitrate Plants and the Remainder of Premises.
Harvey Norman Victoria, Australia	Auditor assessment of suitability of both DFTD process air pollution control equipment and site remediation environmental management associated with thermal treatment of PCB contaminated soil. Conduct of subsequent Proof of Performance Audit and Auditor review of on-going stack emission tests.
Yallourn Energy Victoria, Australia	Data Verification Audit of the summary statistics describing electricity generation, environmental performance, safety performance, employee training and community development.
Bruck Textiles Victoria, Australia	Statutory Environmental Audit of the Wangaratta textile manufacturing facility.

Collie Cooke
Victoria, Australia

Environmental Audit to assess the impact of residual air emissions from existing and proposed liquid ink operations, as required by the EPAV Buffer Distance guidelines.

Kalari Transport
Victoria, SA and NSW, Australia

Environmental Audits of bulk storage, materials handling and road transport operations at the Laverton North, Geelong, Portland, Adelaide and Sydney facilities.

Department of Environment
WA, Australia

Statutory Environmental Audit of Alcoa World Alumina Australia, Wagerup refinery to review ambient air quality and stack emission monitoring programmes, and subsequent community consultation on audit outcomes.

PROJECT EXPERIENCE – AIR QUALITY MODELLING

Gippsland Water
Victoria, Australia

Commissioned to assess air quality impacts associated with process emissions to air and fugitive emissions from material handling operations for soil and organic recycling facility (SORF) Stages 1 to 3. SORF Stages 1 and 2 included the treatment of contaminated soil by in-vessel and windrow composting. SORF Stage 3 proposed contaminated soil treatment by LPG fired indirect thermal desorption. Contaminants modelled included PM_{10}, NO_2, CO, dioxins/furans, PAHs, PCBs, OCPs, benzene, odour and insoluble solids deposition.

Uranium Mine
WA, Australia

Preparation of Air Quality and Noise Monitoring Plans for a proposed uranium mine and project management of background ambient air quality monitoring (insoluble solids deposition, PM_{10}, $PM_{2.5}$ and heavy metals), background noise monitoring and mathematical modelling programmes for air quality (TAPM and AERMOD) and noise (CadnaA).

Yallourn Energy
Victoria, Australia

Project management of environmental monitoring and modelling assessments for the Maryvale Coal Field Development Project, during both the Morwell River diversion construction phase and Maryvale field mining operations. Conduct of PM_{10}, dust deposition and environmental noise monitoring in adjoining residential areas. Development of an emissions inventory and conduct of air quality (PM_{10}) and noise modelling, for both construction and development scenarios.

Port of Portland
Victoria, Australia

Port of Portland proposed construction of a hardwood chip storage and handling facility, the largest in the southern hemisphere with a capacity of 3 million tonnes per annum. Measurement of background concentrations of PM_{10}, $PM_{2.5}$ and dust deposition rates in the Portland township, due to existing sources

Conduct of PM_{10} and $PM_{2.5}$ air quality monitoring, upwind and downwind of various sources at an existing woodchip handling facility in Albany, WA, with subsequent back calculation of emission rates utilising Gaussian plume dispersion modelling techniques. Conduct of emission isolation flux chamber monitoring on the hardwood chip stockpile and leachate pond at the Albany facility, to measure the rate of odour emitted per unit area

Development of a mathematical model to predict PM_{10} and $PM_{2.5}$ concentrations and odour levels at various locations within the Portland township, with a subsequent evaluation against derived quality criteria and recommendations for best practice dust control measures.

Mining Company
Fiji

Technical management of air quality (CALPUFF), noise (CadnaA) and vibration environmental impact assessments for a proposed copper and gold mine in Fiji.

Port of Moresby
Papua New Guinea

The Papua New Guinea Government propose relocation of the Port of Moresby to the Motukea International Wharf site to accommodate growing national shipping needs and as part of strategic urban development of the Port Moresby Central Business District. Technical management of air quality, noise and vibration impact assessments.

Crocodile Gold Corporation
Victoria, Australia

Independent Technical Review of the Environmental Effects Statement for the Big Hill Enhanced Development Project on behalf of the Department of Transport, Planning and Local Infrastructure and the Technical Reference Group, with presentation of the TAPM and CALPUFF review findings during the public EES Inquiry.

Fonterra
Victoria, Australia

Odour audit, odour emission monitoring and AERMOD modelling study of wastewater treatment plant located at Dennington milk processing facility, Warrnambool. Presentation of expert evidence at Planning Panel hearing on proposed residential subdivision.

PROJECT EXPERIENCE – GOVERNMENT POLICY & PUBLICATIONS

Department of Environment
Malaysia

Project Advisor to the study team reviewing the Malaysian *Environmental Quality (Clean Air) Regulations*, as applied to industrial and other point source emissions. Assisted in determining the most appropriate technology for the control of industrial point source emissions, reviewing current emission standards and advising on monitoring techniques for new emission parameters.

EPA
Victoria, Australia

Commissioned by EPAV to prepare the document "*Best Practice Environmental Management Guidelines for the Fired Clay Building Products Industry*". The document was subsequently published in the EPAV Best Practice Environmental Management Series.

PROJECT EXPERIENCE – APPLICATIONS FOR WORKS APPROVAL

Various

Prepared in excess of 60 applications for works approval to install industrial plant and equipment, ranging in value up to $5.5 billion. The works approval application process is rigorous, involving the environmental assessment of noise, air emissions, greenhouse gas generation and waste discharges. Major projects have included:

- **West Gate Tunnel Project** – Project Director for preparation of application for works approval for installation of West Gate road tunnel ventilation systems. The application includes the assessment of air quality and noise impacts and the minimisation of greenhouse gas generation.
- **Terminals** - Redevelopment of the Coode Island chemical handling and bulk liquid storage facilities, including the installation of vapour collection and control systems; installation of dockside receiving and storage facility for 1,3-butadiene; installation of AVGAS storage facility.
- **Austral Bricks** - Installation of clay brick dryers and natural gas fired kiln.
- **Industrial Galvanizers** - Construction of hot dip galvanizing plant on greenfield site (air quality and noise impact assessments).
- **Select Harvests** - Establishment of an almond and nut processing facility, incorporating blanching, frying, roasting, refining, conching and grinding operations.
- **Sita Environmental Solutions** - Installation of a facility to process contaminated soil utilising direct fired thermal desorption and soil stabilisation techniques.
- **South Pacific Tyres** - Installations of; Banbury mixer, extruder, roller die and conveyor to augment existing rubber batching capacity; tractor tyre curing presses and Banbury mixer scrubbing equipment; establishment of precure tyre tread manufacturing facility; 3-roll fabric calenders, splice press, drying drum and twin mills for the processing of passenger tyre rubber batch.
- **Philip Morris** - Installations of dry ice expanded tobacco process for tobacco leaf expansion and improved stem process for tobacco stem expansion.
- **Insulation manufacturer** - Installation of phenol urea formaldehyde resin blending plant.
- **Paper manufacturer** – Installation of paper machine for tissue manufacture.
- **Tile manufacturer** - Installation of drier and natural gas fired kiln for the manufacture of ceramic wall tiles.
- **Printing company** - Installation of flexographic and gravure printing equipment, laminators and extrusion equipment.
- **Nylex** - Installations of; extruder for extrusion of corrugated polymer sheet; polymer sheet/foil co-extrusion line.
- **Pacific Dunlop** - Relocation of master batch Banbury mixing equipment and installation of high molecular weight oil and carbon black storage and transfer systems.

PROFESSIONAL AFFILIATIONS

Past President and Fellow: Clean Air Society of Aust. & New Zealand (CASANZ)

Past Chairperson: CASANZ Odour Special Interest Group

Past Chairperson: CASANZ Measurement Special Interest Group

Fellow: Air & Waste Management Association, USA

Fellow: Institution of Engineers Australia

Full Member: Australian Institute of Occupational Hygienists

Co-Chair: NATA Life Sciences Accreditation Advisory Committee

Chairperson: AS/NZS Committee EV-007 *Methods for Examination of Air*

Chairperson: AS Committee EV-007-1 *Stationary Source Emission Testing*

Chairperson: AS Sub-Committee EV-007-3-1 *Odour Measurement Test Method*

Sessional Member: Victorian Civil and Administrative Tribunal

Technical Expert: National Association of Testing Authorities

Technical Expert: International Accreditation New Zealand

Technical Expert: Hong Kong Accreditation Service

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APPENDIX C

TECHNICAL REPORT G CORRECTIONS

Table 101: Combined impacts: Scenario A (2022)

Pollutant	Units	Averaging period	Maximum predicted GLC[1]	Objective / standard[2]	Receptor ID	Contribution to maximum predicted GLC		
						Tunnel ventilation	Surface roads	Background
PM_{10}	$\mu g/m^3$	24 Hour	**61**	50	1	0.034	2.9	58
		Annual	19	20	14	0.068	1.3	18
$PM_{2.5}$	$\mu g/m^3$	24 Hour	**26**	25	1	0.023	2.8	23
		Annual	7.4	8	1	0.022	1.2	6.1
CO	mg/m^3	8 Hour	1.6	10	4	0.00051	0.27	1.3
NO_2	$\mu g/m^3$	1 Hour	130	225	14	0.10	31	120
		Annual	28	56	14	0.10	6.4	21
Benzene	$\mu g/m^3$	Annual	4.0	10	1	0.0037	1.2	2.8
Toluene	$\mu g/m^3$	24 Hour	54	4100	14	0.017	6.6	47
		Annual	27	410	1	0.0073	2.3	7.6
Ethylbenzene	$\mu g/m^3$	Annual	2.9	NA	1	0.0028	0.52	2.4
Xylene isomers	$\mu g/m^3$	24 Hour	29	1200	14	0.017	6.4	22
		Annual	9.9	950	1	0.0073	2.3	7.6
Formaldehyde	$\mu g/m^3$	24 Hour	7.9	54	1	0.0063	1.4	6.4
PAHs [as B(a)P TEQ]	$\mu g/m^3$	Annual	0.00018	0.0003	14	<0.000005	0.000036	0.00014

Notes:
NA Not available
1 99.9^{th} percentile for 1 hour average and 100^{th} percentile for remaining averages
2 For comparison only

Table 102: Combined impacts: Scenario B (2031)

Pollutant	Units	Averaging period	Maximum predicted GLC[1]	Objective / standard[2]	Receptor ID	Contribution to maximum predicted GLC		
						Tunnel ventilation	Surface roads	Background
PM_{10}	$\mu g/m^3$	24 Hour	**62**	50	14	0.12	3.3	58
		Annual	19	20	14	0.090	1.5	18
$PM_{2.5}$	$\mu g/m^3$	24 Hour	**26**	20[3]	14	0.081	3.1	23
		Annual	**7.6**	7[3]	14	0.055	1.4	6.1
CO	mg/m^3	8 Hour	1.6	10	4	0.00063	0.30	1.3
NO_2	$\mu g/m^3$	1 Hour	140	225	14	0.12	35	100
		Annual	29	56	14	0.13	7.7	21
Benzene	$\mu g/m^3$	Annual	4.1	10	1	0.0045	1.3	2.8
Toluene	$\mu g/m^3$	24 Hour	55	4100	14	0.022	7.6	47
		Annual	27	410	1	0.0090	2.6	25
Ethylbenzene	$\mu g/m^3$	Annual	3.0	NA	1	0.0034	0.58	2.4
Xylene isomers	$\mu g/m^3$	24 Hour	30	1200	14	0.021	7.4	22
		Annual	10	950	1	0.0089	2.5	7.6
Formaldehyde	$\mu g/m^3$	24 Hour	8.1	54	14	0.0064	1.7	6.4
PAHs [as B(a)P TEQ]	$\mu g/m^3$	Annual	0.00018	0.0003	14	<0.000005	0.000041	0.00014

Notes:
NA Not available
1 99.9th percentile for 1 hour average and 100th percentile for remaining averages
2 For comparison only
3 SEPP(AAQ) 2025 revised objective

Table 103: Combined impacts: sensitivity analysis - 2031 maximum tunnel capacity (three lanes)

Pollutant	Units	Averaging period	Maximum predicted GLC[1]	Objective / standard[2]	Receptor ID	Contribution to maximum predicted GLC		
						Tunnel ventilation	Surface Roads	Background
PM_{10}	$\mu g/m^3$	24 Hour	**62**	50	14	0.41	3.3	58
$PM_{2.5}$	$\mu g/m^3$	24 Hour	**26**	20[3]	14	0.28	3.1	23
CO	mg/m^3	8 Hour	1.6	10	4	0.0023	0.30	1.3
NO_2	$\mu g/m^3$	1 Hour	160	225	21	100	20	41
Toluene	$\mu g/m^3$	24 Hour	55	4100	14	0.094	7.6	47
Xylene isomers	$\mu g/m^3$	24 Hour	30	1200	14	0.090	7.4	22
Formaldehyde	$\mu g/m^3$	24 Hour	8.1	54	14	0.032	1.7	6.4

Notes:
NA Not available
1 99.9^{th} percentile for 1 hour average and 100^{th} percentile for remaining averages
2 For comparison only
SEPP(AAQ) 2025 revised objective