28 August 2025

To	Main Roads	**Contact No.**	08 6222 8977
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From	GHD Pty Ltd	**Project No.**	12670915
Project Name	Perth Entertainment and Sporting Precinct		
Subject	Air Quality Risk Assessment		

1. Introduction

The Perth Entertainment and Sporting Precinct (the project) is proposed to be a new multi-use entertainment and sporting precinct in Burswood Park, as shown in Figure 1.1.

GHD Pty Ltd (GHD) was engaged by Main Roads WA (MRWA) to prepare an air quality risk assessment. The air quality risk assessment includes an assessment of air emissions associated with a three day Supercars event.

Figure 1.1 Project boundary (shown in black outline)

1.1 Scope of work

The purpose of this memorandum is to undertake an air quality risk assessment associated with a three day Supercars event at the project as well as qualitative assessment of air emissions from construction of the project.

1.2 Limitations

This memorandum has been prepared by GHD for Main Roads WA and may only be used and relied on by Main Roads WA for the purpose agreed between GHD and MRWA as set out in Section 1.1 of this memorandum.

GHD otherwise disclaims responsibility to any person other than Main Roads WA arising in connection with this memorandum. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this memorandum were limited to those specifically detailed in the memorandum and are subject to the scope limitations set out in the memorandum.

GHD has prepared this memorandum on the basis of information provided by Main Roads WA and others who provided information to GHD (which may also include Government authorities), which GHD has not independently verified or checked for the purpose of this memorandum. GHD does not accept liability in connection with such unverified information, including errors and omissions in the memorandum which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this memorandum are based on conditions encountered and information reviewed at the date of preparation of the memorandum. GHD has no responsibility or obligation to update this memorandum to account for events or changes occurring subsequent to the date that the memorandum was prepared.

The opinions, conclusions and any recommendations in this memorandum are based on assumptions made by GHD and described in this memorandum (refer Section 1.3 of this memorandum). GHD disclaims liability arising from any of the assumptions being incorrect and liability for any decisions taken by Main Roads WA as a consequence of GHD recommendations.

If this memorandum is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

1.3 Assumptions

This assessment assumes the following:

– All information provided by MRWA to GHD is correct at the time of issue.
– The event schedule and car fleets are correct at the time of issue.
– Emission estimates were based on the most reliable and representative available information.
– Air quality modelling was not undertaken for this assessment, as it was considered unnecessary.

2. Project background

2.1 Construction

The construction phase of the project will be undertaken in two phases:

– Early works (Pre-loading) - Phase 1 will involve demolition of existing structures (footpaths, roads etc.), ground improvement (pre-loading), topsoil and tree removal and bulk earthworks.
– Phase 2: Construction of the track, roads, footpaths, building and amphitheatre.

2.2 Operations

The operations phase of the project includes:

– A new outdoor amphitheatre for live music and other events.
– A multi-use track, including for use by FIA approved Supercars, cycling criterium and community sport.
– A multi-purpose building, including event and function facilities and meeting spaces.

The proposed details of the Supercars event is presented in Table 2.1.

Table 2.1 Supercars event detail

Day	Race series	Number of laps	Number of vehicles
Friday	Aussie race cars	17	32
	Touring car masters	17	30
	Toyota 86	17	34
	Dunlop Super2 series	42	22
	Superutes	17	18
	Aussie race cars	17	32
	Supercars (practice/qualifying)	17	26
	Touring car masters	17	30
	Dunlop Super2 series	42	22
	Toyota 86	17	34
	Superutes	17	18
	Supercars (practice/qualifying)	7	26
	Dunlop Super2 series	26	22
	Supercars (practice/qualifying)	7	26
Saturday	Aussie race cars	17	32
	Touring car masters	17	30
	Toyota 86	17	34
	Superutes	17	18
	Aussie race cars	17	32
	Touring car masters	17	30
	Dunlop Super2 series	16	22
	Supercars (practice/qualifying)	7	26

Day	Race series	Number of laps	Number of vehicles
	Toyota 86	17	34
	Superutes	17	18
	Aussie race cars	17	32
	Dunlop Super2 series	31	22
	Supercars	125	26
Sunday	Touring car masters	17	30
	Toyota 86	17	34
	Superutes	22	18
	Aussie race cars	17	32
	Supercars (practice/qualifying)	7	26
	Dunlop Super2 series	16	22
	Touring car masters	17	30
	Toyota 86	17	34
	Supercars (practice/qualifying)	7	26
	Superutes	17	18
	Dunlop Super2 series	31	22
	Supercars	125	26

Three different fuel types will be used across the event; EF75, Elf Race 102 and 98RON.

The EF75 fuel will be used for the Supercars race series and the Dunlop Super2 series. The EF75 fuel is a new lower carbon race fuel created by bp, the official fuel supplier, and “contains more than 80 percent of second generation fuel components that are sourced from renewable feedstocks”, significantly reducing the emissions compared to traditional race fuels (bp, n.d.).

The fuel composition of both the Elf Race 102 and 98RON fuel is 100 percent petrol and will be used across the other race series in the event.

3. Air quality risk assessment

3.1 Key pollutants of concern

The key pollutants emitted from racing events include exhaust emissions, including carbon monoxide (CO), nitrogen oxides (NO_x), sulphur dioxide (SO_2), unburned hydrocarbons (HC) and particulate matter (PM). Combustion processes generally also release air toxics, including volatile organic compounds (VOCs), primarily hydrocarbons such as benzene, toluene, xylenes, polycyclic aromatic hydrocarbons (PAHs) and aldehydes. In addition, heavy metals and formaldehyde are also emitted during combustion (Queensland Government, n.d.).

Race cars are typically not required to have emission controls like catalytic converters or particulate filters, as they are designed for competition and not suitable for road use. However, the higher emissions generally are short-lived, due to the limited timing of the events. The *National Environmental Protection (Air Toxics Measure*) (NEPC, 2011) prescribes a criteria for benzene, formaldehyde, benzo(a)pyrene (as a marker for PAHs), toluene and xylenes and have a 24-hour or annual averaging period and are unlikely to be exceeded for the short term Supercars event scheduled once a year.

Supercars race series has transitioned to ethanol blends, with current racing fuel being EF75 which is composed of 75 percent ethanol, 10 percent synthetic petrol and 15 percent premium pump petrol (Speedcafe, 2023). Ethanol blends like E85 have been associated with lower emissions of harmful toxins compared to petrol (U.S. Department of Energy, n.d.). However, it may also be associated with increased levels of acetaldehyde (CH_3CHO) emissions (U.S. Department of Energy, n.d.). Hence, acetaldehyde emissions were estimated for the racing events along with key pollutants like NO_x, SO_2 and PM.

3.2 Existing environment

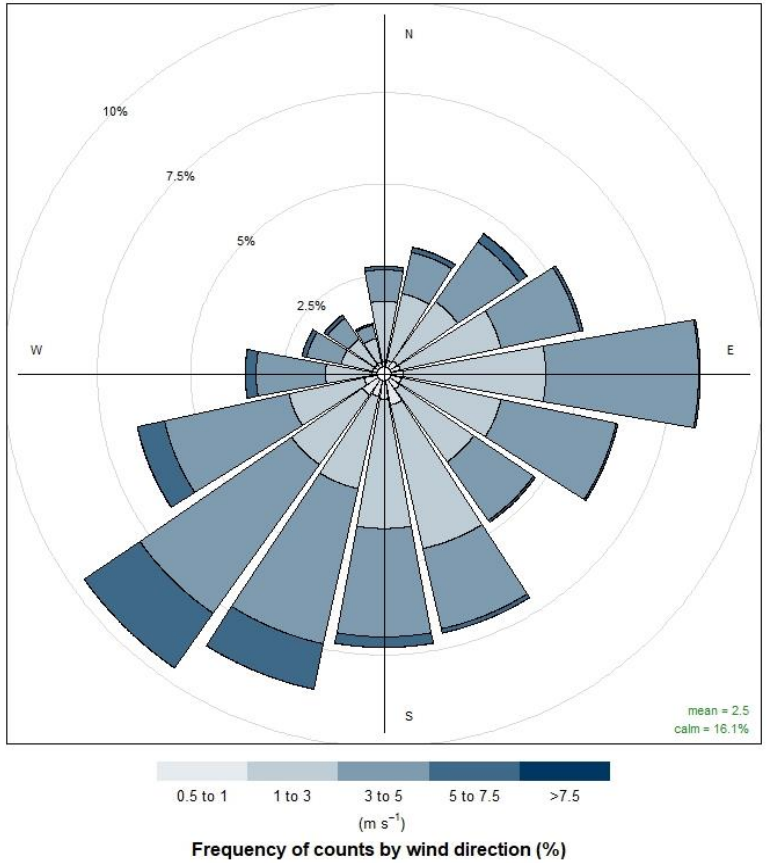
3.2.1 Land use and topography

The project is surrounded by residential apartments and parks located to the east, with the closest residential area located approximately 80 m to the east of the project. The project is also surrounded by sport centres with the Tennis West Centre located approximately 70 m to the north-east and Matgarup Minigolf approximately 170 m to the west of the project. Optus Stadium is located approximately 190 m to the north-west of the project.

3.2.2 Meteorology

Bureau of Meteorology (BoM) operates the Perth Metro weather station (station ID: 009225), located approximately four kilometres to the north-west of the project. The station has been operational since 1994 and monitors for a range of weather observations, including wind speed and direction. A summary of annual and seasonal wind behaviour over five years from 2020 to 2024 is shown in Figure 3.1. Apart from autumn, seasonal winds are predominantly from south-west direction. Autumn months are characterised by wind predominantly from the east. The average wind speed is 2.5 m/s with a proportion of calm winds being 16 percent (<0.4 m/s).

Annual



Seasonal

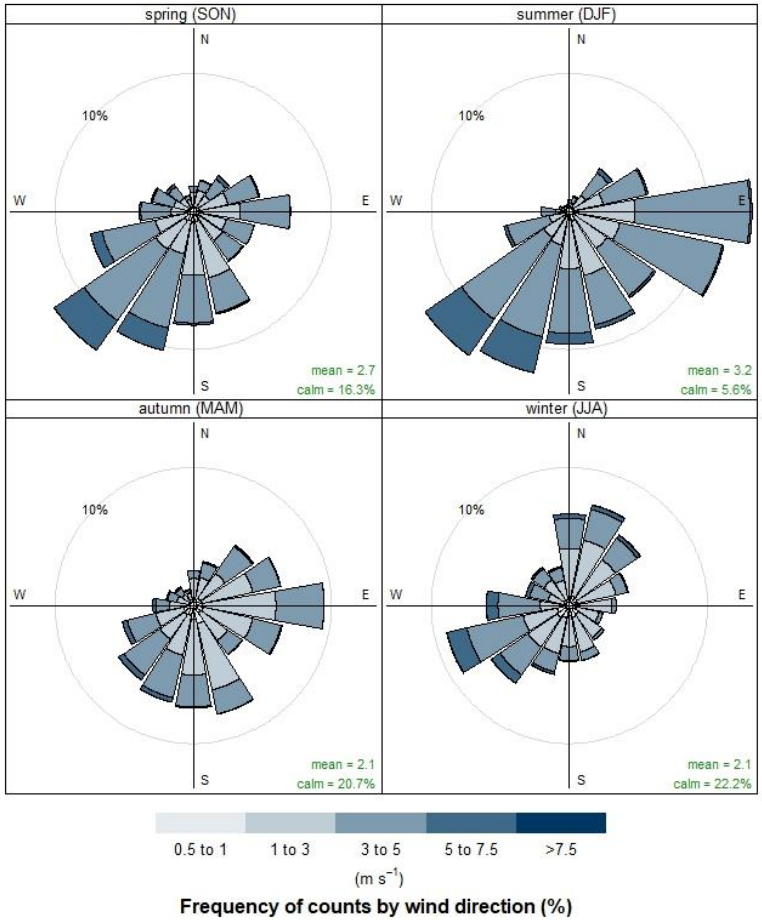


Figure 3.1 Wind data for 2020 – 2024 (Perth Metro BoM station ID: 009225)

3.2.3 Sensitive receptors

A sensitive receptor is defined as “places where people live or regularly spend time, and which are therefore sensitive to emissions from industry with implications for human health or amenity. They include, but are not limited to, residences, healthcare establishments, places of accommodation, places of study, childcare facilities, shopping centres, places of recreation and some public buildings” (DWER, 2021). The sensitive receptor sites were provided to GHD by MRWA and are presented in Table 3.1 and Figure 3.2.

Table 3.1 Sensitive receptor locations

Receptor address	Number of floors	Distance to carriageway (m)
39 Bow River Cres	4	90
20-32 The Promenade	2	100
2 -18 The Promenade	2	120
23 Bow River Cres	4	140
38-50 Bow River Cres	2	150
19 The Circus, Burswood	20	230
96 Bow River Cres	19	230
30 The Circus	20	250
26 Bow River Cres	20	260

Figure 3.2 Sensitive receptors identified for the project

3.2.4 Existing ambient air quality

There is no DWER air quality monitoring site located adjacent to the project. The closest monitoring sites are in Duncraig and Caversham which are not considered representative of air quality around the project.

The region around Caversham monitoring station is a mix of land uses, including semi-rural areas with lower traffic volumes and different land use patterns (e.g. open areas). Burswood is an urban area in Perth, surrounded by major roads, with road vehicle emissions being the dominant pollution source. The monitoring data would be underestimated if obtained from Caversham.

3.3 Construction assessment

This section outlines the qualitative assessment of emissions from the construction of the project. Potential air quality impacts include heavy vehicle exhaust emissions during earthworks and wind erosion from disturbed soil surfaces.

Gaseous emissions from heavy machinery and equipment during construction would consist of products of combustion including NO_x, SO_2, PM_{10} and volatile organic compounds. It is anticipated that these emissions would be discontinuous, varied in location and short lived, and as such are not considered to represent a significant source of air pollution.

Dust also has the potential to be generated during construction activities, primarily from clearing of vegetation, earthmoving and dust lift off from cleared areas under elevated wind speeds. However, these emissions are also anticipated to be short lived and can be reduced or managed by:

– Dust suppression techniques like watering of exposed areas under meteorological conditions of elevated wind speeds
– General housekeeping practices to ensure no accumulation of waste materials within the construction area that may generate dust

3.4 Event assessment

Event details including type of race series, fuel type per race series, number of laps and cars were provided by MRWA and are presented in Table 2.1. GHD reviewed this information to identify the day with potential for worst case emissions. Saturday was chosen as the worst case emission scenario due to maximum number of race series and maximum number of laps for Supercars series.

Emissions were estimated based on:

– Approximate circuit length of three kilometres
– Average race car speed of 140 km/hr
– The eligible vehicles of Toyota86 series are Toyota 86 GT and Toyota 86 GTS (Motorsport Australia, 2024), which are both registered for road use and therefore comply with current Australian Design Rule (ADR) emission requirements. Emissions are assumed to be negligible for this race series.
– Among air toxics, only acetaldehyde emissions were estimated as ethanol blends are primarily associated with increase in acetaldehyde emissions (U.S. Department of Energy, n.d.).
– Fuel type used for different race series as provided by MRWA as presented in Table 3.2.
– Assumptions relating to vehicles using 98RON or ELF Race 102 fuel include:
    - NO_x emissions are similar to that of ADR 36/00 vehicles which are not equipped with catalytic converters. Emission data was obtained from *Comparative Vehicle Emissions Study* (Department of Transport and Regional Services, 2001) and is based on average emissions performance of ADR36/00 vehicles as a percentage of the ADR79/01 (Euro 3) limit.
    - Acetaldehyde emissions are based on the relevant speciation factor applied to volatile organic compounds emission factor for exhaust from petrol vehicles as per the NPI *Emissions estimation technique manual for aggregated emissions from motor vehicles* (Environment Australia, 2000).
    - SO_2 emissions and PM emissions assumed to be similar to road fleet. Emission data was obtained from emission factors (kg/km) for road transport petrol vehicles as per the NPI *Emission estimation technique manual for combustion engines* (Department of the Environment, Water, Heritage and the Arts, 2008).
– Assumptions relating to vehicles using EF75 fuel include:
    - No data specific to EF75 fuel was available. Hence emissions profile was assumed to be similar to E85 fuel.
    - E85 fuel is generally associated with decrease in NOx emissions (-45 percent) and increase in acetaldehyde emissions in comparison to reference fuels with no ethanol (Graham, Belisle, & Baas, 2008). Emission data for E85 fuel was derived by applying this difference to above emission rates for vehicles using 98RON or ELF Race 102 fuel.
    - SO_2 emissions and PM emissions assumed to be similar to road fleet. Emission data was obtained from emission factors (kg/km) for road transport petrol vehicles as per the NPI *Emission estimation technique manual for combustion engines* (Department of the Environment, Water, Heritage and the Arts, 2008).

A summary of emissions factors used for the assessment is presented in Table 3.2.

Table 3.2 Emission inventory

Race series	Fuel type	Emission factors			
		NO_x (g/km)	SO_2 (g/km)	PM (g/km)	CH_3CHO (g/km)
Aussie race cars	98RON	2.55	0.012	0.01	0.01
Touring car masters	Elf Race102	2.55	0.012	0.01	0.01
Superutes	98RON	2.55	0.012	0.01	0.01
Dunlop Super2 series	EF75	1.40	0.012	0.01	0.14
Supercars	EF75	1.40	0.012	0.01	0.14

While the emission factors above were used for emissions estimation, it should be noted that there are several limitations due to lack of data available in relation to motorsport events. The assumption that emissions for vehicles with 98RON and ELF Race 102 are similar to that of ADR 36/00 vehicles without catalytic converters may not be reflective of actual emissions from motorsport events as the testing for the study was based on “real world” driving conditions. Also, the emission data for ADR36/00 vehicles was based on testing a very small sample of vehicles and had considerable variability in test results.

Similarly, although NO_x emissions for vehicles using EF75 blend fuel are assumed to be lower, there is considerable variability and inconsistencies in findings regarding emissions from ethanol blends. The studies by Koç et al. (2009) and Zhai H et al. (2012) found decreased NO_x emissions for E85 fuel in comparison to petrol with no ethanol. The study by S. Varde & Manoharan (2009) showed slight decrease in NO_x emissions with E85 fuel as compared to petrol which was more noticeable at higher engine load and exhaust recirculation rate. However, study by Vojtisek-Lom et al. (2013) showed increase in NO_x emissions associated with use of E85 fuel in an ordinary petrol car as opposed to petrol.

Similarly, there are inconsistent findings regarding HC emissions from ethanol blends. The study by Zhai H et al. (2012) found that E85 fuel is associated with increase in HC tailpipe emissions similar to S. Varde & Manoharan (2009) who found that difference was more pronounced at lower engine loads and higher exhaust recirculation rate. The study by Vojtisek-Lom et al (2013) showed no effects on HC emissions associated with use of E85 fuel in ordinary petrol car as opposed to petrol. However, the study by Koç et al. (2009) found that use of E85 fuel was associated with lower HC emissions as compared to petrol with no ethanol. Other air toxics like non methane hydrocarbons, 1,3 – butadiene and benzene are generally observed to be lower for E85 fuel as opposed to reference fuels with no ethanol (Graham, Belisle, & Baas, 2008). Although, E85 fuel is associated with an increase in formaldehyde emissions, this is much lower when compared to change in acetaldehyde emissions (Graham, Belisle, & Baas, 2008).

It should also be noted that race car engines are tuned for the particular fuel properties, and as such without actual emission test data, it is difficult to estimate the emissions from race cars based on testing completed on road vehicles operating on comparable (E85) fuels, as road vehicles are likley not tuned to take advantage of the specific fuel properties. Hence these limitations should be noted while interpreting emissions from the event.

A summary of estimated emissions for the different race series are presented in Table 3.2.

Table 3.3 Estimated emissions for racing events (Saturday)

Race series	Number of race series per day	Number of laps per race series	Number of vehicles per race series	NOx per race series (g/s/km)	SO_2 per race series (g/s/km)	PM per race series (g/s/km)	CH_3CHO per race series (g/s/km)
Aussie race cars	3	17	32	0.4	0.002	0.001	0.001

Race series	Number of race series per day	Number of laps per race series	Number of vehicles per race series	NOx per race series (g/s/km)	SO_2 per race series (g/s/km)	PM per race series (g/s/km)	CH_3CHO per race series (g/s/km)
Touring car masters	2	17	30	0.4	0.002	0.001	0.001
Superutes	2	17	18	0.2	0.001	0.001	0.0005
Dunlop Super2 series	1	16	22	0.1	0.001	0.001	0.01
Supercars (practice/qualifying)	1	7	26	0.1	0.001	0.0004	0.01
Dunlop Super2 series	1	31	22	0.3	0.002	0.002	0.03
Supercars	1	125	26	0.5	0.004	0.003	0.05

Emissions were also estimated for vehicle count during peak hour at 4:00 pm on Saturday 24 June 2023 at the intersection of Victoria Park Drive and Roger Mackay Drive for a comparison point. The emissions were estimated using factors from NPI *Emission estimation technique manual for combustion engines* (Department of the Environment, Water, Heritage and the Arts, 2008). These emissions are presented in Table 3.4. It should be noted that these emissions are estimated values and does not reflect actual monitoring data.

Table 3.4 Emissions at road intersection over one km (Saturday)

Road intersection	NO_x (g/s/km)	SO_2 (g/s/km)	PM (g/s/km)	CH_3CHO (g/s/km)
Victoria Park Drive and Roger Mackay Drive	0.4	0.01	0.004	NA

A summary of total estimated emissions for the different race series in comparison to the road intersection is also provided in Table 3.5. The peak hour emissions were replicated over 12 hour period for comparison.

Table 3.5 Total emissions during Saturday event

Race series	Number of race series per day	Number of laps per race series	Number of vehicles per race series	NOx per race series (g)	SOx per race series (g)	PM per race series (g)	CH_3CHO per race series (g)
Aussie race cars	3	17	32	12,443	57	39	9
Touring car masters	2	17	30	7777	36	24	8
Superutes	2	17	18	4666	21	15	5
Dunlop Super2 series	1	16	22	1476	12	8	151
Supercars (practice/qualifying)	1	7	26	763	6	4	78
Dunlop Super2 series	1	31	22	2860	24	16	292
Supercars	1	125	26	13,629	114	78	1390
Total emissions							
Total emissions over 12 hour period during race day				**43,614**	**270**	**186**	**1963**

Race series	Number of race series per day	Number of laps per race series	Number of vehicles per race series	NOx per race series (g)	SOx per race series (g)	PM per race series (g)	CH_3CHO per race series (g)
Total emissions at road intersection over 12 hour period assuming peak hour traffic at all hours				**50,835**	**743**	**510**	-

It is observed that the estimated emissions for the race series are comparable to those at the intersection although CH_3CHO emissions could not be estimated for the intersection.

It should be noted that HC emissions are dependent on design variables like combustion chamber and induction system design as well as operating variables like air-fuel ratio, speed and load (Koç, Sekmen, Topgül, & Yücesu, 2009). Additionally higher engine speeds are associated with increased turbulence intensity increases which allows for improved air-fuel mixing process and more complete combustion, which in turn reduces HC emissions (Koç, Sekmen, Topgül, & Yücesu, 2009). NO_x emissions are dependent on the peak temperatures achieved during combustion and may change based on operating conditions (Koç, Sekmen, Topgül, & Yücesu, 2009). This reiterates that the emissions profile for motorsport events could be completely different to the currently available data.

3.5 Air quality risk summary

A qualitative assessment was conducted for construction of the project and emissions estimation was conducted for the event to determine risk of air emissions. Construction emissions are considered to be of minimal risk due to the nature of emissions being short lived. Emissions from the event are comparable to that at the intersection except for acetaldehyde. It should be noted that given the lack of available data these emissions may not be representative of realistic motorsport event emissions. Although emissions from the motorsport events may appear high, the impacts are short lived and of small magnitude as the race events are scheduled for only a few days annually. Hence, the risk of air emissions from the event is likely to be ‘low’.

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4. References

bp. (n.d.). *Supercars*. Retrieved from https://www.bp.com/en_au/australia/home/community/sponsorship/supercars.html

Department of the Environment, Water, Heritage and the Arts. (2008). *Emission estimation technique manual for Combustion engines Version 3.0.* Australian Government.

Department of Transport and Regional Services. (2001). *Comparative Vehicle Emissions Study.* Commonwealth Department of Transport and Regional Services.

DWER. (2021). *Guideline Dust Emissions.* Retrieved from Draft Guideline: Dust emissions

Environment Australia. (2000). *Emissions estimation technique manual for aggregated emissions from motor vehicles.*

Graham, L. A., Belisle, S. L., & Baas, C.-L. (2008). Emissions from light duty gasoline vehicles operating on low blend ethanol gasoline and E85. *Atmospheric Environment*, 4498-4516.

Koç, M., Sekmen, Y., Topgül, T., & Yücesu, H. S. (2009). The effects of ethanol–unleaded gasoline blends on engine performance and exhaust emissions in a spark-ignition engine. *Renewable Energy*, 2101-2106.

Motorsport Australia. (2024). *2025 TOYOTA GAZOO Racing Australia Scholarship Series Sporting & Technical Regulations.*

National Environment Protection Council (NEPC). (2011). *National Environment Protection (Air Toxics) Measure.*

Queensland Government. (n.d.). *Air Toxics*. Retrieved from Air Pollutants: https://www.qld.gov.au/environment/management/monitoring/air/air-pollution/pollutants/toxics

S. Varde, K., & Manoharan, K. N. (2009). Characterization of Exhaust Emissions in a SI Engine using E85 and Cooled EGR. *SAE Technical Paper 2009-01-1952.* Retrieved from https://doi.org/10.4271/2009-01-1952

Speedcafe. (2023). *Secrets of Gen3 'supergreen' fuel revealed*. Retrieved from https://speedcafe.com/secrets-of-gen3-supergreen-fuel-revealed/

U.S. Department of Energy. (n.d.). *Ethanol Vehicle Emissions*. Retrieved from Alternative Fuels Data Center: https://afdc.energy.gov/vehicles/flexible-fuel-emissions

Vojtisek-Lom, M., Pechout, M., & Mazac, M. (2013). Real-World On-Road Exhaust Emissions from an Ordinary Gasoline Car Operated on E85 and on Butanol-Gasoline Blend. *SAE Technical Paper 2013-24-0102.* Retrieved from https://doi.org/10.4271/2013-24-0102

Zhai, H., Frey, H., Rouphail, N. M., Gonçalves, G. A., & Farias, T. L. (2012). Comparison of Flexible Fuel Vehicle and Life-Cycle Fuel Consumption and Emissions of Selected Pollutants and Greenhouse Gases for Ethanol 85 Versus Gasoline. *Journal of the Air & Waste Management Association*.