TE MANATŪ WAKA
MINISTRY OF TRANSPORT

Domestic Transport Costs and Charges Study

Working Paper C1.2
Road Infrastructure - Total and Average Costs

Prepared for Te Manatū Waka Ministry of Transport (NZ)
David Lupton & Associates Limited in association with Ian Wallis Associates Ltd
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Disclaimer

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Research, Economics and Evaluation

The Research, Economics and Evaluation team operates within the System Performance and Governance Group of Te Manatū Waka Ministry of Transport. The team supports the Ministry's policy teams by providing the evidence base at each stage of the policy development.

The team is responsible for:

- Providing sector direction on the establishment and use of the Transport Evidence Base (see below) – including the collection, use, and sharing of data, research and analytics across the transport sector and fostering the development of sector research capabilities and ideas.
- Leading and undertaking economic analyses, appraisals and assessment including providing economic input on business cases and funding requests.
- Performing the evaluation function for Te Manatū Waka, including designing monitoring and evaluation frameworks and approaches, developing performance metrics and indicators, and designing, conducting and procuring evaluations.

The Transport Evidence Base

The Transport Evidence Base Strategy creates an environment to ensure data, information, research and evaluation play a key role in shaping the policy landscape. Good, evidence-based decisions also enhance the delivery of services provided by both the public and private sectors to support the delivery of transport outcomes and improve wellbeing and liveability in New Zealand.

The Domestic Transport Costs and Charges study aims to fill some of the research gaps identified in the 2016 Transport Domain Plan (Recommendation R6.2), which forms part of the Transport Evidence Base.

Citation

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For more information

For more information about this project and associated report, please contact: info@transport.govt.nz.

Glossary of terms and abbreviations

ESA	Equivalent Standard Axle
CAM	Cost Allocation Model
DTCC	Domestic Transport Costs and Charges (study)
GVW	Gross Vehicle Weight (mass);
HV	Heavy Vehicle
km	Kilometre
MBCM	Monetised Benefits and Costs Manual (maintained by WK)
PCE	Passenger Car Equivalent
PV	Powered Vehicle
RUC	Road User Charge
TMW	Te Manatū Waka Ministry of Transport
TOF	Transport Outcomes Framework
WK	Waka Kotahi New Zealand Transport Agency

Executive Summary

The primary purpose of this paper is to estimate the total and average economic costs by vehicle type for the use of the NZ road infrastructure (state highways and local roads), Road infrastructure costs (attributable, joint and common costs) are allocated between road users based on the characteristics of each vehicle type. This results in fully allocated costs that reflect the assessed contribution of each vehicle type to the expenditure on road infrastructure. They are nevertheless average costs in the sense that the allocated expenditure is summed by cost category and divided by the total output in that category.

We made use of the Cost Allocation Model (CAM) maintained by The Ministry of Transport (MOT) for deriving recommended road user charges (RUC) and petrol excise duty (PED). CAM is used to allocate the expenditure of the New Zealand Transport Agency (Waka Kotahi or "WK") which includes non-road expenditure (expenditure on public transport, railways, sea freight) as well as expenditure on roads. However, as a first step, CAM allocates all expenditure on roads to 'cost drivers'. The rates are then adjusted so that all WK expenditure is covered. This paper is primarily concerned with the results from the first step: the allocation of road infrastructure expenditure.

The CAM process allocates financial costs relating to building and maintaining roads (Expenditure) to cost drivers – characteristics of vehicles such as axle loads that are a direct or indirect cause of road expenditure.

The main steps involved in applying the CAM process are as follows:

- Identify all government and municipal agencies that have road-related expenditure and prepare a schedule of all relevant annual costs ("schedule of costs"), disaggregated as far as possible into individual cost items. For example, cost items include patching potholes, repairing signs.
- For each cost item in the schedule of costs, identify the cost driver or the intended beneficiary group, e.g. number of equivalent standard axle-kilometres (ESA-km) or number of driver-km.
- From road use statistics and surveys etc, estimate the overall quantum of each cost driver for the relevant year- e.g. number of ESA-km or number of powered vehicle-km per year.
- Divide the cost item total by the quantum of the cost driver and aggregate by broad categories to give an average cost per unit of each cost driver for that category of expenditure.
- Use estimates of the distances travelled and the characteristics of each vehicle type to allocate all roading-related costs against vehicle types.

The five 'cost drivers' used in CAM to allocate road infrastructure costs are:

- Heavy vehicle-kilometres including trailers (HV)
- Gross vehicle weight-kilometres (GVW)
- Equivalent Standard Axle-kilometres (ESA)
- Passenger Car Equivalent-kilometres (PCE)
- Powered vehicle-kilometres (PV)

Table ES.1: Road cost allocation (2018/19)

All costs in $ million 2018/19	HV-km	PCE-km	GVW-km	ESA-km	PV-km	Total
Local Roads (LR):						
LR maintenance and operations	1.03	0.00	11.11	78.96	653.85	744.95
LR renewal	0.00	0.00	130.46	226.15	281.25	637.86
LR new and improved roads	2.61	103.27	2.79	47.18	267.86	423.71
State Highways (SH):						
SH maintenance and operations	0.00	16.45	7.58	42.51	349.00	415.54
SH renewal	0.00	0.00	99.43	95.51	100.41	295.36
SH new and improved roads	0.00	434.85	65.19	144.43	558.08	1,202.55
Regional improvements	0.13	3.33	76.05	0.00	101.89	181.39
Total cost ($ million)	**3.77**	**557.88**	**392.60**	**634.75**	**2,312.35**	**3,901.36**
Kilometres billion	5.25	51.91	193.63	2.69	48.68	48.68
Rate ($ per 1000 km)	**0.72**	**10.75**	**2.03**	**235.91**	**47.50**	**80.14**

Source: Ministry of Transport

Table ES.2: Average economic costs and their allocation

All costs in $ million 2018/19	HV-km	PCE-km	GVW-km	ESA-km	PV-km	Total
Local roads:						
Maintenance and operation	1.03	0.00	11.11	78.96	653.85	744.95
Renewal	0.00	0.00	130.46	226.15	281.25	637.86
Capital charge	25.47	544.41	0.00	368.38	1,521.75	2,460.00
State Highways:						
Maintenance and Operation	0.00	16.45	7.58	42.51	349.00	415.54
Renewal	0.00	0.00	99.43	95.51	100.41	295.36
Capital charge	0.14	594.98	139.25	298.43	955.19	1,988.00
Total cost ($ million)	**26.64**	**1,155.84**	**387.84**	**1,109.94**	**3,861.45**	**6,541.71**
Kilometres (billion)	5.25	51.91	193.63	2.69	48.68	48.68
Rate ($ per 1000 km)	**5.08**	**22.27**	**2.00**	**412.52**	**79.32**	**134.38**

Source: Consultant estimates

Table ES.3: Average cost comparisons by vehicle type

Vehicle type	Cost rates per thousand vehicle km (2018/19)		
	Financial cost $/1000	Economic cost $/1000	Actual charge $/1000
Motorbike	$54	$91	$33
Car	$65	$109	$66
LCV1	$65	$109	$66
LCV2	$63	$105	$66
MCV	$132	$227	$137
HCV1	$337	$571	$377
HCV2A	$393	$656	$396
HCV2B	$461	$748	$316
Bus 2 axle	$132	$225	$201
Bus 3 axle	$296	$499	$403

Chapter 1 Introduction

1.1 Study scope and overview

The Domestic Transport Costs and Charges (DTCC) study aims to identify all the costs associated with the domestic transport system and its impacts on the wider New Zealand economy, including costs (financial and non-financial) and charges borne by transport users.

The Study is an important input to achieving a quality transport system for New Zealand that improves wellbeing and liveability. Its outputs will improve our understanding of the economic, environmental and social costs associated with different transport modes – including road, rail, public transport and coastal shipping – and the extent to which those costs are currently offset by charges paid by transport users.

The DTCC is intended to support the wider policy framework of Te Manatū Waka, in particular the Transport Outcomes Framework (TOF). The TOF seeks to make clear what government wants to achieve through the transport system under five outcome areas:

- Inclusive access.
- Economic prosperity.
- Healthy and safe people.
- Environmental sustainability.
- Resilience and security.

Underpinning the outcomes in these areas is the guiding principle of mode neutrality. In general, outputs of the DTCC Study will contribute to the TOF by providing consistent methods for (a) estimating and reporting economic costs and financial charges; and (b) understanding how these costs and charges vary across dimensions that are relevant to policy, such as location, mode, and trip type.

Robust information on transport costs and charges is critical to establishing a sound transport policy framework. The Study itself does not address future transport policy options; but the study outputs will help inform important policy development in areas such as charging and revenue management, internalising externalities, and travel demand management.

The Study was undertaken for Te Manatū Waka by a consultant consortium headed by Ian Wallis Associates Ltd. The Study has been divided into a number of topic areas, some of which relate to different transport modes (including road, rail, urban public transport and coastal shipping), and others to transport-related impacts or externalities (including accidents, congestion, public health, emissions, noise, biodiversity and biosecurity).

Working papers (25) have been prepared covering each of the topic areas. Their titles, topic areas and specialist authors are listed in Appendix 2.

1.2 Costing Practices

The focus of DTCC is on NZ transport operations, economic costs, financial costs and charges for the year ending 30 June 2019 (FY 2018/19). Consistent with this focus, all economic and financial cost figures are given in NZ$2018/19 (average for the 12-month period) unless otherwise specified.

All financial costs include any taxes and charges (but exclude GST); while economic costs exclude all taxes and charges.

The DTCC economic and financial analyses comprise essentially single-year assessments of transport sector costs and charges for FY 2018/19. Capital charges have been included in these assessments, with annualised costs based on typical market depreciation rates plus an annualised charge (derived as 4% p.a., in real terms, of the optimised replacement costs of the assets involved).

1.3 Paper scope and structure

Road infrastructure costs include the costs of acquiring the right-of-way; building and maintaining the pavement; providing road markings, signage, lighting and other road furniture; road and driver management and road safety administration.

This Working Paper (WP) is primarily concerned with road construction and maintenance costs arising from road use. In this paper we first estimate the average financial costs based on a road cost allocation matrix that is part of Te Manatū Waka the Ministry of Transport (TMW) Cost Allocation Model (CAM). CAM allocates total road expenditure (as incurred in any given year) between road user types and is used by TMW to determine recommended rates for road user charges (RUC) – primarily paid by heavy vehicles – and petrol excise duties (PED) paid by light vehicles.

The costs estimated in this paper are fully allocated costs: all road infrastructure costs are allocated to road users based on an assessment of the contribution to the total cost of the type of vehicle. They are average costs in the sense that the total cost attributable to or allocated to vehicles of a particular type are averaged over all vehicles of that type.

We also estimate the total and average economic costs associated with road construction and maintenance by vehicle type. This involved replacing the actual expenditure on new roads and road improvements in any given year with an annual capital charge calculated as the current depreciated replacement cost (DRC) of the road network multiplied by 4.0%, which is the weighted average cost of capital (WACC) used throughout the DTCC Study.

Other economic cost components relating to the use of road infrastructure are covered in other working papers. In particular, the marginal costs of road infrastructure operations and maintenance are covered in WP C1.1. Road capacity-related costs (primarily congestion) are considered in WP D2, and WP D1 assesses costs relating to road accidents. Environmental costs associated with road use are covered in WPs D4 (Emissions), D5 (Noise) and D6 (Biodiversity and Biosecurity).

Chapter 2 Methodology

2.1 Approach

Our analysis is concerned with the total and average economic costs of road infrastructure by vehicle type. Road infrastructure is used by a wide variety of vehicles for a variety of purposes. Estimating the 'cost' associated with any particular user is a classic common cost problem: there is no 'correct' allocation of costs between road users.

We made use of TMW's cost allocation model (CAM) to help estimate average economic road infrastructure costs by vehicle type. CAM is owned by TMW and is used to help determine recommended charges for road users. It is relevant to the Domestic Transport Costs and Charges study in two main ways: firstly, to understand the basis for current charges and secondly, to provide a means of estimating average economic road infrastructure costs. The charges calculated by CAM are designed to recover WK's annual expenditure, which includes public transport and some rail and shipping expenditure. However, our estimate of the average economic road cost uses the CAM cost allocation matrix but only includes expenditure on roads.

The establishment of CAM dates back to the New Zealand Transport Policy Study (1973) which recommended the abolition of regulatory restrictions on the use of trucks in competition with New Zealand Railways and instead proposed the use of pricing to ensure efficient allocation of traffic between the modes. To achieve this, it recommended a cost allocation study as a basis for the calculation of user charges and the appropriate level of non-user contributions. The Officials Committee established to consider and where appropriate implement the Study's recommendations developed proposals for what became the road user charges (RUC) system that has been a key component of the funding system for the New Zealand road network ever since.

The objective of CAM has thus always been to ensure that the charges faced by road users reflect the costs that they impose on the road system although it now covers more than just road expenditure. CAM addresses the common cost problem by attributing different proportions of each cost category based on the demands imposed by different vehicle types. For example, while heavy vehicles are the main contributors to road wear, the standard to which the road is maintained – and thus the cost of maintenance – is largely driven by private passenger vehicle numbers.

The CAM approach can be summarised as follows:

- Identify all government and municipal agencies that have road-related expenditure and prepare a schedule of all relevant annual costs ("schedule of costs") disaggregated as far as possible into individual cost items. For example, cost items include patching potholes, repairing road signs.
- For each cost item in the schedule of costs, identify the cost driver or the intended beneficiary group, e.g. number of equivalent standard axle-kilometres (ESA-km) or number of vehicle-km.
- From road use statistics, surveys etc, estimate the quantum of each cost driver for the relevant year- e.g. number of ESA-km or number of vehicle-km per year.
- Divide the cost item total by the quantum of the cost driver and aggregate by broad categories to give a cost per unit of each cost driver for that category of expenditure.

Three further steps are required to take the rates derived in the model and calculate the actual charges.

- The total among to be recovered is adjusted reflecting the fact that WK only pays approximately half of the local authority roading costs but has expenditure on public transport and other land transport services
- the amount to be recovered from each vehicle type needs to be calculated based on the vehicle characteristic and
- this then needs to be converted into a distance-based charge for that vehicle type.

As noted above, the rates so obtained are the theoretical or modelled rates. They are based on the budget expenditure and expected travel statistics. The rates actually charged are set by the Government after taking advice from Te Manatū Waka and The Treasury.

CAM attributes financial costs and is used as a basis for setting financial charges. For this study we needed to determine the total and average economic costs. To determine these, we updated the cost and travel data to 2018/19 actuals and replaced the financial capital expenditure in CAM – which are based on a PAYGO principle – with an estimate of the economic cost of capital. This charge was then allocated between users following the same approach as used in CAM.

2.2 Data sources and literature

We used the Te Manatū Waka CAM as it is specifically designed for New Zealand conditions, A specific cost allocation model had to be designed for New Zealand, because:

- The RUC charging mechanism was world-leading and differed from most other countries in the OECD that predominately rely on a diesel tax to recover both heavy vehicle road charges and light vehicle road charges. The current NZ model is designed to calculate road charges by vehicle weight and classes of vehicle axle configuration.
- New Zealand roads are primarily unbound granular basecourse (compacted gravel) pavements. This type of road is weaker than typical OECD roads, with axle loads regulated to not exceed 8.2 tonnes. Other countries allow axle load limits of 10 tonnes or even 13 tonnes, with pavements of asphaltic concrete or cement concrete. The weaker road structure results in different wear characteristics and requires costs to be allocated differently.
- New Zealand highways are predominately two-lane highways with lots of curves and gradients, as opposed to predominately four lane highways in other OECD countries. This results in a high percentage of New Zealand’s state highway roading construction expenditure being spent on passing lanes and road straightening, unlike other countries.
- New Zealand bridges have to meet earthquake standards, unlike many other countries, such as Australia and Britain. Earthquake standards not only increase total bridge costs but also increase the percentage of costs allocated to vehicle weight (i.e. heavy vehicles).

For the above reasons, the CAM rates are considered a better guide to New Zealand road sector costs than any in the international literature.

All the data used for this study were provided by the Te Manatū Waka .

2.3 Analysis of costs

2.3.1 Road expenditure

Total road expenditure considered for this analysis includes all expenditure on roads by WK and local authority (LA) road expenditure that is approved for shared funding by WK. It does not include road expenditure financed solely by the LA, which would typically include expenditure that is not related to road use.

The CAM rates were based on budgeted expenditure (see Table 2.1 for expenditure in 2018/19).

Table 2.1: Budgeted Road Expenditure by work category (2018/19)

Activity Class	WC No.	NLTF Work Category (WC)	Local $M		State highway $M		Total $M	
Road Maintenance and Operation	111	Sealed Pavement Maintenance	126.7	7%	51.5	3%	178.1	5%
	112	Unsealed Pavement Maintenance	37.7	2%	0.3	0%	38	1%
	113	Routine Drainage Maintenance	48.1	3%	12.9	1%	61	2%
	114	Structures Maintenance	18.2	1%	39.7	2%	57.9	2%
	121	Environmental Maintenance	61.8	4%	69	4%	130.8	4%
	122	Traffic Services Maintenance	87.1	5%	40.3	2%	127.4	4%
	123	Operational Traffic Management	20.9	1%	43.5	2%	64.5	2%
	124	Cycle Path Maintenance	79.1	5%	0.6	0%	79.7	2%
	131	Level Crossing Warning Devices	1.6	0%	-	0%	1.6	0%
	140	Minor events	11.3	1%	-	0%	11.3	0%
	141	Emergency Reinstatement	5.5	0%	4.9	0%	10.4	0%
	151	Network and Asset Management	90.1	5%	77.4	4%	167.6	5%
	161	Property Management	-	0%	14.8	1%	14.8	0%
	171	Financial grants	-	0%	-	0%	-	0%
Sub-total			588.1	34%	354.9	20%	943	27%
Road Renewal	211	Unsealed Road Metalling	47.3	3%	0.5	0%	47.8	1%
	212	Sealed Road Resurfacing	203.3	12%	131.2	8%	334.5	10%
	213	Drainage Renewals	51.1	3%	7.9	0%	59	2%
	214	Sealed Road Pavement Rehabilitation	113.4	7%	55.9	3%	169.3	5%
	215	Structures Component Replacements	41.9	2%	29.9	2%	71.9	2%
	221	Environmental Renewals	0.7	0%	3.2	0%	3.9	0%
	222	Traffic Services Renewals	45.8	3%	23.7	1%	69.5	2%
	231	Associated Improvements	-	0%	-	0%	-	0%
	241	Preventative Maintenance	-	0%	-	0%	-	0%
Sub-total			503.6	29%	252.2	14%	755.8	22%
New and Improved Road Infrastructure	321	New Traffic Management Facilities	13.7	1%	51.8	3%	65.5	2%
	322	Replacement of Bridges and Other Structures	9.8	1%	33.5	2%	43.4	1%
	323	New Roads	87	5%	386.8	22%	473.7	14%
	324	Road Improvements	233.4	14%	509.7	29%	743.1	21%
	325	Seal Extension	1.5	0%	-	0%	1.5	0%
	331	Property Purchase	-	0%	88.2	5%	88.2	3%
	332	Property Purchase	20.4	1%	-	0%	20.4	1%
	333	Advance Property Purchase	-	0%	-	0%	-	0%
	XXX	Targeted Community Fund	-	0%	-	0%	-	0%
	341	Minor Improvements	232.2	14%	65.3	4%	297.5	9%
	357	Resilience Improvements	29.7	2%	2.1	0%	31.8	1%
Sub-total			627.7	37%	1,137.40	65%	1,765.10	51%
Total			**1,719.50**	**100%**	**1,744.50**	**100%**	**3,464.00**	

Source: Te Manatū Waka

2.3.2 Allocation to cost drivers

CAM uses a road cost allocation matrix to allocate expenditure on roads to each of five cost drivers. The aim of the cost allocation is to allocate road costs in a way that reflects the impact or contribution of each cost driver to each category of expenditure. Definitions for the cost drivers are given in Table 2.2.

Table 2.2: Road cost allocation by cost driver

Parameter	Abbreviation	Description	Related costs	Activities
Powered vehicle	PV	excludes trailers	driver related costs, safety, enforcement	police, road safety, signage
Passenger car equivalent	PCE	effect of vehicle on road capacity	Road capacity, congestion	road widening, traffic management
Gross vehicle weight	GVW	maximum weight of vehicle + load	damage to bridges, weight related cost	structures, bridges, pavement
Heavy vehicle	HV	whether classified heavy	enforcement	policing RUC etc
Equivalent standard axles	ESA	effect of axle load on pavement	pavement wear /damage	road maintenance and renewal

Table 2.3 shows the allocation percentages for the work category (WC) sealed pavement maintenance under local road expenditure to each of the cost drivers. The full allocation table is shown as Appendix 3. It can be seen from the table that for urban roads, sealed pavement maintenance costs are allocated between vehicle weight (GVW) axle load (ESA) and powered vehicles (PV). For rural roads, the costs are allocated between axle load and powered vehicles.

Table 2.3: Extract from CAM road cost allocation matrix

Activity Class	WC No.	NLTF Work Category (WC)	Sub-Category	% of WC	% of Sub-Category: Use-Related				
Local Road Costs					HV-km	PCE-km	GVW-km	ESA-km	PV-km
Maintenance and Operation of Local Roads	111	Sealed Pavement Maintenance	Urban <200	9%	-	-	16%	35%	49%
			200-5000	17%	-	-	16%	37%	47%
			>5000	4%	-	-	16%	40%	44%
			Rural <200	33%	-	-	-	42%	58%
			200-1000	20%	-	-	-	45%	55%
			>1000	5%	-	-	-	50%	50%
			Shoulders	12%	-	-	-	25%	75%

The table shows that total expenditure under WC 111, sealed pavement maintenance, was $126.7 million (Table 2.1) of which $68.8 million was WK expenditure and $57.8 million was expenditure by local authorities. Applying the percentages in Table 2.2 to the expenditure for the work category gives the expenditure allocations shown in Table 2.4.

Table 2.4: Allocated costs (example)

Sub-category	Allocation to cost drivers				
	HV-km	PCE-km	GVW-km	ESA-km	PV-km
Urban <200	-	-	1,828,453	3,999,740	5,599,636
200-5000	-	-	3,434,508	7,942,299	10,088,866
>5000	-	-	782,134	1,955,334	2,150,868
Rural <200	-	-	-	17,499,644	24,166,175
200-1000	-	-	-	11,528,671	14,090,598
>1000	-	-	-	3,195,196	3,195,196
Shoulders	-	-	-	3,799,681	11,399,044
Sub-total			**6,045,094**	**49,920,566**	**70,690,383**

CAM applies the percentages in Appendix 3 to the expenditures in Table 2.1. Table 2.5 summarises the resulting allocations for all road infrastructure budgeted expenditure in 2018/19.

Table 2.5: Road Costs by Cost Driver ($ million 2018/19)

Activity Class	HV-km	PCE-km	GVW-km	ESA-km	PV-km
Maintenance and operation of local roads	0.8	0.0	8.8	62.3	516.2
Renewal of local roads	0.0	0.0	103.0	178.5	222.1
New and improved infrastructure for local roads	3.9	153.0	4.1	69.9	396.8
Maintenance and operation of state highways	0.0	14.0	6.5	36.3	298.1
Renewal of state highways	0.0	0.0	84.9	81.6	85.8
New and improved infrastructure for state highways	0.0	370.2	55.5	122.9	475.1
Regional improvements	0.1	2.1	47.7	0.0	63.9
Total road expenditure- $million	**4.8**	**539.3**	**310.5**	**551.6**	**2,057.9**
Percentage	0%	16%	9%	16%	59%

2.3.3 Calculation of unit rates

The attributed costs are divided by the total kilometres for each cost driver to obtain unit costs of road use (average use-related costs). For example, the PV cost is divided by PV-km – the total kilometres expected to be operated by powered vehicles in the year. The PCE cost was divided by the expected total PCE-km. The resulting rates are shown in Table 2.6.

Table 2.6: Calculation of unit rates for budgeted road expenditure (2018/19)

Cost driver	Expenditure	Kilometres (000)	Price per km (000)	% Total Expenditure
HV	$4,765,721	4,010,197	$1.19	0.14%
PCE	$539,277,078	51,220,557	$10.53	15.57%
GVW	$310,452,698	199,450,159	$1.56	8.96%
ESA	$551,612,183	2,744,810	$200.97	15.92%
PV	$2,057,856,117	47,210,360	$43.59	59.41%
Total	**$3,463,963,797**			**100.00%**

These unit costs are then applied to the road use characteristics of each vehicle type to obtain an estimate of the financial cost by vehicle type.

2.4 Adjustment of CAM to recover WK expenditure

2.4.1 Estimation of total WK costs

The rates shown in Table 2.6 above were derived within CAM by allocating the total budgeted expenditure on road infrastructure to the five distance-based cost drivers. They therefore represent the fully allocated cost of road infrastructure. We used these financial costs as a basis for calculating the average economic cost by vehicle type. This is a measure of the resources used by road users.

CAM is set up to calculate the RUC and petrol excise duty (PED) that would be required for the full recovery of WK's own expenditure. This does not include the share of local road expenditure met by local authorities, but does include other land transport expenditure, particularly on public transport. Motor vehicle registration, licensing, liquid petroleum gas, compressed natural gas, and toll fees are treated as an input. The rates based on fully allocated road infrastructure costs are used as a starting point for calculating RUC and PED but need adjustment to ensure sufficient money is collected.

Table 2.7: Budget expenditure by WK and Local Authorities 2018/19

Activity Class	Waka Kotahi spending ($)	Local Government spending ($)
Maintenance and operation of local roads	318,578,594	269,565,650
Renewal of local roads	268,329,369	235,270,075
New and improved infrastructure for local roads	331,374,583	296,360,990
Maintenance and operation of state highways	354,884,237	
Renewal of state highways	252,242,597	
New and improved infrastructure for state highways	1,023,650,701	
Road safety promotion	51,758,646	14,162,464
Rail and sea freight	170,184,417	45,713,791
Domestic sea freight		
Walking and cycling facilities	126,374,803	78,812,872
Public transport services	576,815,452	339,414,829
Public transport infrastructure	256,434,706	151,012,002
Road policing	347,010,000	
Regional improvements	83,365,699	30,341,303
Total	**4,213,719,508**	**1,465,919,806**
Total expenditure on roads	**2,632,425,780**	**831,538,018**

Source: Te Manatū Waka

The difference between the costs covered by the road cost allocation described in section 2.3.3 and WK expenditure covered by CAM is shown by Table 2.7. In the table, the items within the green boxes (lines 2-7 and 15) include WK and local government, expenditure covered by the road allocation matrix described in section 2.3.3 and add up to $3.4 billion. The costs in the second column highlighted in the red box totalling $4.2 billion are those met by WK and include WK contribution to local roads but also include non-road expenditure. The Local Government contribution (3rd column) comes from councils (via rates and other funding).

Total budgeted WK expenditure in 2018/19 was $4,214 million. About $337 million of that comes from revenue received from other sources that do not vary with distance, which includes registrations. This leaves $3,877 million to be recovered from RUC and PED. The rates based on allocation of road expenditure alone would recover $3,464 million. The additional $413 million required is allocated by adding this to the PV cost. This increases the PV rate by some on 20%, to $52.35.

2.4.2 Calculation charges by vehicle type

The total costs to be recovered from each vehicle type are calculated by applying the unit rates to the projected kilometres operated and the vehicle characteristics. This is illustrated by Table 2.8 (light vehicles) and Table 2.9 (heavy vehicles). The rates are used to calculate the recommended RUC for different vehicle types based on the axle configuration and maximum load.

Table 2.8: Cost recovery from light vehicles

Cars/van/ute	Units (000) km	Rate per 000 km	To recover
HV	0	1.19	0
PCE	44,042,038	10.53	463,600,608
GVW	122,436,866	1.55	189,689,094
ESA	212,689	201.16	42,784,527
PV	44,042,038	52.35	2,305,743,552
Average		**68.16**	**3,001,817,781**

Source: Te Manatū Waka

Table 2.9: Cost recovery from heavy vehicles

Trucks (not towing)	Units	To recover	Trucks (towing trailers)	Units	To recover
HV	2,098,250	2,493,562	HV	952,401	1,131,834
PCE	4,739,342	49,887,833	PCE	1,399,254	14,728,996
GVW	36,790,687	56,999,107	GVW	22,229,105	34,439,127
ESA	1,525,137	306,796,615	ESA	642,412	129,227,621
PV	2,641,092	138,269,733	PV	446,853	23,394,204
		554,446,850			**202,921,783**

Source: Te Manatū Waka

The final step is to determine the level of fuel tax to recover $3.00 billion (Table 2.8) from 44 billion km of petrol vehicle travel and the RUC structure required to recover $757 million (Table 2.9) from heavy and non-petrol-powered vehicles.

For petrol powered vehicles, this is a matter of assuming a fuel consumption rate and using that to calculate the PED required to result in an average charge of 6.8 cents per kilometre. If the assumed average fuel consumption is 9.5 litres per 100 km, the rate would need to be 71.6 cents per litre. For RUC, the CAM rates are used to develop a RUC charge by vehicle type (mass, axle configuration) that reflects the particular characteristics of the vehicle.

The actual road user charge is set by Cabinet and has deviated from the CAM figure in recent years. Cabinet decided to apply a uniform increase rather than the increases indicated by CAM.

2.5 Adjustment from financial costs to economic costs

2.5.1 Adjustments required

One of the aims of the DTCC Study is to be able to compare the costs incurred by or on behalf of each type of transport vehicle with the price faced by the vehicle owner or driver (essentially the decision-maker). The road cost allocation within CAM captures the expenditure on roads in each year by type of vehicle. However, for a long-lived asset such as a road, the amount of expenditure in any one year is not necessarily the same as the average economic cost of providing the road. We have calculated the average cost as the operating and maintenance cost plus a capital charge for the use of the accumulated asset. The capital charge is based on the depreciated replacement value and reflects the investment needed to maintain and expand the network.

There is a question as to whether to use renewals or a depreciation charge to represent the ‘using up’ of the resource. We propose to use the renewals figure as giving the better estimate. Estimation of the average cost therefore involves deducting the annual budget expenditure on new and improved infrastructure and adding a capital charge for the use of the road asset. Table 2.10 shows the estimated capital value of the road asset.

Note that WK and the local road authorities use accrual accounting and have road asset values and depreciation in their accounts. However, our understanding is that these are based on historical values and nominal rates of depreciation. We have not used these estimates, using instead an assessed depreciated replacement value as the basis for the calculation.

Table 2.10: Estimated capital value of the road asset (2018/19)

Item	Replacement Cost		Depreciated Replacement Cost	
	Total	Per Route Km	Total	Per Route Km
	$B	$M	$B	$M
Roads:				
State Highways	62.23	5.5	49.7	4.5
Local Roads (Note)	76.25	0.9	61.5	0.7
Total	**138.48**		**111.2**	
Analysis by Asset Category				
Recoverable, non-depreciating (land)			33.4	
Non-recoverable (all other asset types)			77.8	

Note This assumes a similar relationship between replacement costs and depreciated replacement costs for the local road network as was determined for the State Highway network.

Source: DTCC Study, Working Paper C2: Valuation of the New Zealand Road Network

Using the depreciated replacement cost of $49.7 billion for state highways and $61.5 billion for local roads (Table 2.10) and applying a cost of capital of 4.0% pa real, this translates into an annual capital charge of $4.448 billion pa (State highways $1.99 billion pa, Local roads $2.46 billion pa). This compares with the budgeted expenditure for new roads and road renewal of $1.76 billion for 2018/19 under the current PAYGO model (Table 2.6) and actual expenditure of $1,808 million (Table ES.1).

Local authority road costs include the cost of footpaths and on-street car-parking.

2.5.2 Allocating the capital charge

Following the same approach as CAM, we need to allocate the capital costs to road users based on the relevant cost drivers. This is not an exact science and the allocations used here would usefully be subject to further research and study. The proportion of costs that are land and formation, structures, pavement and other are based on figures estimated for state highways. Further work is needed for local body roads including to separate out costs for parking and footpaths.

Land and formation are estimated to constitute 50% of the capital value for state highways . The value is a function of the road length and the road width. The length of road is related to its function in providing access. For state highways this is best represented by PV-km. On the other hand, the width of a road contributes to its carrying capacity. The area of land taken up by a road is thus related to the traffic volume in PCE. Since heavy vehicles are wider, some of the width-related cost needs to be allocated to heavy vehicles.

The question then is, how do we allocate the land and formation cost between PV and PCE. One option would be to compare the average state highway width (30 metres) with the minimum width needed for access alone. CAM allocates the expenditure for new state highways 86% to PCE and 14% to PV, implying a width of 4.3m is adequate for access alone (which is equivalent to a single lane road).

In urban areas, the length of the local road network is a function of land area served. Road networks tend to be denser where land values are higher. There is a case for charging for the length of local road through local body (unimproved value) rates rather than PV. Also, the width of the road taken up by footpaths and cycle ways might be better charged to the local body than to PCE. As this is somewhat speculative, we have used the CAM allocation of the land and formation costs of new roads.

Bridges, culverts and other structures make up 25% of the road value. For structures, the mass of the vehicle determines the strength required. In CAM, the cost of new state highway bridges is allocated 47% to GVM-km, 45% to PCE and 8% to PV; while for local roads the allocation is 46% to GVM-km, 45% to PCE and 9% to PV, while replacement of local road bridges and strictures is allocated 34% and State Highways 37% to GVM-km. We have used the new bridge allocation.

Road pavements are estimated to constitute 15% of the capital value for state highways. Most rural pavements consist of an aggregate base-course with a surface wearing layer. The required strength of this layer and thus its thickness is based on the load it will carry measured in equivalent standard axles (ESA). Pavement costs are dependent on the width, length and depth of pavement. Following the same approach as above, we calculate the proportion of the cost due to ESA by comparing average depth of basecourse plus subbase for state highways (34 cm) with the minimum required for 'light traffic'. CAM allocates 60% of the cost to ESA for both state highways and local roads implying a minimum thickness of 14 cm which is not unreasonable. On this basis, and ignoring any fixed costs, the ESA-km share of pavement costs should be 60%. The other 40% should be shared based on width as for land and formation.

Other components of the capital cost include traffic management and drainage that for new roads CAM allocates almost entirely to PV. There is a case for parking, footpaths and cycleways to be allocated to PV but the use of local access as a cost driver would be better.

The resulting overall allocation of road capital costs for state highways are thus HV 3%, PCE 29.9%, GVW 7% ESA 15% and PV 48%.

Table 2.11: Allocation of state highway capital costs

	Factors share	HV	PCE	GVW	EDA	PV
Land	0.30	0.00	0.44	0.00	0.00	0.56
Formation	0.20	0.00	0.44	0.00	0.00	0.56
Pavement	0.15	0.00	0.00	0.25	0.00	0.75
Structures	0.25	0.00	0.15	0.00	0.60	0.25
Other	0.10	0.00	0.44	0.32	0.00	0.24
Overall	**1.00**	**0.00**	**0.30**	**0.07**	**0.15**	**0.48**

The percentages are slightly different for local roads, the resulting allocation being HV 1%, PCE 22%, GVW 0% ESA 15% and PV 62%.
The road costs shown in Table 2.6 are budgeted roading expenditures for 2018/19. They need to be updated to actual expenditure. The kilometres operated can also be updated. Replacing "new and improved infrastructure" in Table ES.1 by the capital charge, and updating the maintenance and renewal costs from budget to actual, we get the figures in Table 2.12.

Table 2.12 Cost by Cost Driver – Capital Charge Approach ($ million 2018/19)

Table 2.12: Cost by Cost Driver – Capital Charge Approach ($ million 2018/19)

	HV-km	PCE-km	GVW-km	ESA-km	PV-km	Total
Local road maintenance	1.03	0.00	11.11	78.96	653.85	744.95
Renewal of Local Roads	0.00	0.00	130.46	226.15	281.25	637.86
Capital charge TLA	25.47	544.41	0.00	368.38	1,521.75	2,460.00
Maintenance and Operation of State Highways	0.00	16.45	7.58	42.51	349.00	415.54
Renewal of State Highways	0.00	0.00	99.43	95.51	100.41	295.36
Capital charge SH	0.14	594.98	139.25	298.43	955.19	1,988.00
Total cost $million	**27**	**1,156**	**388**	**1,110**	**3,861**	**6,542**
Kilometres billion	5,246	51,911	193,631	2,691	48,680	48,680

Source: Consultant estimates

As before, these unit costs can be applied to the road use characteristics of each vehicle type to obtain an estimate of the economic cost by vehicle type.

Chapter 3 Costs and Charges for Sample Vehicles

3.1 Comparison of rates

Table 3.1 compares the recommended charge by cost driver as calculated using CAM from Table 2.6 with the average economic cost shown in Table 2.12.

Table 3.1: Comparison between CAM rate and average economic cost, 2018/19

Cost driver	CAM rate $ per km)	Average Economic Cost $/km (000)
HV	$1.19	$5.08
PCE	$10.53	$22.27
GVW	$1.56	$2.00
ESA	$200.97	$412.52
PV	$43.59	$79.32

Source: Consultant estimates

Table 3.3 applies the rates shown in Table 3.1 to the estimated travel output for nine vehicle classes defined as follows.

Table 3.2: Description of vehicle classes

Vehicle class	Description
Car	Two axle vehicle less than 3.5 tons including vehicle with trailer
LCV1	Light trucks with two single-tyred axles
LCV2	Light trucks with twin-tyred back axles
MCV	Light trucks with three axles
HCV1	Trucks with four or more axles (not part of HCV2 rigs)
Trailers	Heavy trailers not included in HCV2.
HCV2A	“H” class rigs with six, seven or eight axles
HCV2B	“H” class rigs with nine or more axles
Bus	Bus

Table 3.3: Estimated RUC and average economic cost. (km in billion)

Vehicle class	vehicle km	HV-km	PCE-km	GVW -km	EDA-km	PV-km	Financial cost $/1000	Actual charge $/1000	Economic cost $/1000
Motorbike	0.4	0.0	0.2	0.2	0.0	0.4	53.9	33.0	91.5
Car	35.7	0.0	35.7	99.2	0.2	35.7	65.0	66.1	109.1
LCV1	2.1	0.0	2.1	6.0	0.0	2.1	65.0	65.9	109.1
LCV2	7.0	0.0	7.0	17.4	0.0	7.0	62.5	65.9	105.2
MCV	1.1	1.1	2.3	8.3	0.2	1.1	132.3	137.4	227.0
HCV1	0.6	1.2	1.2	11.4	0.6	0.6	336.9	377.2	570.5
HCV2A	0.7	1.4	1.4	19.4	0.8	0.7	393.3	395.9	656.1
HCV2B	0.6	1.3	1.3	28.0	0.8	0.6	461.0	316.1	747.9
Bus 2axle	0.3	0.2	0.6	2.1	0.1	0.3	132.0	201.3	224.9
Bus 3axle	0.1	0.1	0.2	1.5	0.1	0.1	296.0	402.5	498.8

Source: WK, Consultant estimates

The results in Table 3.3 confirm that current RUC are set higher than the CAM recommendations for heavy vehicles but less than our estimate of the economic cost.

3.2 Fuel Excise Duty

For light vehicles, the average economic cost is thus $108 per thousand kilometres. Fuel duties and levies average 77.76 cents per litre, (Table 3.4). Of the charges in Table 3.4, the ACC levy and the ETS levy do not relate to the provision of road infrastructure, leaving 66.58 cents per litre as the charge for road use.

Table 3.4: Automotive fuel taxes and levies (cents/litre) in 2018/19

Automotive Petrol	cents/litre
Fuel Excise Duty	62.15
Petroleum or Engine Fuels Monitoring Levy	0.30
Local Authority Petroleum Tax	0.66
ACC levy	6.00
Auckland Regional Fuel Tax	3.47
ETS Levy	5.18
Total	**77.76**

To compare the average economic cost with the PED and other charges, it is necessary to multiply 66.58 cents by the assumed average fuel consumption of 9.5 litres per 100 km, giving a rate of 63 cents per kilometre or $63 per thousand kilometres, only 58.6% of the economic cost.

Chapter 4 Limitations and Future Updates

4.1 Commentary

The main issue in calculating average economic costs by vehicle type is the attribution of joint and common costs, CAM provides a rigorous and defensible method of dividing the costs of maintaining and improving the road network between vehicle types in a fair and neutral manner based on the cost causality of each vehicle type . It works by allocating costs to five cost 'drivers'. The methodology has been reviewed multiple times: while the application of the methodology has been challenged and a number of changes made, the allocation of costs between users appears to be robust.

CAM calculates the contribution required from each vehicle class and hence the charges required to recover the total expenditure on roads in any one year. The basic calculation in CAM allocates the total (state highway plus local roads) budgeted expenditure to five cost drivers. However, there is no longer a nexus between money collected from motorists and money spent on roads. Additional costs are added to the base rate to pay for non-road expenditure by WK, while roading authorities pay approximately half the cost of WK-approved works on local roads. Since roads are funded on a PAYGO basis, the charges are based on the capital expenditure on road system improvements currently being undertaken rather than any concept of return on assets employed.

To calculate the average economic costs of the road system, we have taken the CAM analysis and stripped out the new and improved road infrastructure items and added in an economic charge based on the value of the roading asset. A comparison between the CAM rates and the estimated average economic costs was given in Table 3.1. Note that while CAM determines the allocated cost to be recovered from each vehicle type, the actual cost recovery will depend on multiple factors. For example, the analysis shows that the CAM price for light vehicles should be seven cents per kilometre. However, for charging purposes, this needs to be converted into a price per litre of petrol, so that the actual cost to each motorist will depend on their vehicle's fuel consumption. The truck rate is derived as an average cost per vehicle kilometre, but this is converted into a charge that depends on the maximum permitted load and the axle configuration. Costs by cost-driver calculated in CAM are used to make this calculation.

If the economic capital charge approach were applied in practice for setting charge rates for road use, it would bring the funding calculation more into line with the way roads are treated in each road authority's accounts . Charges would most likely increase for all motorised road users (whether diesel or petrol-powered), and the roads budget would be expected to generate a positive financial return. A secondary effect of such a change is that it would result in a slight reduction in overall road traffic volumes, and hence revenue, with a small switch to other transport modes (particularly the switching of some truck traffic to rail transport). Further analysis would be required (beyond the scope of DTCC) to quantify these likely impacts.

4.2 Limitations and exclusions

CAM allocates what are in fact common costs to cost drivers. This allows the total cost to be allocated to vehicle types based on their characteristics and results in a 'fair and reasonable' division of the total cost. However, the resulting rates will not necessarily reflect the cost impact if (say) the proportion of heavy vehicles was to change. While the PAYGO approach ensures that users in aggregate cover the current expenditures on maintaining and improving the road network, it does not take account of the historical resources committed to the road system. On the other hand, imposing a capital charge based on the depreciated replacement cost of the network would imply requiring the road system to provide a return on assets, many of which are non-recoverable and have no alternative use.

The average economic costs estimated in this paper (chapter 3) are on a comparable basis to the average costs of other transport infrastructure and services being assessed in the DTCC Study, but they do not reflect either the costs or the savings from expanding or reducing the role of road transport.

4.3 Potential areas for further work

The treatment of local authority roads between CAM and WK as funding agency is inconsistent and could potentially be improved. There is some logic in local authorities being responsible for the 'access' function of roads and for WK being responsible, on behalf of road users, for the 'travel' function. This would replace the current, somewhat arbitrary, user contribution made by WK to the cost of (WK approved) local road projects. Several possible ways of doing this could be examined further. One approach would be through CAM, including 'access' as one of the cost drivers and assigning a proportion of the capital and maintenance costs to this driver. Another approach would be for local authorities to own and maintain their roads and to charge WK (representing road users) a fee based on use. In this second model, road user charges for use of council roads paid into the land transport fund would be passed back to the local authority road owner.

Based on the financial analysis, there appears to be a significant difference between the costs – and thus the amount of the charge that would need to be applied – between state highways and local roads. Further work on the urban/rural split would be required before any strong conclusions can be drawn. To develop the equivalent economic analysis would require further work on the area and value of the land utilised.

The issue of the local contribution is complicated by the use by WK of land transport fund moneys paid by motorists for public transport (particularly) and other non-road purposes. This has created distortions in what was initially a road user fund that was paid by road users and spent on their behalf.

There may be a case for changing from the current PAYGO-based charging system (operationalised through CAM) to an economic cost-based charging structure, with charges based on securing a return on the total economic value of road system assets. This would have the potential advantages of: (i) reducing the effects of any year-to-year variations in expenditure on new roads and road improvements on charge rates to road users; (ii) better aligning expenditure and funding practices in the NZ roading sector with the prevailing practices in other parts of the NZ transport sector which receive government funding. Substantial further work would be required before taking any decisions on this question: such work is well outside the scope of the current DTCC Study.

Appendix 1 Bibliography

An Independent Review of the New Zealand Road User Charging System. Report to the Minister of Transport Road User Charges Review Group, 2009

New Zealand Transport Policy Study. Wilbur Smith and Associates, 1973.

Review of the Cost Allocation Model. Final Report of the Cost Allocation Model Working Group, Te Manatū Waka Ministry of Transport, April 2001

Update of the Road User Charges Cost Allocation Model. Report to Te Manatū Waka Ministry of Transport. Allan Kennaird Consulting, May 2009

WSP Opus (2019). 2019 Valuation of the State Highway Network Report. Te Manatū Waka Ministry of Transport

Appendix 2 Listing of DTCC Working Papers

The table below lists the Working Papers prepared as part of the DTCC Study, together with the consultants responsible for their preparation.

Ref	Topic/Working Paper title	Principal Consultants	Affiliation
	MODAL TOPICS		
C1.1	Road Infrastructure – Marginal Costs	David Lupton	David Lupton & Associates
C1.2	Road Infrastructure – Total & Average Costs		
C2	Valuation of the Road Network	Richard Paling	Richard Paling Consulting
C3	Road Expenditure & Funding Overview		
C4	Road Vehicle Ownership & Use Charges		
C5	Motor Vehicle Operating Costs		
C6	Long-distance Coaches	David Lupton	David Lupton & Associates
C7	Car Parking	Stuart Donovan	Veitch Lister Consulting
C8	Walking & Cycling		
C9	Taxis & Ride-hailing		
C10	Micro-mobility		
C11.2	Rail Regulation	Murray King	Murray King & Francis Small Consultancy
C11.3	Rail Investment		
C11.4	Rail Funding		
C11.5	Rail Operating Costs		
C11.6	Rail Safety		
C12	Urban Public Transport	Ian Wallis & Adam Lawrence	Ian Wallis Associates
C14	Coastal Shipping	Chris Stone	Rockpoint Corporate Finance
C15	Cook Strait Ferries		
	SOCIAL AND ENVIRONMENTAL IMPACT TOPICS		
D1	Costs of Road Transport Accidents	Glen Koorey	ViaStrada
D2	Road Congestion Costs	David Lupton	David Lupton & Associates
D3	Health Impacts of Active Transport	Anja Misdrak & Ed Randal	University of Otago (Wellington)
D4	Air Quality & Greenhouse Gas Emissions	Gerda Kuschel	Emission Impossible
D5	Noise	Michael Smith	Altissimo Consulting
D6	Biodiversity & Biosecurity	Stephen Fuller	Boffa Miskell

Note:
The above listing incorporates a number of variations from the initial listing and scope of the DTCC Working Papers as set out in the DTCC Scoping Report (May 2020).

Appendix 3 CAM Road Cost Attribution Table

Activity Class	WC No.	NLTF Work Category (WC)	Sub-Category	% of WC	% of Sub-Category: Use-Related				
					HV-km	PCE-km	GVW-km	ESA-km	PV-km
Local Road Costs									
Maintenance and Operation of Local Roads	111	Sealed Pavement Maintenance	Urban <200 vpd	9%	-	-	16%	35%	49%
			200-5000 vpd	17%	-	-	16%	37%	47%
			>5000 vpd	4%	-	-	16%	40%	44%
			Rural <200 vpd	33%	-	-	-	42%	58%
			200-1000 vpd	20%	-	-	-	45%	55%
			>1000 vpd	5%	-	-	-	50%	50%
			Shoulders	12%	-	-	-	25%	75%
	112	Unsealed Pavement Maintenance		100%	-	-	-	10%	90%
	113	Drainage Maintenance	Rural	90%	-	-	-	20%	80%
			Street cleaning	10%	-	-	-	-	100%
	114	Structures Maintenance	Bridge structural components	50%	-	-	20%	-	80%
			Other bridge components	50%	-	-	10%	-	90%
	121	Environmental Maintenance		100%	-	-	-	-	100%
	122	Traffic Services Maintenance	Pavement marking	25%	-	-	-	-	100%
			Signs, delineation, etc	25%	-	-	-	-	100%
			Lighting	50%	-	-	-	-	100%
	123	Operational Traffic Management	Incident response	45%	-	-	-	-	100%
			Traffic devices	55%	-	-	-	-	100%
	124	Cycle Path Maintenance		100%	-	-	-	-	100%
	131	Level Crossing Warning Devices		100%	50%	-	-	-	50%
	141	Emergency Reinstatement		100%	-	-	-	-	100%
	151	Network and Asset Management	Road maintenance	80%	-	-	-	-	100%
			Road control	20%	-	-	-	-	100%
	140	Minor events		100%	-	-	-	-	100%
	171	Financial grants		100%	-	-	-	-	100%
Renewal of Local Roads	211	Unsealed Road Metalling		100%	-	-	25%	65%	10%
	212	Sealed Road Resurfacing	Urban - Residential	34%	-	-	20%	50%	30%
			Urban - Other	12%	-	-	100%	-	-
			Rural - Structure	18%	-	-	30%	60%	10%
			Age	36%	-	-	10%	10%	80%
	213	Drainage Renewals		100%	-	-	-	20%	80%
	214	Sealed Pavement Rehabilitation		100%	-	-	25%	65%	10%
	215	Structures Component Replacements	Bridge structural components	50%	-	-	20%	-	80%
			Other	50%	-	-	10%	-	90%
	221	Environmental Renewals		100%	-	-	-	-	100%
	222	Traffic Services Renewals	Pavement marking	25%	-	-	-	-	100%
			Signs, delineation, etc	25%	-	-	-	-	100%
			Lighting	50%	-	-	-	-	100%
	231	Associated Improvements	Seal widening	70%	-	20%	-	40%	40%
			Other	30%	-	-	-	-	100%
	241	Preventative Maintenance		100%	-	-	-	-	100%
New and Improved Infrastructure for Local Roads	321	New Traffic Management Facilities		100%	-	100%	-	-	-
	322	Replacement of Bridges and Structures	Bridges	80%	-	-	34%	-	66%
			Pavement	10%	-	-	-	30%	70%
			Land, formation	10%	-	-	-	-	100%
	323	New Roads	Bridges	-	-	46%	45%	-	9%

Activity Class	WC No.	NLTF Work Category (WC)	Sub-Category	% of WC	% of Sub-Category: Use-Related				
					HV-km	PCE-km	GVW-km	ESA-km	PV-km
			Pavement	25%	-	33%	-	60%	7%
			Land, formation,	75%	-	83%	-	-	17%
	324	Road Improvements	Bridges	-	-	-	45%	-	55%
			Pavement	40%	-	-	-	60%	40%
			Land, formation,	60%	-	-	-	-	100%
	325	Seal Extension	Bridges	-	-	-	45%	-	55%
			Pavement	90%	-	-	-	80%	20%
			Land, Formation	10%	-	-	-	-	100%
	332	Property Purchase		100%	19%	40%	-	-	41%
	333	Advance Property Purchase		100%	19%	40%	-	-	41%
	XX	Targeted Community Fund		100%	-	30%	-	-	70%
	341	Minor Improvements		100%	-	30%	-	-	70%
	357	Resilience Improvements		100%	-	-	-	-	100%
State Highway Costs									
Maintenance and Operation of State Highways	111	Sealed Pavement Maintenance	Urban <200 vpd	0%	-	-	20%	50%	30%
			200-5000 vpd	3%	-	-	20%	55%	25%
			>5000 vpd	5%	-	-	20%	60%	20%
			Rural <200 vpd	1%	-	-	-	45%	55%
			200-1000 vpd	19%	-	-	-	50%	50%
			>1000 vpd	66%	-	-	-	55%	45%
			Shoulders	6%	-	-	-	25%	75%
	112	Unsealed Pavement Maintenance		100%	-	-	-	10%	90%
	113	Drainage Maintenance	Rural	92%	-	-	-	20%	80%
			Street cleaning	8%	-	-	-	-	100%
	114	Structures Maintenance	Bridge structural components	40%	-	-	20%	-	80%
			Other bridge components & structures	60%	-	-	10%	-	90%
	121	Environmental Maintenance	Stock truck effluent disposal facilities	10%	-	-	-	100%	-
			Other	90%	-	-	-	-	100%
	122	Traffic Services Maintenance	Pavement marking	40%	-	-	-	-	100%
			Signs, guardrails and delineation	40%	-	-	-	-	100%
			Lighting	20%	-	-	-	-	100%
	123	Operational Traffic Management	Incident response	40%	-	-	-	-	100%
			Traffic devices	60%	-	-	-	-	100%
	124	Cycle Path Maintenance		100%	-	-	-	-	100%
	131	Level Crossing Warning Devices		100%	-	-	-	-	100%
	141	Emergency Reinstatement		100%	-	-	-	-	100%
	151	Network and Asset Management	Road maintenance	78%	-	-	-	-	100%
			Road control	22%	-	-	-	-	100%
	161	Property Management		100%	-	95%	-	-	5%
Renewal of State Highways	211	Unsealed Road Metalling		100%	-	-	25%	65%	10%
	212	Sealed Road Resurfacing	Surface (Skid resistance)	18%	-	-	100%	-	-
			Structure (Defects)	82%	-	-	40%	40%	20%
	213	Drainage Renewals		100%	-	-	-	20%	80%
	214	Pavement Rehabilitation		100%	-	-	25%	65%	10%
	215		Bridge structural components	40%	-	-	20%	-	80%

Activity Class	WC No.	NLTF Work Category (WC)	Sub-Category	% of WC	% of Sub-Category: Use-Related				
					HV-km	PCE-km	GVW-km	ESA-km	PV-km
		Structures Component Replacements	Other bridge components & structures	60%	-	-	10%	-	90%
	221	Environmental Renewals	Stock truck effluent disposal facilities	10%	-	-	-	100%	-
			Other	90%	-	-	-	-	100%
	222	Traffic Services Renewals	Pavement marking	40%	-	-	-	-	100%
			Signs, guardrails & delineation	40%	-	-	-	-	100%
			Carriageway lighting	20%	-	-	-	-	100%
	231	Associated Improvements	Seal widening	60%	-	-	-	40%	60%
			Other	40%	-	-	-	-	100%
	241	Preventative Maintenance		100%	-	-	-	-	100%
New and Improved Infrastructure for State Highways	321	New Traffic Management Facilities		100%	-	100%	-	-	-
	322	Replacement of Bridges /Structures	Bridges	60%	-	-	37%	-	63%
			Pavement	10%	-	-	-	30%	70%
			Land, formation,	30%	-	-	-	-	100%
	323	New Roads	Bridges	20%	-	47%	45%	-	8%
			Pavement	20%	-	34%	-	60%	6%
			Land, formation,	60%	-	86%	-	-	14%
	324	Road Improvements	Bridges	10%	-	4%	45%	-	51%
			Pavement	30%	-	3%	-	60%	37%
			Land, formation,	60%	-	7%	-	-	93%
	325	Seal Extension	Bridges	-	-	-	45%	-	55%
			Pavement	50%	-	-	-	80%	20%
			Land, formation,	50%	-	-	-	-	100%
	331	Property Purchase		100%	-	40%	-	-	60%
	341	Minor Improvements		100%	-	-	-	-	100%
	357	Resilience Improvements		100%	-	-	-	-	100%
Regional improvements									
Regional improvements	321	New Traffic Management Facilities		100%	-	100%	-	-	-
	322	Replacement of Bridges /Structures		100%	-	-	34%	-	66%
	323	New Roads		100%	-	46%	45%	-	9%
	324	Road Improvements		100%	-	-	45%	-	55%
	331	Property Purchase		100%	19%	40%	-	-	41%
	357	Resilience Improvements		100%	-	-	45%	-	55%

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Working paper C1.2

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