Vehicle Emission Prediction Model: VEPM 6.1 update technical report

Prepared for

Waka Kotahi NZ Transport Agency

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Executive summary

Waka Kotahi NZ Transport Agency commissioned an update of key assumptions and emission factors in the Vehicle Emission Prediction Model (VEPM), which was last updated in 2019 (Sridhar and Metcalfe, 2019). These include:

- Changes to significantly reduce bulk run processing times and rationalise the spreadsheet model.
- Replacing all existing Euro emission factors with emission factors from the latest version of COPERT (the EU standard vehicle emissions calculator)
- Reviewing all correction factors
- Incorporating articulated truck emission factors and estimated VKT into VEPM
- Incorporating bus emission factors into VEPM
- Incorporating New Zealand real world fuel consumption correction factors for diesel passenger cars and diesel light commercial vehicles

Incorporation of articulated trucks in VEPM 6.1 has resulted in somewhat higher fleet weighted NOx and $PM_{2.5}$ emission factors. Fuel consumption factors in VEPM 6.1 are higher than VEPM 6.0 due to the incorporation of articulated trucks as well as real-world fuel consumption correction factors for diesel light duty vehicles.

Contents

1.0 Introduction

1.1 Background and scope

The Vehicle Emissions Prediction Model (VEPM) was developed by Waka Kotahi NZ Transport Agency (hereafter referred to as Waka Kotahi) and Auckland Council to predict emissions from vehicles in the New Zealand fleet under typical road, traffic and operating conditions. The model provides estimates suitable for air quality assessments and regional emissions inventories.

VEPM requires a detailed breakdown of kilometres travelled by the fleet. Fleet weighted emission factors are calculated by multiplying the emissions factors in g/km for each vehicle class by the proportion of kilometres travelled by that class for any given year.

Waka Kotahi commissioned Emission Impossible Ltd to update key assumptions and emission factors in VEPM. These include:

- Changes to significantly reduce bulk run processing times and rationalise the spreadsheet model.
- Replacing all existing Euro emission factors with emission factors from the latest version of COPERT (the EU standard vehicle emissions calculator)
- Incorporating articulated truck emission factors and estimated VKT into VEPM
- Incorporating bus emission factors into VEPM
- Incorporating New Zealand real world fuel consumption correction factors for diesel passenger cars and diesel light commercial vehicles

1.2 Purpose and scope of this report

This technical report:

- Provides details of the VEPM updates, including key assumptions
- Summarises the differences in fleet weighted emission factors between VEPM 6.0 and VEPM 6.1.

Further information and technical reports relating to development of the Vehicle Emission Prediction Model are available on the Waka Kotahi Highways Information Portal website.[1]

[1] https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/planning-and-assessment/vehicle-emissions-prediction-model/

2.0 VEPM Updates

Fleet weighted emissions are calculated in VEPM by multiplying the emissions factors in g/km for each vehicle category by the proportion of vehicle kilometres travelled (VKT) by that category for a defined year. VEPM is based on emissions from the European COPERT model, which are published by the European Environment Agency in a spreadsheet (EEA 2019b).

2.1 Spreadsheet and data processing improvements

Extensive changes were made to the VEPM 6.1 spreadsheet model to:

- Significantly reduce bulk run processing time,
- Rationalise various worksheets to make them easier to update and understand,
- Reduce the potential for errors,
- Fix a number of minor errors.

All changes are summarised in the *Changelog* worksheet of VEPM 6.1.

2.2 Vehicle fleet

Vehicle kilometres travelled (VKT) data is used in VEPM to calculate the proportions of VKT travelled for each vehicle category. Default VKT data in VEPM are from the Vehicle Fleet Emission Model (VFEM2), provided by Ministry of Transport. VKT data are unchanged from VEPM 6.0.

2.3 Emission factors and correction factors

We have checked for updates and new information for all emission factors and most correction factors in VEPM. Key outcomes were:

- All hot emission factors in VEPM 6.1 have been updated with the latest COPERT factors from the EMEP/EEA guidebook (EEA 2019b)
- A review of degradation factors (EMM 2020) concludes that the factors in VEPM are outdated. EMM considers it is likely that degradation factors in COPERT will be reviewed within the next 12 months. We recommend review and update of all degradation factors in VEPM when the COPERT review is completed.
- Light duty vehicle gradient correction factors are based on an old version of PIARC guidance. We recommend that update of these factors should be considered in future updates of VEPM.

Appendix 1 summarises the sources of emission factors and correction factors in VEPM 6.0 and VEPM 6.1, and notes where changes are recommended for future updates. The source of emission factors and correction factors in VEPM 6.0 was described fully in previous technical reports (EFRU, 2011., Sridhar and Metcalfe, 2017., Sridhar and Metcalfe, 2019).

In VEPM 6.1, **all hot emission factors for all vehicle classes are consistent with COPERT emission factors,** which are published in the latest version of the EMEP/EEA guidebook (EEA 2019a).

2.4 Articulated trucks

To account for the effect of trailers on heavy vehicle emissions and fuel consumption, articulated truck emission factors have been incorporated into VEPM 6.1.

Heavy commercial vehicle (HCV) VKT data from the Ministry of Transport VFEM2 model is broken down by vehicle weight category according to the gross vehicle mass (GVM) of the powered unit (truck) only. The weight of any separately registered trailer units is not included in the GVM, and there is no breakdown to indicate whether vehicles have trailers or not.

Emission factors are provided in COPERT for rigid and articulated trucks separately. The articulated truck emission factors are based on the Gross Combined Mass (GCM) which is the combined mass of the truck and trailer(s).

This means that assumptions are required to estimate the proportion of HCV VKT that is travelled by articulated trucks.

Total VKT data for trucks and trailers separately is available from the Ministry of Transport vehicle fleet statistics spreadsheet (MoT 2018) for 2001 to 2018 (figure 1). These truck and trailer VKT are based on road user charges (RUC) data.

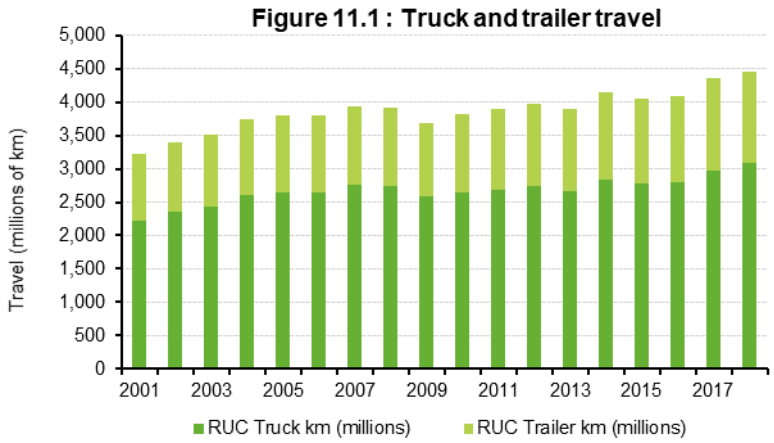

Figure 1: Truck and trailer VKT based on RUC data. Source: MoT (2018)

Ministry of Transport provided a breakdown of these truck and trailer VKT by RUC type for 2001 to 2018. This data was broken down by RUC types shown in Table 1.

Table 1: Truck and trailer VKT derived from road user charges (RUC) data

RUC type	Description
2, 6, 14, 19	Powered vehicles (i.e. trucks). For example, RUC type 14: 
29, 30, 33, 37, 43, 951	Unpowered vehicles (i.e. trailers). For example, RUC type 37: 
929, 939	Leading trailers. For example, RUC type 929: 

We have assumed that all trailer travel is undertaken by a truck towing a single trailer, except for leading trailers (RUC types 929 and 939). We have assumed that leading trailers are always towed with another trailer. On this basis, VKT of leading trailers (RUC type 929 and 939) was subtracted from total trailer VKT to estimate total VKT of trucks that are towing trailers as shown in Table 2.

Table 2: Truck and trailer VKT derived from road user charges (RUC) data

Year	RUC Truck VKT (millions)	RUC Trailer VKT (millions)	RUC Leading Trailer VKT (millions)	RUC VKT of Trucks with Trailers (millions)
2001	2,229	988	0	988
2002	2,353	1,042	0	1042
2003	2,436	1,078	0	1078
2004	2,601	1,148	0	1148
2005	2,652	1,146	0	1146
2006	2,652	1,149	0	1149
2007	2,753	1,185	0	1185
2008	2,734	1,194	0	1194
2009	2,591	1,098	0	1098
2010	2,653	1,175	0	1175
2011	2,675	1,222	0	1222
2012	2,738	1,247	38	1209
2013	2,665	1,238	94	1144
2014	2,831	1,309	99	1210
2015	2,787	1,275	100	1175
2016	2,809	1,284	104	1180
2017	2,982	1,383	119	1264
2018	3,079	1,384	119	1265

The RUC based truck VKT doesn't exactly match the HCV VKT in VEPM. The estimated RUC based VKT of trucks with trailers have therefore been adjusted to account for this difference as shown in Table 3.

The adjusted VKT of trucks towing trailers is assigned to trucks > 7.5 tonnes (based on the assumption that the proportion of VKT travelled by powered units in the 3.5-7.5t category towing a trailer is negligible). Table 3 shows the total VKT of >7.5 tonne HCVs in VEPM 6.1 as well as the percentage of > 7.5 tonne truck VKT that is undertaken by trucks towing a trailer.

For the years 2019 to 2020 the proportion of VKT allocated to trucks towing a trailer is assumed to be 51% and 50% for the years 2021 to 2050.

Table 3: Adjusted truck and trailer VKT derived from road user charges (RUC) data and proportion of >7.5t VKT travelled with a trailer

Year	RUC total Truck VKT (millions)	VEPM total HCV VKT (millions)	RUC/VEPM Ratio	RUC VKT of Trucks with Trailers from Table 1 (millions)	Adjusted VKT of Trucks with Trailers (millions)	VEPM >7.5t HCV total VKT (millions)	% >7.5t VKT with trailer
2001	2,229	2,174	103%	988	964	1,609	60%
2002	2,353	2,273	104%	1042	1,007	1,698	59%
2003	2,436	2,363	103%	1078	1,045	1,774	59%
2004	2,601	2,519	103%	1148	1,112	1,903	58%
2005	2,652	2,602	102%	1146	1,125	1,967	57%
2006	2,652	2,646	100%	1149	1,146	2,005	57%
2007	2,753	2,714	101%	1185	1,168	2,060	57%
2008	2,734	2,711	101%	1194	1,184	2,070	57%
2009	2,591	2,576	101%	1098	1,092	1,962	56%
2010	2,653	2,578	103%	1175	1,141	1,972	58%
2011	2,675	2,590	103%	1222	1,183	1,995	59%
2012	2,738	2,583	106%	1209	1,141	2,004	57%
2013	2,665	2,642	101%	1144	1,134	2,069	55%
2014	2,831	2,739	103%	1210	1,170	2,163	54%
2015	2,787	2,803	99%	1175	1,181	2,222	53%
2016	2,809	2,894	97%	1180	1,215	2,297	53%
2017	2,982	3,051	98%	1264	1,293	2,440	53%
2018	3,079	3,175	97%	1265	1,305	2,543	51%

The proportion of VKT allocated to trucks towing a trailer is then used to estimate emissions from trucks towing trailers in VEPM as follows:

- Each VEPM powered truck category above 7.5t is matched to a COPERT articulated truck category (Table 4).
- For each VEPM category the derived proportion of trailer VKT for the fleet year (Table 3) is allocated to the corresponding COPERT articulated truck category (Table 4).

The matches in Table 4 are based on the assumption that the gross weight of a trailer is typically around 20 tonnes, so the gross combined weight of a truck towing a trailer is typically around 20 tonnes heavier than the corresponding truck weight. On this basis the >30 tonne powered truck category is matched to the >50 tonne articulated category. The other categories do not correspond exactly so an approximate match is assigned in Table 4.

Table 4: powered truck categories matched to articulated truck categories

VEPM Powered truck category	COPERT Articulated truck category
7.5-10t	20-28t
10-20t	28-34t
20-25t	34-40t
25-30t	40-50t
>30t	>50t

Further work is recommended to investigate whether RUC data (including electronic RUC data from E-Road) could be used to improve the split between rigid and articulated truck VKT and to validate the overall gross combined weight distribution of the New Zealand truck fleet.

2.5 Bus emission factors

Separate bus emission factors have been added in VEPM 6.1[2].

Vehicle categories in the COPERT emissions model do not match categories in the NZ fleet data from VFEM. This means that assumptions are required, as summarised in Table 5.

Table 5: COPERT vehicle categories for buses assumed in VEPM 6.1

	NZ Fleet Data	COPERT vehicle classes used
Buses	3.5 - 12t	Urban Buses Midi <= 15t
	>12 t	Urban Buses Standard 15 – 18 t
		Coaches Standard <=18t

For the default fleet break-down it is assumed that 80% of buses > 12 tonnes are urban buses standard and 20% are coaches. We have no data to support this assumption.

2.6 Brake and tyre wear emission factors for articulated trucks and buses

Brake and tyre wear emission factors in VEPM 6.0 were updated to be consistent with the EMEP/EEA guidebook (EEA, 2019c). The methodology has not changed, however new vehicle classes have been included in VEPM 6.1.

The default number of axles for rigid heavy-duty vehicles were unchanged from VEPM 6.0. The default number of axles for buses and articulated trucks was defined based on maximum default weights provided by Waka Kotahi (reproduced in Sridhar and Metcalfe 2019) as shown in Table 6.

[2] In previous versions of VEPM, bus emission factors were assumed to be the same as trucks. Bus VKT were combined with heavy commercial vehicle (HCV) VKT.

Table 6: Default number of axles assumed in VEPM 6.1 for calculation of tyre wear emission factors

Vehicle classification		Default number of axles
Rigid	3.5 – 7 t	2 axles
Rigid	7.5 - 10 t	2 axles
Rigid	10 – 20t	3 axles
Rigid	20 – 25t	4 axles
Rigid	25 – 30t	5 axles
Rigid	>30t	6 axles
Articulated	14-20t	5 axles
Articulated	20-28t	6 axles
Articulated	28-34t	6 axles
Articulated	34-40t	7 axles
Articulated	40-50t	8 axles
Articulated	> 50t	9 axles
Bus	<=15t	2 axles
Bus	15-18	3 axles

2.7 New Zealand real world fuel consumption correction factors

New Zealand real world fuel consumption correction factors have been applied to light duty diesel vehicles in VEPM 6.1.

Ministry of Transport has developed real world fuel consumption factors for diesel and petrol vehicles in New Zealand using fuel consumption and travel data from a large data set of fuel card transactions (Wang et al 2015). Previous work has found that there is good agreement between VEPM and these real-world fuel consumption for light duty petrol vehicles. However, it was found that light duty diesel fuel consumption is underestimated by VEPM (Kuschel et al 2019). New Zealand real world adjustment factors have been developed, as shown in Table 7, so that light duty diesel fuel consumption estimates from VEPM are more realistic. The methodology and assumptions for derivation of the factors are described in Metcalfe, Kuschel and Gimson (2020).

Table 7: New Zealand real world fuel consumption adjustment factors applied in VEPM 6.1

Vehicle type	Engine size category in VEPM	Real world fuel consumption adjustment factor
Diesel LPV	<2000cc	1.29
	≥2000cc	1.14
Diesel LCV	N/A	1.08

The adjustment factors are applied in VEPM 6.1 to adjust fuel consumption predictions (and consequently CO_2 emission predictions) for diesel LPVs and LCVs for all years of manufacture.

3.0 VEPM 6.0 versus VEPM 6.1

This section briefly describes the differences between VEPM 6.0 and the updated VEPM 6.1.

3.1 Effect on fleet weighted emission factors

This section discusses the effect of changes in the assumptions on fleet weighted emission factors. Figures 2 to 7 show fleet weighted emission factors for carbon monoxide (CO), volatile organic compounds (VOC), nitrogen oxides (NOx), $PM_{2.5}$, brake and tyre and fuel consumption from VEPM 6.0 and VEPM 6.1.

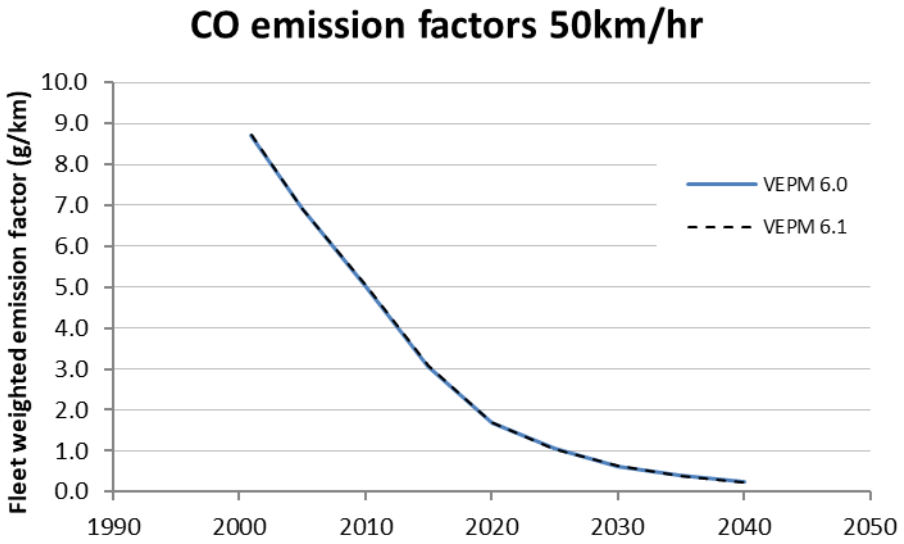

Figure 2: Comparison of CO emission factors from VEPM 6.0 and VEPM 6.1

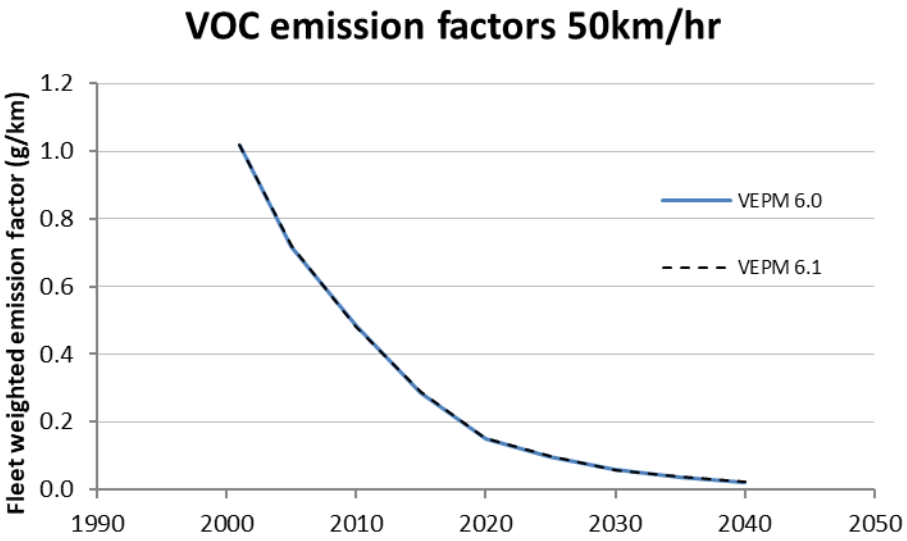

Figure 3: Comparison of VOC emission factors from VEPM 6.0 and VEPM 6.1

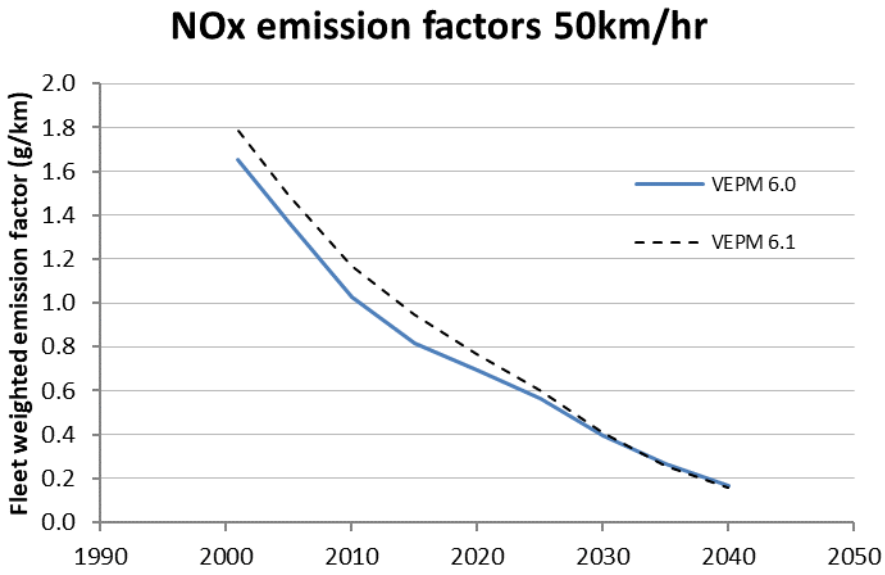

Figure 4: Comparison of NOx emission factors from VEPM 6.0 and VEPM 6.1

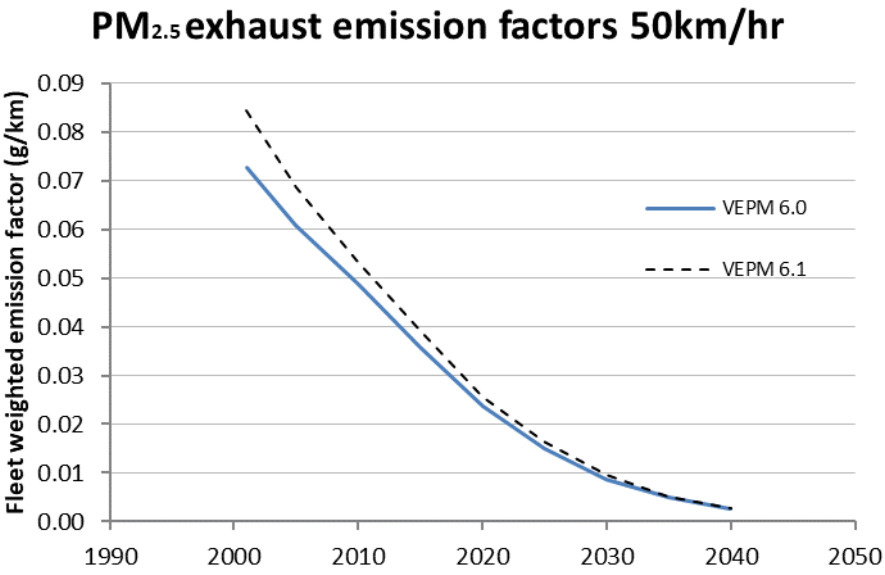

Figure 5: Comparison of $PM_{2.5}$ emission factors from VEPM 6.0 and VEPM 6.1

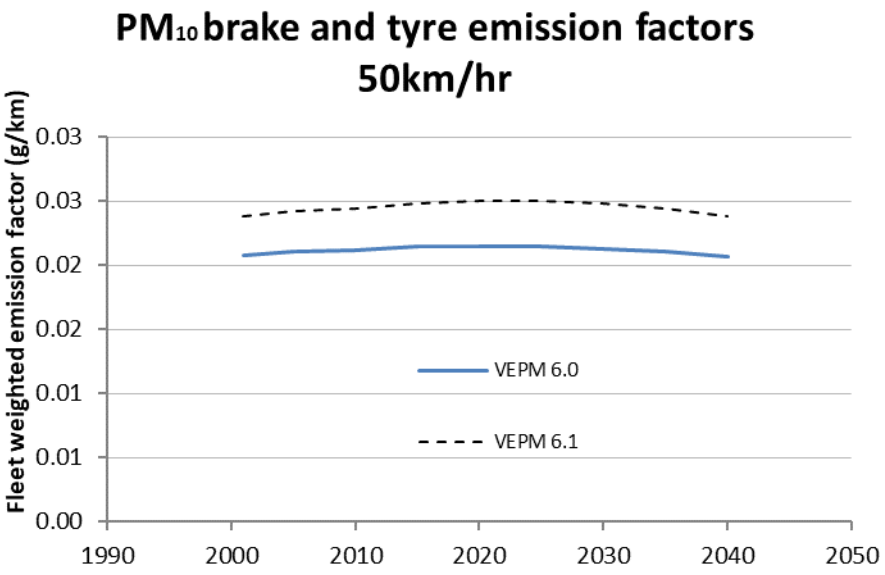

Figure 6: Comparison of brake and tyre wear emission factors from VEPM 6.0 and VEPM 6.1

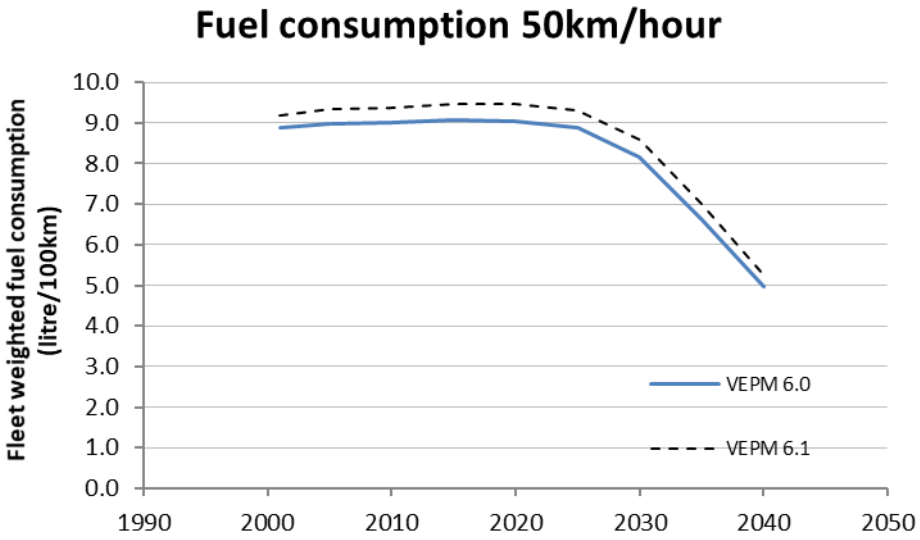

Figure 7: Comparison of fuel consumption from VEPM 6.0 and VEPM 6.1

3.1.1 Discussion of the fleet weighted emission factor comparison

Figures 2 and 3 show that VEPM 6.1 updates made very little difference to fleet weighted average CO and VOC emission factors.

Some of the significant differences between VEPM 6.0 and VEPM 6.1 are discussed briefly in the following sections.

3.1.2 NO_X and $PM_{2.5}$ factors

Fleet weighted NOx and $PM_{2.5}$ exhaust emission factors are generally higher in VEPM 6.1 compared with VEPM 6.0. This difference is primarily due to Incorporation of articulated

trucks into VEPM 6.1 (discussed in Section 2.4). Articulated trucks are heavier (because trailer weight is included in the vehicle weight) and have higher emission factors on average compared with rigid trucks.

3.1.3 Brake and tyre wear emission factors

Brake and tyre wear PM_{10} emission factors are significantly higher in VEPM 6.1 compared with VEPM 6.0. This is because articulated vehicles are included in VEPM 6.1. These vehicles have more axles (as shown in Table 6), which results in higher brake and tyre wear emission factors. Emission factors for 2-axle HCVs were also incorrectly calculated in VEPM 6.0, resulting in underestimation of brake and tyre wear emission factors for this category.

3.1.4 Fuel consumption

Fuel consumption is higher in VEPM 6.1 compared with VEPM 6.0. At 50km/hour in 2020 (with all other settings at default) the fleet weighted average is approximately 5% higher in VEPM 6.1 compared with VEPM 6.0.

Key reasons for this difference are:

- Inclusion of real-world fuel consumption correction factors for light duty diesel vehicles (discussed in Section 2.7). Diesel car fuel consumption is approximately 17% higher and diesel LCV fuel consumption is approximately 8% higher in VEPM 6.1 compared with VEPM 6.0.
- Incorporation of articulated trucks into VEPM 6.1 (discussed in Section 2.4). The difference between VEPM 6.1 and VEPM 6.0 depends on the settings. At 50km/hour with all settings at default, heavy duty fleet weighted average diesel consumption is approximately 18% higher in VEPM 6.1 compared with VEPM 6.0 due to the inclusion of articulated trucks (as shown in Figure 8).

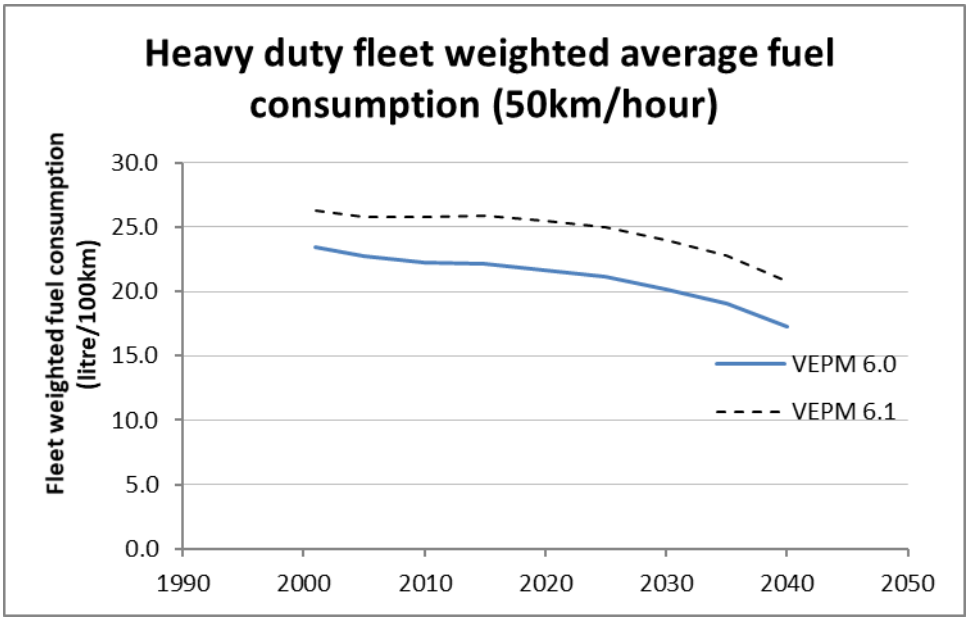

Figure 8: Comparison of heavy duty fleet weighted fuel consumption from VEPM 6.0 and VEPM 6.1

4.0 Conclusions and recommendations

Improvement of VEPM is an area of ongoing research, and recommendations from previous reports are not repeated here. Specific recommendations relating to this update of the model are as follows:

- The fleet projection included in VEPM 6.1 is unchanged from VEPM 6.0. This fleet data is for the Base Case described in the Transport Outlook: Future State report (MoT, 2017). Future emissions, especially CO_2, are sensitive to the rate of uptake of electric vehicles assumed in fleet projections. There is considerable uncertainty in the likely rate of uptake of electric vehicles in future, so fleet data should be reviewed and updated regularly. Users should consider sensitivity analysis for the proportion of electric vehicles in the fleet for future projections.
- A review of degradation factors (EMM 2020) concludes that the factors in VEPM are outdated. EMM considers it is likely that degradation factors in COPERT will be reviewed within the next 12 months. We recommend review and update of all degradation factors in VEPM when the COPERT review is completed.
- Light duty vehicle gradient correction factors are based on an old version of PIARC guidance. We recommend that update of these factors should be considered in future updates of VEPM.
- Further work is recommended to investigate whether RUC data (including electronic RUC data from E-Road) could be used to improve the accuracy of the split between rigid and articulated truck VKT and to validate the overall gross combined weight distribution of the New Zealand truck fleet.
- Further work is recommended to investigate whether diesel fuel consumption estimates are more realistic (relative to regional or national fuel sales data) based on VEPM 6.1 compared to VEPM 6.0.
- The EMEP/EEA emission factor database includes emission factors for methane (CH_4) and nitrous oxide (N_2O). Inclusion of these pollutants in VEPM would allow for calculation of CO2-e emission factors, and could be considered in future updates.
- In general, it is recommended that VEPM should be updated whenever COPERT is updated. The detailed fleet profile should also be updated regularly.

References

EEA (2019). *Air pollutant emission inventory guidebook 2019 1.A.3.b.i-iv Road Transport.* European Environment Agency. Available at: https://www.eea.europa.eu/publications/emep-eea-guidebook-2019

EEA (2019b) *Air pollutant emission inventory guidebook 2019 1.A.3.bi-iv Road Transport Appendix 4 Emission Factors 2019*. Available at: https://www.eea.europa.eu/publications/emep-eea-guidebook-2019

EEA (2019c). *Air pollutant emission inventory guidebook 2019 1.A.3.b.vi-vii Road tyre and brake wear 2019*. European Environment Agency. Available at: https://www.eea.europa.eu/publications/emep-eea-guidebook-2019

EFRU (2008). *Development of a vehicle emissions prediction model*. Prepared for Auckland Council by Energy & Fuels Research Unit, The University of Auckland, December 2008.

EFRU (2011). *Vehicle Emissions Prediction Model (VEPM) Version 5.0 Development and User Information Report*. Prepared for NZ Transport Agency and Auckland Council by Energy & Fuels Research Unit, The University of Auckland, November 2011

EFRU (2012). *Vehicle emissions prediction model (VEPM) version 5.1.* Prepared by Energy and Fuels Research Unit, Auckland University, July 2012.

EMM (2020). 2020 update of the Vehicle Emissions Prediction Model (VEPM), Review of degradation factors. Prepared by Paul Boulter, EMM Consulting, April 2020

Kuschel et al, 2019. *Testing New Zealand vehicles to measure real world fuel use and exhaust emissions.* NZ Transport Agency research report 658. https://www.nzta.govt.nz/resources/research/reports/658/

MoT (2018). *2018 New Zealand Vehicle Fleet Annual Spreadsheet.* Ministry of Transport. https://www.transport.govt.nz/mot-resources/vehicle-fleet-statistics/

Sridhar S and Metcalfe J (2017) *VEPM 5.3 Vehicle Emission Prediction Model Technical Updates: technical report.* Prepared by Emission Impossible for NZ Transport Agency

Sridhar S and Metcalfe J (2019) *VEPM 6.0 Vehicle Emission Prediction Model Technical Updates: technical report.* Prepared by Emission Impossible for NZ Transport Agency

Metcalfe J, Kuschel G, Gimson N (2020) *Vehicle Emission Prediction Model VEPM 6.1: Investigation into improving real-world fuel consumption factors*. Prepared by Emission Impossible for NZ Transport Agency

PAE (2016). Comments on VEPM Technical Updates – proposed content. Prepared by Paul Boulter, Pacific Environment Limited, 11 December 2016

Wang, H, I McGlinchy, S Badger and S Wheaton (2015) Real-world fuel efficiency of light vehicles in New Zealand. *Proceedings of the 37th Australasian Transport Research Forum*, Sydney, Australia, 30 September-2 October 2015. atrf.info/papers/2015/index.aspx

Appendix 1: Emission factor data sources in VEPM 6.0 and VEPM 6.1

Factor	Vehicle Class	VEPM 6.0	VEPM 6.1	Comments
Hot running	All vehicle categories	EEA 2018	EEA 2019	All hot emission factors updated to the latest version from EMEP/EEA (EEA, 2019b)
Hot running	Japanese domestic imports (light duty) up to YOM 2010	EEA 2018 based on EURO/JCAP equivalent emissions factors as described in EFRU (2008)	EEA 2019 with no change to equivalencies	Note that all Japanese and European vehicles were assumed to be equivalent from YOM of 2010 onwards because increased harmonisation means vehicle emission standards are similar. This means that no changes/updates to the equivalencies are considered necessary going forward.
Cold start	All light duty	EEA 2018	EEA 2019. No change	No change in latest version of EMEP/EEA guidebook (EEA, 2019). Paul Boulter previously suggested consideration of Au COPERT cold start factors (PAE, 2016). However, there is no data for Australian vehicles from ADR79-01. Based on this there seems to be little value in considering changes to VEPM at this stage.
Fuel correction	All gasoline and diesel	EPEFE as described in EFRU (2008), and EFRU (2011).	No change	No change to assumptions described in EFRU (2008) and EFRU (2011). Note that EMEP/EEA correction factors (EEA, 2019) are the same as the original EPEFE factors used in VEPM, so no change is required.
Degradation	European gasoline	EEA 2018	EEA 2019. No change	No change in latest version of EMEP/EEA guidebook (EEA, 2019)
Degradation	Japanese domestic imports	JCAP as described in EFRU (2008).	No change	No change to assumptions described in EFRU (2008) for pre 2010 vehicles. Note that all vehicles from YOM 2010 onwards are assumed to be equivalent to European standards – including degradation factors. So no changes/updates are necessary going forward.

Factor	Vehicle Class	VEPM 6.0	VEPM 6.1	Comments
Degradation	Light duty diesel	European Auto-Oil study as described in EFRU (2008), and EFRU (2011).	No change	No change to assumptions described in EFRU (2008) and EFRU (2011). EMEP/EEA does not include degradation factors for light duty diesel. Review of degradation factors is recommended (EMM 2020) and will be considered for future updates.
Degradation	Heavy duty diesel	Euro Auto-Oil study + EPA M6.HDE.001 as described in EFRU (2008).	No change	No change to assumptions described in EFRU (2008). EMEP/EEA does not include degradation factors for HDV. Review of degradation factors is recommended (EMM 2020) and will be considered for future updates.
Catalyst removal	Light duty gasoline	EEA 2018 with adjustment factors	EEA 2019 with no change to adjustment factors	No change to assumptions described in EFRU (2008).
Gradient	Light duty	PIARC (CO and NOx only for gasoline vehicles and CO, NOx and PM for diesel vehicles)	No change	No change to assumptions described in EFRU (2012). However, we note that PIARC guidance has been updated. Recommended that update of factors be considered for future updates.
f-NO2	All	EEA 2018	EEA 2019. No change	No change in latest version of EMEP/EEA guidebook (EEA, 2019)
Brake and tyre wear	All	EEA 2019c	No change	
NZ real world fuel consumption	Light duty diesel		New in VEPM 6.1	Correction factors applied in VEPM 6.1 based on methodology and assumptions described in Metcalfe, Kuschel and Gimson (2020).