Vehicle Dimensions and Mass Review:

Framework for Options Assessment

&

Draft Rule Change Cost Benefit Analysis

Report to the Ministry of Transport

November 2015

Acronyms and Abbreviations

COF	Certificate of Fitness
ESA	Equivalent Standard Axle
HPMV	High Performance Motor Vehicle
MOT	Ministry of Transport
NPV	Net Present Value
NZTA	New Zealand Transport Agency
RUC	Road User Charge
VDAM	Vehicle Dimensions and Mass
WIM	Weight in Motion
WOF	Warrant of Fitness

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Executive Summary

The Ministry of Transport (MOT) and New Zealand Transport Agency (NZTA) are considering possible changes to the rules that define the maximum allowable weight and size of vehicles on New Zealand Roads. These rules are known as the Vehicle Dimensions and Mass (VDAM) rule.

Castalia has been asked to develop a framework for assessing options to change the VDAM rule and to prepare a cost benefit analysis of the preferred options. This paper considers the issue of changes to heavy vehicles carrying freight. A second paper considers changes to the rules for intercity buses.

Our findings confirm that VDAM rule changes can bring significant net economic benefit

We identify six major categories of costs and benefits to evaluate the overall impact of these changes. Our assessment is that the combined effect of these changes is to deliver net benefits of between $502 million and $1,561 million.

- The current projected pathway for changes to freight fleet vehicles, delivers an additional $502 million benefit (net present value) due largely to the projected growth in payloads for vehicles near the current 44 tonne limit
- The central scenario of expected increases in high performance vehicles due to the combination of additional changes, delivers net economic benefit of $1,136 million net present value (NPV)
- Optimistic and conservative scenarios of fleet changes estimate a range of $1,561 million and $815 million net benefits respectively.

Terms of Reference for the VDAM Project

The regulatory system covering VDAM manages the risks to road safety resulting from the size and weight of heavy vehicles (primarily trucks and buses). The regulatory system also attempts to balance the risks that heavy vehicles present to public safety and the efficient operation of the heavy vehicle fleet.

The VDAM rule was introduced in 2002 and specifies, amongst other things, the dimensions and mass limits for vehicles and their performance requirements. Since its inception, the VDAM rule has undergone 11 amendments. These amendments have accounted for the projected increase in freight transport activity, changes in vehicle technology, design and use, and the government's policies and commitments in the transport sector.

The Terms of Reference for this project outline the parameters and approach for the policy development phase of the VDAM reform. It is expected that any changes will deliver net benefits to New Zealand by enabling improved commercial road transport productivity. The productivity improvements will be a result of optimising the fit between vehicles and the road network, while reducing compliance costs and after considering infrastructure costs and safety outcomes.

Options provided to date for reforming the VDAM Rule

The draft options for change to the VDAM, at this time, include:

- Changes to restrictions on mass
- Changes to restrictions on vehicle dimensions

- Simplification of the permitting regime
- Allowing heavier and larger buses on intercity routes (see accompanying paper on buses).

There are six major categories of impact from VDAM rule changes

The framework considers costs and benefits across the following categories:

> **Efficiency (productivity):** The weight and dimension limits have important impacts on the efficiency of road freight transportation. A higher loading on a vehicle will generally result in more efficient transportation per tonne-kilometre. This is the basis for the current programmes to allow “50Max” and High Productivity Motor Vehicles (HPMV) on New Zealand roads by extending the Class 1 limits.
>
> **Safety:** Safety is very important to this analysis because freight trips impose particular safety risks on heavy vehicle drivers and other road users. A higher number of trucks on the road for a given freight task will increase the risk exposure of other road users and truck operators. A higher weight per vehicle will lead to potentially larger consequences should an accident occur. However newer vehicles often incorporate higher standards of safety equipment, and therefore while heavier and wider, may not be riskier overall.
>
> **Environmental impacts:** Environmental externalities are relevant to consider as road transport creates externalities from vehicle emissions. The two primary externalities involve human health issues arising from particulates and global climate impacts from carbon dioxide emissions.
>
> **Road maintenance costs:** Road maintenance is relevant because the weight carried per axle on road vehicles impacts the required frequency of road surface maintenance and infrastructure standards. The standards of infrastructure can vary across road controlling authorities, so the cost can also vary by region. Increases in road maintenance are often a trade off with increases in weight.
>
> **Road infrastructure costs:** Road infrastructure is built to meet peak demands– such as the maximum amount of vehicles passing through a particular point and the maximum size or weight of the fleet using a particular road. Road infrastructure costs are relevant because current infrastructure limits the use of higher mass vehicles. Facilitating the use of higher performance vehicles may require new infrastructure.
>
> **Compliance costs:** Compliance costs result from enforcement activities and also from permitting and licensing requirements. In general, reducing compliance costs for a given regulatory outcome provides a net benefit. Compliance itself can also improve or diminish any of the other categories of impact (productivity, safety, etc) for any particular option.

This report uses a counterfactual test to assess the costs and benefits of the draft rule changes

Changes to the VDAM rule need to be assessed against a baseline of projected outcomes assuming that the current rule remains in place. In this report, incremental changes to outcomes are projected across a 30-year timeframe and assessed in net present value (NPV) Terms for each scenario.

Baseline analysis for the next 30 years (until 2045) defines the:

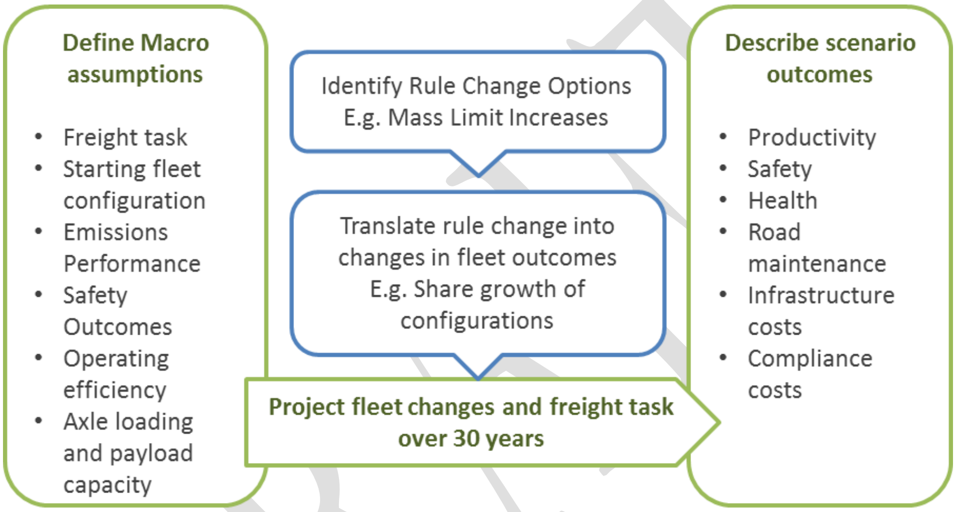
- Expected freight task

- Expected fleet configuration to deliver freight task
- Expected road maintenance costs
- Expected safety outcomes
- Expected productivity baseline
- Expected emissions profile.

The 'current policy scenario' is the expectation of outcomes without changes to the rules (including the baseline expectation of the above factors). In this case, we expect that there would be an increase in growth of 50Max trucks if rules do not change because the current permitting programme, and current growth in HPMVs, would continue.

Figure E.1 describes the cost benefit analysis (CBA) model overview:

Figure E.1: CBA Model Overview



The expected value of the current policy settings with no change to the rules is $502 million net benefit[1]

The current policy settings lead to expected growth in 50Max categories and other HPMV categories. The CBA shows that this 'counterfactual' returns $502 million in net benefits in present value terms compared with no change in the vehicle fleet. Previous CBA for 50Max has identified net benefits of $164 million (based on projected net benefits over a 5-year horizon).[2] This counterfactual assumes that 50Max will grow to 20 percent of the freight task by 2045.

Draft rule change options provide a significant increase in net benefits compared with our counterfactual

The draft rule change options involve the following possible changes:

- Increase in the general access limit from 44 tonnes to 45 tonnes (and other specific categories)
- Increase allowable vehicle width from 2.5m to 2.55m

[1] This is compared with stopping all growth in 50Max or HPMVs at the current level

[2] See "Monitoring, Evaluation and Review of the Vehicle Dimensions and Mass Rule Implementation May 2011 to April 2013". Report by Stimpson and Co. dated March 2014

- Increase allowable vehicle height from 4.25 metres to 4.3 metres
- Allow 50 Max vehicles to operate without a permit but within the 50 Max network
- Changes to permitting including 2 year bulk permitting for HPMV and more flexibility for authorities

The evolution of the heavy vehicle fleet is, in practice, a result of a combination of policy choices made over time. A CBA analysis has limited ability to assess the specific impacts of a single change to one part of the rule. The most appropriate method for analysis for a CBA is therefore to consider combinations of policy changes that generate a particular direction of change and high or low rates of change to the heavy vehicle fleet.

Four scenarios are calculated to assess the impact of rule changes. These are:

- **Scenario A:** The current policy settings (our expectation of outcomes with current settings with no change to rules)
- **Scenario B:** Draft rule change option with an optimistic interpretation of growth (our expectation of impact with an optimistic interpretation of all variables)
- **Scenario C:** The draft rule change option (our central estimate of the draft rule change options)
- **Scenario D:** Draft rule change option with a conservative interpretation of growth (our expectation of impact with a conservative interpretation of all variables).

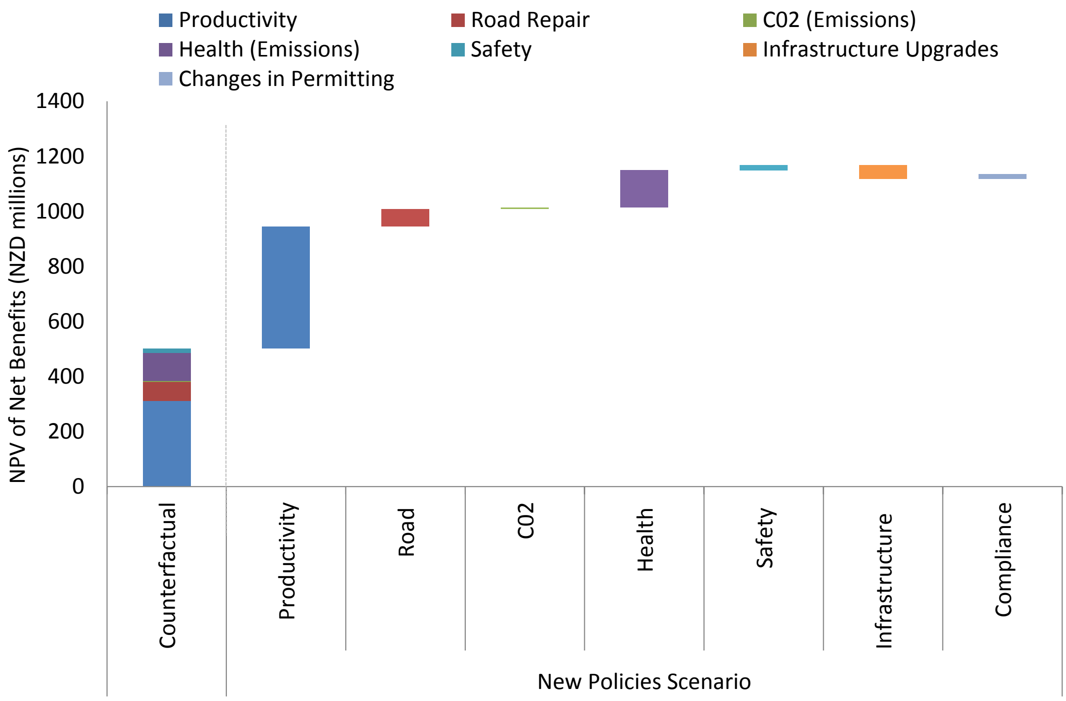
Our central forecast of freight task shares leads to a threefold increase in expected net benefits. Summary scenario outcomes are described in Table E.1.

Table E.1: Scenario Net Benefits

Scenario	Costs ($m, NPV, 8%)	Benefits ($m, NPV, 8%)	Net Benefits
A: Current Policy	0	502	502
B: New Policies— Optimistic	(50)	1,561	1,561
C: New Policies—Expected	(50)	1,186	1,136
D: New Policies—Conservative	0	815	815

The final benefits reach $1.561 million NPV (or about three times the counterfactual of $502 million) under Scenario B—ignoring buses in the interim. The cumulative change in costs and benefits under Scenario C with the counterfactual as the baseline, is shown in Figure E.2.

Figure E.2: Net Change in Costs and Benefits (Scenario C—"Expected")



Operating costs and max payloads are the most important variables

Sensitivity testing shows that the anticipated max payloads on 50Max trucks and the average expected payload on 44 tonne trucks are the most important variables in the CBA. This is followed by the operating costs for 50Max trucks. The least important variable (smallest impact) was changes to the assumptions on safety risks and expected fuel economy for new classes.

1 Introduction

Castalia has been engaged by Ministry of Transport (MOT) to:

- Develop a framework for assessing options to change the VDAM Rule
- Provide a cost benefit analysis (CBA) of the preferred options for change.

The Terms of Reference for this project outline the parameters and approach for the policy phase of the VDAM Reform. Any changes to the rule aim to deliver net benefits to New Zealand by enabling improved commercial road transport productivity. The productivity improvements will be a result of optimising the fit between vehicles and the road network, while reducing compliance costs.

This report presents a framework for assessing options to change the VDAM rule. This framework identifies the type of impacts that any rule changes will have, and how different impacts can be evaluated. The framework is then applied through a cost benefit analysis of proposed rule changes for the heavy vehicle freight fleet. An accompanying paper performs the same analysis for the heavy vehicle bus fleet.

The cost benefit analysis describes the baseline scenario (the counterfactual), and presents three scenarios that explore how the possible changes proposed will affect overall outcomes.

2 Analytical Framework

We present a framework for analysing the various impacts that would be generated by any changes to the VDAM rule. We also identify how each type of impact can be measured, and the information sources that can be used to estimate impacts. These impacts are quantified in the CBA presented in Section 4.

The framework considers impacts of rule changes across the following categories:

- Productivity
- Safety impacts
- Environmental impacts
- Road maintenance costs
- Road infrastructure costs
- Compliance costs (including administration costs).

Scenario analysis is the primary method to understand the impact of rule changes

Each scenario for rule changes generates a different configuration of fleet and market share of the freight task for each category of vehicle. This outcome will produce a productivity, safety, environmental, maintenance, infrastructure and compliance cost result for each scenario.

2.1 Productivity Benefits

Changes in maximum vehicle dimensions and mass will have a direct impact on vehicle productivity. Higher payloads lead to fewer trips–other things remaining equal–which reduces the cost per tonne-kilometre.

Productivity impacts are not confined to freight. Options to change the VDAM rule will also affect productivity across other transport activities, including passenger transport and the movement of specialised vehicles, such as cranes.

Measures and sources

We measure truck productivity as the cost per tonne-kilometre to shift freight. This measure captures truck productivity improvements relative to any increase in capital and operating costs to accommodate the trip. Productivity changes for passenger transport are measured by the cost per passenger-kilometre.

We assume capex costs and labour costs are the same between 44Max trucks and higher weight trucks. In terms of elasticity of operating costs to kilometres travelled, we assume that newer trucks are likely to be used more than the older trucks they replace. This provides a lower running cost. Larger 50Max trucks are scaled from the average for fuel cost per tonne per payload shown in

Table 2.1.

Table 2.1: Operating Cost per kilometre

Operating Cost per km	Current $/km	Operating Cost Elasticity to Annual Travel
B-Train NZ 8 axles 44Max	2.55	-0.40
Artic NZ 6 axles 39Max	2.65	-0.35
Truck Trailer 8 axles 44Max	2.85	-0.40
Average	2.68	-0.38
58Max	3.10	-0.38
50Max	2.86	-0.38
Incremental Fuel Cost per tonne-kilometre of Payload	0.03	0.03

Source: http://www.rtfnz.co.nz/cms_show_download.php?id=148

Clearly heavy vehicles are not routinely filled to their maximum carrying capacity. As with other modes that transport goods and people, heavy vehicles have utilisation rates that are less than 100 percent. The utilisation rates are important for understanding the productivity impacts of heavy vehicles because average loading levels directly affect the cost of completing a given freight task (with lower utilisation rates leading to higher costs).

Average cargo by truck weight assumptions are provided in Table 2.2 including proposed rule options. Some larger vehicle options are within the model but are not current rule change options.

Table 2.2: Average Cargo by Truck Weight and Rule options

Max	Ave	Ave Tare Weight	Average Payload t/km
60	49.4	17.7	28.3
58	47.7	17.7	27.2
50	41.2	17.2	22.5
44	36.2	16.7	19.5

42	25.0	15.9	9.1
41	29.8	15.6	14.2
39	26.7	14.8	11.9
37	21.1	14.0	7.1
36	21.8	13.7	8.1
	Special Case		
Max	**Ave**	**Est Truck Weight**	**Average Cargo t/km**
44 OD	38.15	16.7	21.5

Source: WiM data for the 44Max. Assume ratio of tare weight and average payload for 44Max to scale with truck mass limit

Assumptions about compliance in the system impact our baseline assumptions. If an option was to change the tolerance levels that compliance officers accept for overweight trucks, for example, then this would have an impact on the expected average payload. Similarly an increase in effort within the compliance regime would also have an impact on expected average payloads.

2.2 Safety

The safety outcomes from changes to the VDAM rule have three main drivers:

- The number of trips for a given freight task–increases in efficiency may lead to fewer trips and result in a lower safety risk to all users of the network
- Increased mass of each individual vehicle–higher mass may pose a safety risk as the consequences of an accident increase with mass
- Newer vehicles incorporate higher standards of safety equipment–accelerating fleet turnover may increase safety outcomes therefore if it lowers the expected fleet age.

We expect that improvements in productivity will provide benefits to safety through reduced truck movements. However, some of this benefit will be lost as, safety risks increase with weight. For example, 50 tonne trucks require greater stopping distances and will carry more energy into any collision or accident. This will mean higher mass trucks will have higher risks and cause more serious outcomes.

Newer technology generally has higher safety factors and lower risk. But newer technology would also be introduced under a counterfactual of no changes to VDAM as the fleet turns over. Benefits from this source would only arise as a result of change options that led to the rate of fleet turnover that are caused by changes to the VDAM.

Measures and sources

We assess the direct effect of trip numbers to measure safety risk exposure. This is quantified by measuring the safety risk exposure from the number of trucks and trips based on known incident rate data.

These two secondary effects are small and act in opposite directions. Neither can be adequately quantified. For this reason we assume that these small qualitative impacts that act in opposite directions do not change the outcome of safety effects in proportion to overall trip exposure.

Accident frequency baseline assumptions are described in Table 2.3.

Table 2.3: Accident Frequency

# per 100 x 10^6 kms	Total Accidents	Fatalities	Injuries
50Max ,44Max OD, Existing 44Max Fleet	9.87	1.68	8.19

Source: Stimpson and Co. report with Castalia assumption on 50Max

Safety costs are a result of accident frequency and the cost of accidents. The assumptions on the cost of injury and death are described in Table 2.4. This is the standard assumption used in transport analysis and is based on willingness to pay to avoid a fatality or serious injury study.

Table 2.4: Safety Costs

Cost per Fatality	$4,582,000
Cost per Serious Injury	$857,000
Cost per Minor Injury	$90,000

Source: http://www.transport.govt.nz/assets/Uploads/Research/Documents/Social-Cost-June-2014-update.pdf—Table 4

The CBA model will generate trip numbers by class within each scenario which will be multiplied by safety risk factors of exposure. This is then multiplied by cost of life/injury.

2.3 Environment and Health

There are several sources of environmental impact from VDAM rule changes. Less truck trips will create benefits from a reduction in noise, localised congestion, and reduced emissions. Direct environmental impacts include:

- Truck movements–reduced truck kilometres will reduce net emissions
- Engine cycle–at low speed, higher mass trucks could have higher emissions or pollutants
- Regulated technologies–compliance standards may require higher mass trucks to incorporate technology that reduces emissions and pollutants. These regulations will come at cost that needs to be assessed as part of the cost benefit analysis.

Each scenario for rule changes generates a different configuration of fleet and market share of the freight task for each category of vehicle. This outcome will produce an emission profile for each scenario.

Measures and sources

The model generates trip kilometres for a given freight task, which generates an expected emission rate for a given fleet configuration. Fuel economy assumptions are presented in Table 2.5.

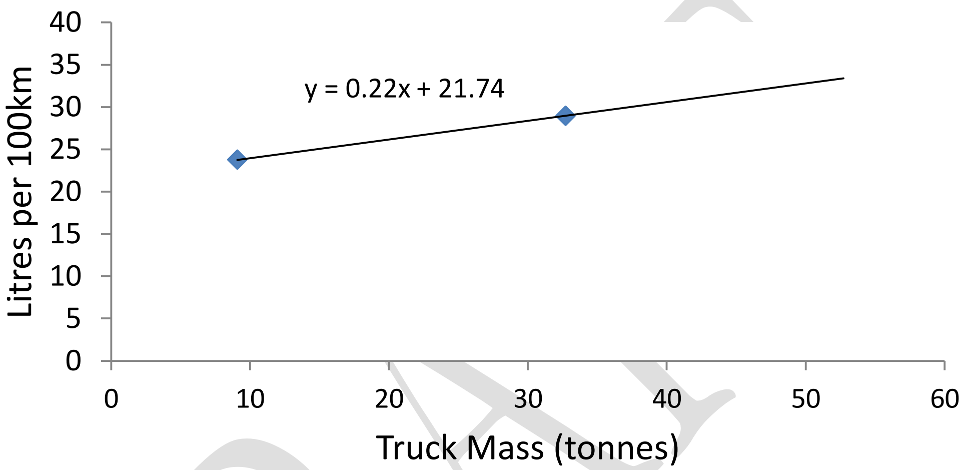
Table 2.5: Fuel Economy

Class	Litres per 100 km (at Average Capacity)
50Max	33
37Max-44Max	31

Source: Adapted from Oak Ridge National Laboratory (2011) Effect of Weight and Roadway Grade on the Fuel Economy of Class-8 Freight Trucks, http://cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2011_471.pdf

The relationship between mass and litres per 100km is shown in Figure 2.1.

Figure 2.1: Projected Fuel Efficiency



Source: Adapted from http://cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2011_471.pdf

Emissions cost is determined by the relationship between diesel emissions and health costs related to air pollution. We assume a fixed proportion of diesel emissions to health costs. presents our assumptions for the cost of emissions.

Table 2.6 presents our assumptions for the cost of emissions.

Table 2.6: Emissions Cost

Diesel Emissions	kg $C0_2$-eq per Litre	2.7
Carbon Costs	NZ$ per tonne-$C0_2$	$40.0
Total Air Pollution Health Costs from Rigid & Articulated Trucks	NZ$/year (m)	$741.4

Source: http://www.hapinz.org.nz/HAPINZ%20Update_Vol%201%20Summary%20Report.pdf

Carbon cost taken from NZTA's Economic Evaluation Manual found at https://www.nzta.govt.nz/assets/resources/economic-evaluation-manual/economic-evaluation-manual/docs/eem-manual.pdf

2.4 Compliance Costs

A number of different costs arise from administering and interacting with the system that controls vehicle dimensions and mass. We have grouped these costs under the heading of "compliance costs" which includes:

- Stakeholder compliance costs:
  - Time and cost to apply for permits and permissions including time spent waiting to have weight checked
  - Cost of any required equipment to achieve compliance
- Administrative costs–the costs of operating and enforcing the VDAM rule:
  - Capital cost of new technology to check vehicle weights
  - Operating cost to conduct compliance checks and enforcement
- Indirect costs:
  - Productivity costs if enforcement was to tighten and weight limits were effectively reduced, or benefits if loads could be achieved closer to tolerances
  - Fines (which could reduce if systems were more accurate and simpler to use)
  - Road wear costs (which could reduce if mistakes in overloading were to diminish, or loads decreased).

Increasing compliance processes and effort will increase costs. These costs are due to increased monitoring effort or from new investments into weigh-in stations. The time to stop and be checked will also raise compliance costs on vehicle owners/transport operators.

The weight in motion report highlighted that trucks often exceeded the maximum 44 tonne weight limit and a compliance tolerance threshold is in operation.[3] There are many reasons why weight might exceed the limit, some related to a simple failure to comply, and some related to less controllable variations in payload such as weather, or in some circumstances density of product. If the tolerances were reduced *and this led to a lower average payload* then this will reduce the productivity of the fleet. It is likely that the relationship is complex however and a suite of factors including compliance effort would also have an impact.

Measures and sources

The number of permits required and their length determines the total cost of time for the industry. To assess the total cost of this time, we use the average wage in the transport industry scaled up to account for overheads. In the same fashion the number of stops required and the duration of each leads to the cost of time per check.

To quantify the impact of the strictness of in motion checks and thresholds/tolerances, we assume a level of lost productivity based on the expected number of checks that are performed.

Table 2.7 presents an example of a compliance cost benefit generated by a reduction in declined permits in a year.

[3] See "Annual Weight-In-Motion (WiM) Report 2013" available at http://www.nzta.govt.nz/resources/weigh-in-motion/

Table 2.7: Example of Compliance Cost Benefits from Reduced Permits

Compliance benefit	
Number of declined permits per year	310
Hours to lodge permit	8
Hourly labour costs – full cost estimate	50
Annual Compliance Benefit	124,000

2.5 Road Repair Costs

Road damage increases exponentially with weight on each axle. The average expectation is that it increases to the fourth power, but power factor values as high as 7 and as low as 2.5 might be suitable in some circumstances. The configuration of trucks carrying the freight task is therefore a critical factor affecting pavement damage and road maintenance and repair costs.

Bridges and other fixed infrastructure also degrade more rapidly with higher weights.

Limits on the availability of roads for certain vehicles also impacts on productivity, as some routes may not be usable by higher weight trucks. This means that in some scenarios, heavier vehicles can only gain limited market share because the network from their origin to destination is not capable of handling the efficiently sized load.

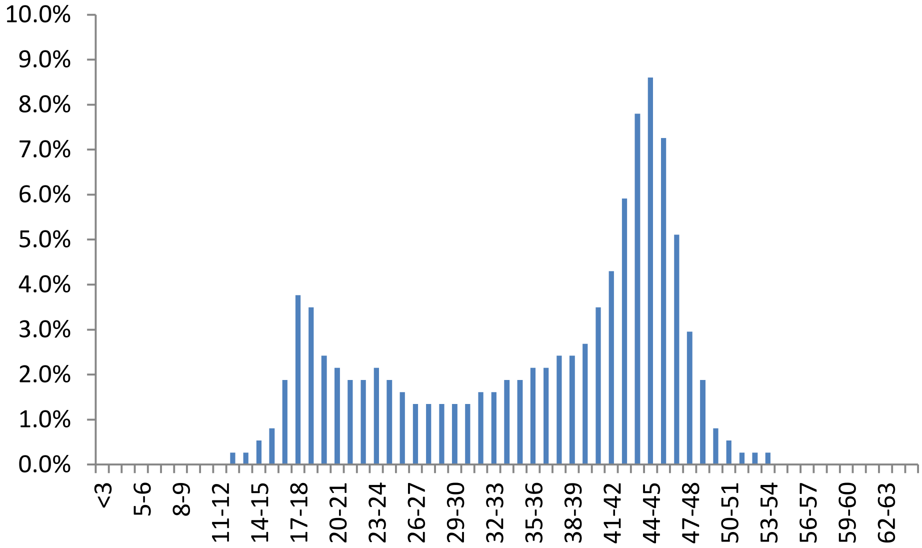
Measures and sources

We calculate road repair costs by looking at the variance of Equivalent Standard Axle (ESA) across the fleet. We multiply the ESA of each truck by the number of kilometres the truck travels and sum this across the fleet to get a measure of the total ESA on the roads.

Estimating the ESA from its average payload is not an accurate measure because the ESA varies exponentially with a truck's mass. Instead, we have calculated the average truck ESA per kilometre by taking an ESA distribution over the truck weight multiplied by the frequency of time at which the truck is used at that weight.

Figure 2.2 shows the percentage of trips frequency per vehicle mass for 44Max trucks. The average per trip is 35.7 tonnes, with an estimated truck weight of 12.5 tonnes and an estimated average payload of 23.2 tonnes.

Figure 2.2: 44Max Percentage of Trips Frequency per Vehicle Mass (tonnes)



Source: Castalia based on WiM data.

We assess a truck configuration evolution under different rules which includes expectations of:

- Number of axles, spacing of axles and number of tyres on each axle
- Distribution of weight across axle
- Type of suspension used.

A crucial aspect for this task will be our macro-projection on the growth/change in each heavy vehicle class caused by the rule change.

Assumed pavement strength is described in Table 2.8.

Table 2.8: ESA Power Factors

ESA Power Factor	4.0
Road User Costs for Trucks > 3.5t	$709.9 million

Source: What do heavy vehicles pay for and is it enough? (Table 2, Page 11)

2.6 Infrastructure Costs

Infrastructure costs will likely increase with higher mass trucks. Although only 40 bridges on State Highways remain unavailable to 50 tonne trucks, the costs of upgrading these bridges may be significant. Higher mass trucks could also negatively affect the useful life of assets such as bridges.

Measures and sources

We take the upper bound infrastructure upgrade cost from the Stimpson and Co. report[4] of $54 million in present value terms. We use this fixed figure to reflect the cost of

[4] "Monitoring, Evaluation and Review of the Vehicle Dimensions and Mass Rule Implementation May 2011 to April 2013". Report by Stimpson and Co. dated March 2014

infrastructure upgrades if higher mass vehicles grow their share of vehicle trips, which includes most scenarios modelled. Further information on the exact level and nature of investments that would be needed–beyond the current investment plan–if the weight of vehicles grew significantly would be a useful addition to this study.

2.7 Wider Costs and Benefits

In our view, there will be positive and negative secondary influences from the proposed rule changes.

Wider Benefits will include economic benefits from improved productivity. Consumers will benefit from reduced costs of goods. This may lead to an increased consumption of goods and services. These benefits may also have positive regional impacts—with areas relying more on road transportation enjoying greater benefits.

Wider costs will include any significant secondary costs if cargo shifts from rail to road. Road transport has higher emission and safety costs. In addition, there may be small savings from reduced rail freight, given that operating and capital requirements are relatively inelastic to rail freight volumes.

Measures and Sources

We have not included an appraisal of wider costs and benefits.

3 Baseline Analysis

Changes to the rules are assessed against a baseline of projected outcomes. Incremental changes to outcomes are projected across a 30-year timeframe and assessed in current dollars for each option.

The baseline analysis includes the:

- Expected freight task
- Expected fleet configuration to deliver freight task
- Expected road maintenance costs
- Expected safety outcomes
- Expected productivity outcomes, including the net impacts of compliance costs
- Expected emissions profile of the vehicle fleet.

We then measure how changes to VDAM rule alter the configuration of the vehicle fleet, and how those changes drive incremental costs and benefits.

3.1 Current State Analysis

The annual kilometres travelled by vehicle type number is presented in Table 3.1.

Table 3.1: Annual Kilometres per Vehicle Type Number

Trailer Type #	Number of Units	Annual kms
28	306	13,839
29	4,024	40,021
33	5,428	48,004
37	3,418	26,131
43	9,467	65,956

44 OD/50/58Max[5]	Modelled	65,956
Other (less used) Heavy Trailers	1,588	11,634

Source: http://www.nzta.govt.nz/vehicle/your/50max/docs/report-of-vehicle-configurations.pdf

From this baseline data, we estimate the number of trailers in the existing fleet and use this data to estimate the number of trucks. Based on the different annual kilometres travelled, we derive the percentage of tonne kilometres per weight class.

Figure 3.1 presents summary statistics on the vehicle fleet and their current share of the freight task.

Figure 3.1: Current State Share of Tonne-kilometre by Class

Existing Fleet Data[6]	PAT Truck Class	Number of Trucks %	% of Tonne-kms
50Max	1133, 1032, 1020, 951, 915, 914	2.6%	4.7%
44 OD	1133, 1032, 1020, 951, 915, 914, 891, 851, 751	2.60%	3.0%
44	1020, 951, 915, 914, 891, 851, 847, 826, 751, 713, 77, 63	76.2%	81.5%
42	747, 66, 61	0.1%	0.1%
41	791, 68	3.1%	3.9%
39	69	11.0%	5.9%
37	52	0.5%	0.1%
36	53	2.4%	0.7%

Source: Adpated from WiM data and from http://www.nzta.govt.nz/vehicle/your/50max/docs/report-of-vehicle-configurations.pdf

The future shares of different classes under different rule change scenarios are the key prediction to assess the costs and benefits of proposed rule changes.

3.2 Growth under the Counterfactual

The counterfactual is the expectation of outcomes without changes to the rules and therefore incorporates growth in the current 50Max category. In this case we expect that there would be an increase in growth of 50Max trucks if rules do not change. This will generate costs and benefits.

The counterfactual is what we wish to measure proposed rule changes against. This can be distinguished from a measurement against a static current state. The current state is evolving in a particular direction. It is deviations from this direction that we wish to assess as this provides a much more realistic benchmark for actual value created. It also places a focus on the assumptions that make up the counterfactual as these become as

[5] Larger dimension and higher mass trucks are likely to be operated efficiently, thus we assume all B-Train and Truck-Trailer configurations under these categories operate at a high efficiency

[6] Eligible PAT truck types for 50Max and 44 OD, based on pro-forma requirements

important to the outcomes as the assumptions regarding how options will influence this path.

For example, 50Max and HPMV classes are currently growing their share of the freight task. This growth will have an expected path under the counterfactual and our assessment of rule changes is relative to this counterfactual. We estimate the value of the current path compared with current state and assess the benefit cost ratio (BCR) of this path.

Assumptions on the expected rate of growth of the newer classes and the maximum share that they can grow to are important for this analysis. This assumption is described in Table 3.2.

Table 3.2: Capture of Total Tonne-KM ("The Counterfactual")

Future Capture of Total tonne-km[7]	Share
50Max	20.0%
44 OD	10.0%
44	59.2%
42	0.1%
41	4.0%
39	6.1%
37	0.1%
36	0.7%

Source: calculated from http://www.nzta.govt.nz/vehicle/your/50max/docs/report-of-vehicle-configurations.pdf

4 Draft Rule Change Assessments

The draft options paper details some options for change. It is expected that there will be some variations to these options in the future; however, these options have been used to test and develop the framework for assessment. The most material changes presented to date are:

- Changes to restrictions on mass
- Changes to restrictions on vehicle dimensions
- Simplification of the permitting regime.

The changes contemplate making it easier for 50Max trucks to gain market share through permitting changes. We examine rates of uptake for 50Max vehicles given these rule changes.

The tolerance of the current compliance regime for weight is known. The average weight is 46 tonnes against a limit of 44 tonnes. This is generated by WIM data. The draft rule changes consider a tolerance of 0.5 tonnes and a limit of 45 tonnes on current 44 tonne category trucks.

[7] Approximated from existing permits for 50Max, and 44 OD

4.1 Draft Rule Change Options

The specific draft rule changes presented to date are described in Table 4.1.

Table 4.1: Draft Rule Change Options

Category	Draft options
Changes to Dimensions	▪ Increase allowable vehicle width from 2.5m to 2.55m ▪ Increase in allowable vehicle height from 4.25 metres to 4.3 metres
Changes to Mass	▪ General category goes from 44 tonnes to 45 tonnes with a tolerance of 0.5 tonnes ▪ 50Max is allowed without a permit on the 50Max network ▪ Increase mass limits for specific categories ▪ Increase pro forma car transporter gross mass from 36 tonnes to 38 tonnes
Changes to Permitting	▪ Introduce two year bulk permits for HPMV- ▪ Give RCAs greater flexibility to permit overweight vehicles ▪ Formalise current working list of indivisible loads ▪ Provide exceptions for crane boom sections

Source: MOT

4.2 Impacts of the Draft Rule Changes on Freight Task Shares

The rule changes are expected to increase the growth rates of share of 50Max fleet. The reduced restrictions on network use and the permitting changes will lead industry to perform an increasing share of the freight task with the higher productivity vehicles.

The way that the rules are designed and enforced will affect the growth rates of heavier vehicles. For example, the self-permitting option with a limited network would have a lower rate of growth of heavier vehicle classes than the unrestricted option.

Compliance thresholds may also reduce anticipated load factors, although this will depend on the degree of enforcement. Conversely, dimension changes would increase payload factors—with wider vehicles generally carrying heavier loads.

Buses will be assessed separately to the freight fleet model analysis.

Rule changes lead to fleet model impacts

The rule changes lead to changes in outcomes in the fleet model. The key outcomes that affect the cost benefit analysis are the:

- Extent that 50Max trucks grow their market share of the freight task
- Extent to which HPMV vehicles grow their share of the freight task
- Extent to which the 44 tonne category changes its net payload factors.

Four scenarios of change are modelled

Scenarios of change are inputted into the cost benefit model to generate incremental changes across the evaluation framework. For each scenario a pathway is predicted based on an interpretation of the changes that would occur under the conditions set for the scenario. Our scenarios are:

- **Scenario A**: The current policy settings

- **Scenario B**: Draft rule change option with an optimistic interpretation of growth
- **Scenario C**: The draft rule change option
- **Scenario D**: Draft rule change option with a conservative interpretation of growth.

We describe key parameters for our scenarios in Table 4.2. Other factors will also cause changes in outcomes besides these parameters.

Table 4.2: Fleet Share Parameters for Scenarios A, B, C, D

Freight Task	2015	2045			
	Current	A: Counterfactual	B: New Policies—Optimistic	C: New Policies—Expected	D: New Policies—Conservative
50Max	~3-5%	20%	50%	35%	20%
44 [Over Dimension]	~3-5%	10%	15%	12.5%	10%
36-44	92%	70%	45%	52.5%	70%

These scenarios are inputted into the fleet model and CBA model to generate incremental costs and benefits across the categories in the evaluation framework. A summary of the cost benefit ratios is provided in Table 4.3.

Table 4.3: Net Benefits for Scenarios A, B, C, D

Scenario	Costs ($m, NPV, 8%)	Benefits ($m, NPV, 8%)	Net Benefits
A: Current Policy	0	502	502
B: New Policies— Optimistic	(50)	1,561	1,510
C: New Policies—Expected	(50)	1,186	1,136
D: New Policies—Conservative	0	815	815

Infrastructure costs are set at the value obtained from the Stimpson report[8] reflecting investment costs identified to date.

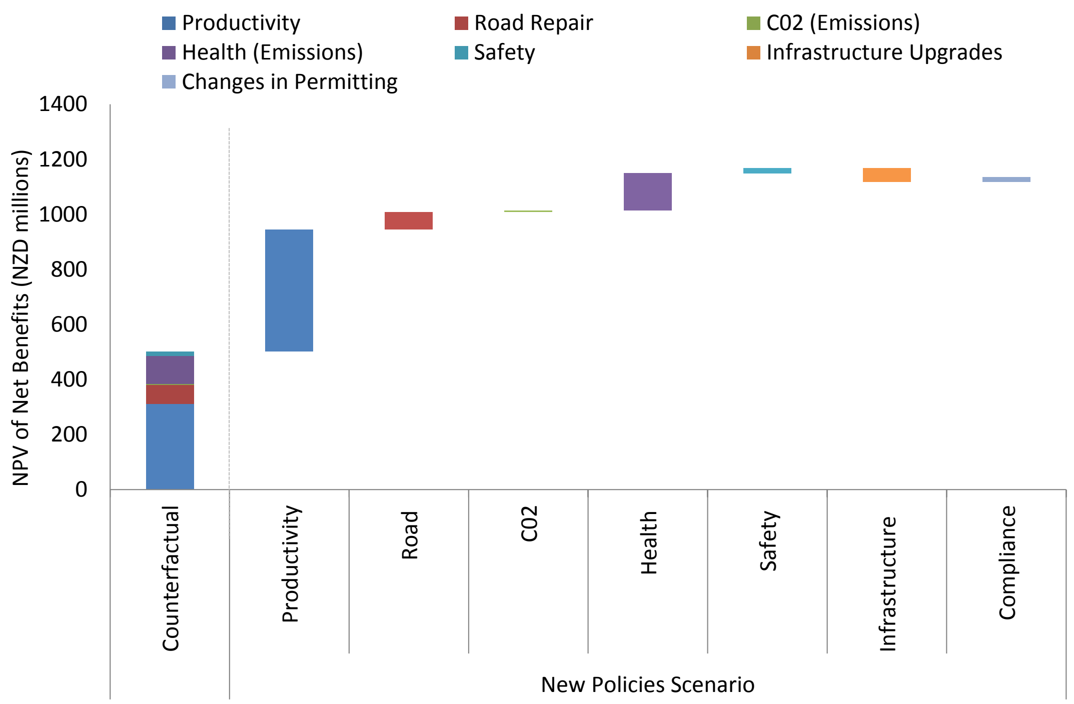
Drivers of benefits and our expected outcome under Scenario C

The final benefits reach $1.136 billion NPV (or approximately three times the counterfactual of $502 million) under Scenario C—buses are considered separately in the accompanying paper.

A summary of the impact from each evaluation framework outcome is shown in Figure 4.1.

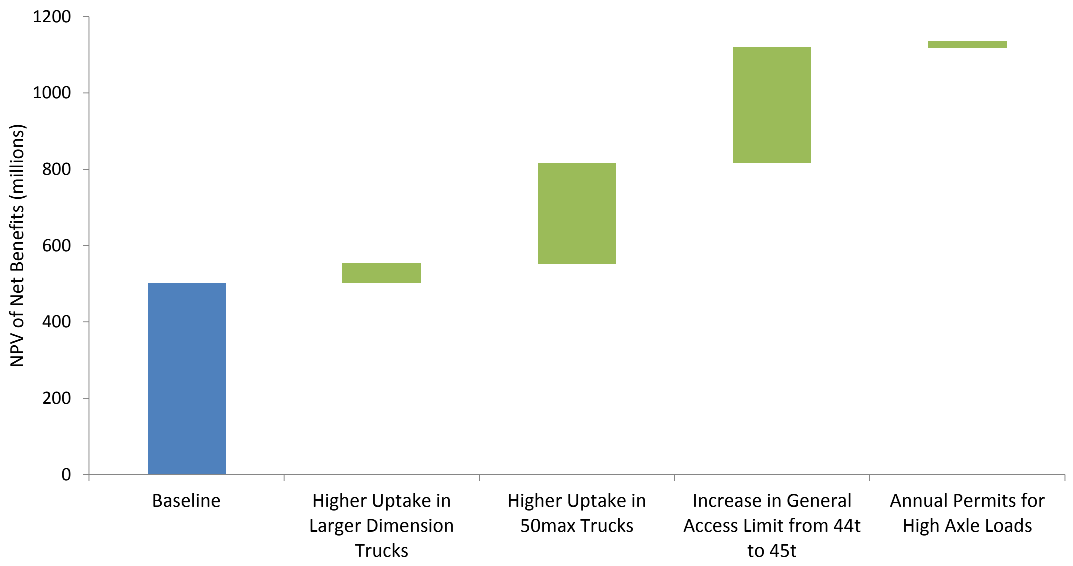
[8] "Monitoring, Evaluation and Review of the Vehicle Dimensions and Mass Rule Implementation May 2011 to April 2013". Report by Stimpson and Co. dated March 2014

Figure 4.1: Net Change in Costs and Benefits (Scenario C—"Expected")



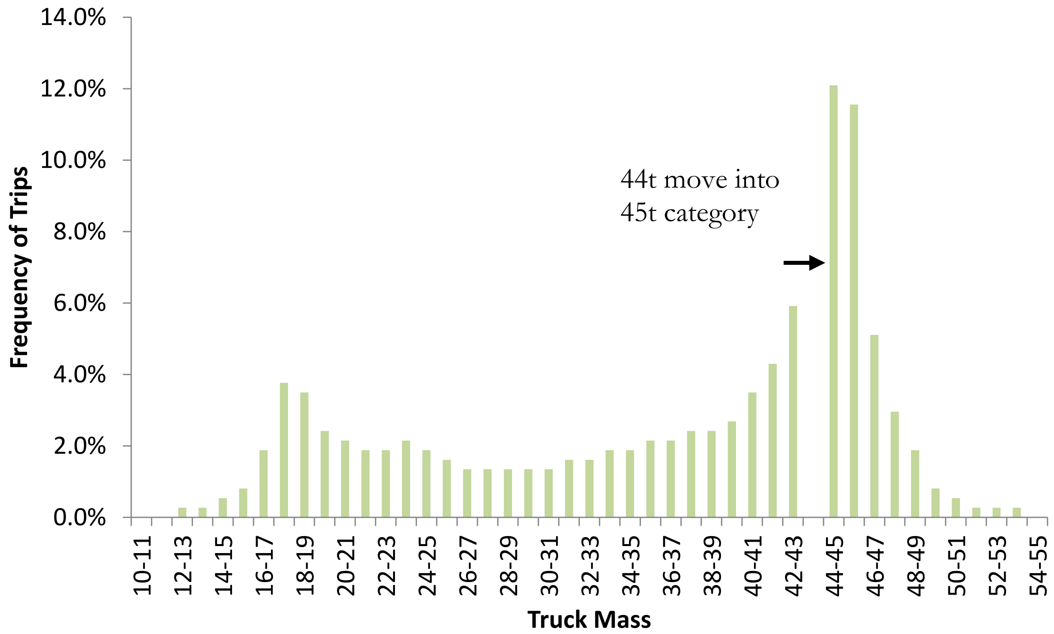
We have also disaggregated theses cost and benefits by each key policy reform. Increasing the general limit from 44 tonnes to 45 tonnes has the largest impact, and the growth in 50 Max also contributes significantly.

Figure 4.2: Key Drivers of Costs and Benefits (Scenario C—"Expected")



In our analysis we have assumed the 45 tonne limit will result in a 0.12 tonne increase in the average payload. This increase was calculated by assuming that the existing truck trips at the 44 tonne limit now increase to 45 tonne. Using the WiM data, about 12 percent of trips were at or close to the 44 tonne limit compliance. Given that this new limit would result in immediate productivity benefits for incumbent operators, the NPV of net benefits equates to about $350 million. The effect of an increase in the general access limit on the trip frequency by mass is illustrated below.

Figure 4.3: Assumed Trip Frequency Distribution with Change in the General Limit from 44 tonne to 45 tonne



Source: Castalia based on WiM data.

4.3 Summary of Results of Cost Benefit Analysis

Scenario A: The current policy (counterfactual)

The current policy scenario is the set of assumptions that make up the expected outcome if no changes are enacted by this Review. It is subject to uncertainty as the growth of the 50Max and other aspects of the fleet must be estimated. The assumptions that create this scenario outcome are the baseline assumptions that are used in each of the scenarios.

The baseline assumptions in the current policy counterfactual are:

- 50Max and higher dimension trucks grow at historical rates over the outlook period
- 50Max has a maximum 20 percent capture of freight by 2045
- We assume that as 44 trucks shift to 50Max the average payload increases by 3.0 tonnes—this assumes that 50Max operators maximise their use of the higher payload allowance
- Higher Dimension trucks capture 10 percent of freight by 2045
- No change in permitting
- Pro-forma vehicle requirements apply to 50Max.

Table 4.4 presents the net outcomes for each of the framework assessment parameters.

Table 4.4: Scenario A Costs and Benefits ($ millions)

Base Case	NPV Costs	NPV Benefits
Productivity		311.6
Road Costs		67.8
$C0_2$ Costs		4.0
Health Costs		102.3
Safety Costs		16.3
Infrastructure Upgrades		
Compliance Costs		
Total	0.0	502.0
Net Benefits	502.0	

Scenario B: Optimistic Scenario

The optimistic scenario presents the set of assumptions for parameters that are the most favourable without being unrealistic outliers. The assumptions are:

- 50Max grows aggressively to capture 50 percent of the freight market by 2045[9]—given no annual permitting on units that meet pro-forma requirements. Trucks must have a minimum of nine or more axle to qualify under a 50Max open access
- As in our counterfactual, we assume that as 44 trucks shift to 50Max the average payload increases by 3.0 tonnes. We have run a sensitivity analysis to test this assumption
- Large dimension 44 trucks increase their market capture to 15 percent—given that permit applications are streamlined facilitating higher growth
- Weight restrictions on 44 increased to 45 with a 0.5 tonne tolerance—we estimate that this would increase the average payload of compliant incumbent operators by 0.12 tonne.
- Permit application for high axle loading, issued on 2-yearly basis rather than a trip by trip basis

Table 4.5 presents the net changes to each of the framework assessment categories under Scenario B.

Table 4.5: Scenario B Costs and Benefits ($ millions)

Base Case	NPV Costs	NPV Benefits
Productivity		966.4
Road Costs		199.0
$C0_2$ Costs		12.3
Health Costs		317.0
Safety Costs		48.5
Infrastructure Upgrades	-50.5	

[9] This is the highest share of the task that has been estimated as achievable for HPVs based on historical growth rates for HPVs and the nature of the task undertaken

Compliance Costs		17.4
Total	-50.5	1560.6
Net Benefits	1,510	

Scenario C: Draft Rule Change Scenario

The Scenario C is the expected or midpoint scenario for each of the parameter assumptions. It is the expected outcome without being optimistic or conservative. The variations to assumptions are:

- We have altered the freight task assumption used in Scenario B, reducing the growth in the task allocation of 50Max (from 50 percent to 35 percent), and over dimension 44 trucks (from 15 percent to 12.5 percent).

Table 4.6 presents the net changes to each of the framework assessment categories under Scenario C.

Table 4.6: Scenario C Costs and Benefits ($ millions)

Base Case	NPV Costs	NPV Benefits
Productivity		754.4
Road Costs		131.2
$C0_2$ Costs		9.5
Health Costs		238.1
Safety Costs		35.4
Infrastructure Upgrades	-50.5	
Compliance Costs		17.4
Total	-50.5	1185.9
Net Benefits	1,136	

Scenario D: Draft Rule Change Scenario (Conservative)

The conservative scenario presents the set of assumptions for parameters that are the most favourable without being unrealistic outliers. The assumptions are:

- We have altered the freight task assumption under Scenario B, reducing the growth in the task allocation of 50Max (from 50 percent to 20 percent), and over dimension 44 trucks (from 15 percent to 10 percent).
- The only difference between this scenario and our baseline scenario is the change in the general access limit from 44t to 45t and the change in permitting.

Table 4.7 presents the net changes to each of the framework assessment categories under this scenario.

Table 4.7: Scenario D Costs and Benefits ($ millions)

Base Case	NPV Costs	NPV Benefits
Productivity		541.5
Road Costs		63.7
$C0_2$ Costs		6.6
Health Costs		159.0

Safety Costs		26.4
Infrastructure Upgrades		
Compliance Costs		17.4
Total	0.0	814.7
Net Benefits	815	

4.4 Scenario Sensitivity Analysis

We have modelled sensitivities to key variables using Scenario A—the counterfactual–as a baseline to understand the sensitivity of each of the baseline assumptions.

We have tested a 5 percent higher accident rate from 50Max trucks compared with the baseline assumption of no change due to weight. Here we are testing the impact of a safety risk factor from increasing weight. We are interested in whether the impact of current new 50Max trucks is hiding this factor as they are new trucks and have lower accident rates. Even without 50 max options trucks there would still be fleet turnover as new trucks replace old. New 44 tonne trucks will also have better accident risk ratings than older 44 tonne trucks.

We also test a 5 percent increase in 50Max operating costs and a 5 percent reduction in fuel efficiency. These variables have been estimated in the model and we are interested in testing the impact that inaccuracies in this estimate would have on the results.

We test the impact of a fall in the 50Max average payloads. Assumptions about the actual increase in payload that would occur if 50Max trucks become more prevalent are made in the model. We are interested in whether the estimate of constant average payloads (compared with current payloads for 50Max trucks) is a strong assumption that has a significant impact on the result. An alternative assumption is that as they become more prevalent the average loading falls (or rises).

A higher discount rate is a standard test.

Table 4.8: Scenario A Sensitivity Analysis ($ millions)

	Previous Net Benefit	New Net Benefit	Rank
50Max Safety Risk (+5%)	502	495	*5*
50Max Operating costs (+5%)	502	281	*2*
50Max Fuel economy (-5%)	502	475	*4*
Average 50Max payloads reduce from 22.5 tonne to 21.4 tonne (-5%)—for comparison the 44 average is 19.5 tonne	502	172	*1*
Discount rate (from 8% to 9%)	502	428	*3*

The sensitivity testing shows that net benefits are most sensitive to payloads and operating costs. This is expected as productivity gains are the biggest factor in the net benefit determination.

4.5 Independent Option NPV Analysis

While the expected result will be combinations of change it is also helpful to attempt to identify individual impacts from small specific changes. Caution needs to be exercised with any addition of these impacts as they will all interrelate in a scenario analysis and double counting is possible with the addition of elements.

Dimension component options

The dimension component is the width and height restrictions on vehicles. We have modelled an increase in width from 2.5m to 2.55m and an increase in height from 4.25 metres to 4.3 metres.

For the wider dimension option we assume that larger dimensioned trucks would increase its market share to 7.5 percent after 10 years, from a current market share of about 3 percent. Relaxing permitting requirements on wider vehicles will facilitate a greater market adoption and will flow through into increase payload productivity. Expected NPV results for a wider dimension allowance is presented in Table 4.9.

Table 4.9: Increase Vehicle Width from 2.5m to 2.55m

Base Case	NPV Costs	NPV Benefits
Productivity		147.2
Road Costs	-0.4	
$C0_2$ Costs		1.7
Health Costs		34.7
Safety Costs		6.2
Infrastructure Upgrades		
Compliance Costs		
Total	-0.4	189.9
Net Benefits	189.5	

Increasing the height allowance from 4.25 metres to 4.3 metres will enable higher payloads. We estimate that the additional height allowance would increase the productivity use of capacity by about 1 percent incrementally over time. Expected NPV results for a higher dimension allowance is presented in Table 4.10.

Table 4.10: Increase Vehicle Height from Trucks from 4.25 to 4. 3 metres

Base Case	NPV Costs	NPV Benefits
Productivity		49.6
Road Costs		9.3
$C0_2$ Costs		0.6
Health Costs		12.2
Safety Costs		3.6
Infrastructure Upgrades		
Compliance Costs		
Total		75.3
Net Benefits	75.3	

Allow Road Controlling Authorities Flexibility

Under this option, this could lead to more or less permit applications. For simplicity we have assessed the change in compliance costs from a 10 percent change in permit applications to illustrate the compliance cost effects.

Table 4.11: Road Controlling Authority Permitting of High Axle Loads (Flexibility)

	Current (estimated)	10% increase	10% decrease
Number of Permits Issues	7,011	7,712	6,309
Annual Compliance Cost	$1,262,200	$1,402,400	$1,121,800

Bulk permitting

This option changes fleet permitting of 50Max and HPMV. Given that there are only a limited number of 50Max and HPMV permits are issued each year, we expect this saving will be relatively modest. Although we note that without change, permitting costs would increase in-line with growth in the 50Max and HPMV freight task.

Table 4.12: Single Permit for Operator on 50Max and HPMV

Base Case	NPV Costs	NPV Benefits
Productivity		
Road Costs		
$C0_2$ Costs		
Health Costs		
Safety Costs		
Infrastructure Upgrades		
Compliance Costs		1.6
Total	0.0	1.6
Net Benefits	1.6	

50Max self-permitting with limited routes

50Max self-permitting, with no application required, but unlike the mass option above, route restrictions would still apply. Pro-forma requirements would also apply. Under this option, permitting costs would reduce significantly, however we assume permitting would still be required on 50Max trucks seeking use of rural roads.

Table 4.13: 50Max self-permitting with limited routes

Base Case	NPV Costs	NPV Benefits
Productivity		
Road Costs		
$C0_2$ Costs		
Health Costs		
Safety Costs		
Infrastructure Upgrades		
Compliance Costs		17.4
Total	0.0	17.4
Net Benefits	17.4	

Appendix A: Note on Safety

The impact that changes in vehicle dimensions and mass have on safety outcomes is a critical factor to consider in deciding on any change.

The statistical value of life is a way to compare two safety situations with each other and identify a preferable choice, or, to direct the amount of investment justified by safety benefits relative to other benefits. Sometimes however no decrease in safety is contemplated irrespective of the non-safety benefits.

Our approach to measuring safety in this study is to use the statistical value of life as our common measure of safety outcomes. A reduction in net safety costs using this measure refers to an expectations that the scenario being modelled will incur less deaths (or equivalent serious injuries). It does not mean that a trade-off is being made with non-safety costs when safety benefits exist. It does however treat all deaths or serious injuries equivalently with each other.

There are several sources of safety impacts from changes to VDAM rules. These come about as a result of the impact of the rules on the nature of the fleet and the number of trips required to deliver the freight task. This can be summarised as follows:

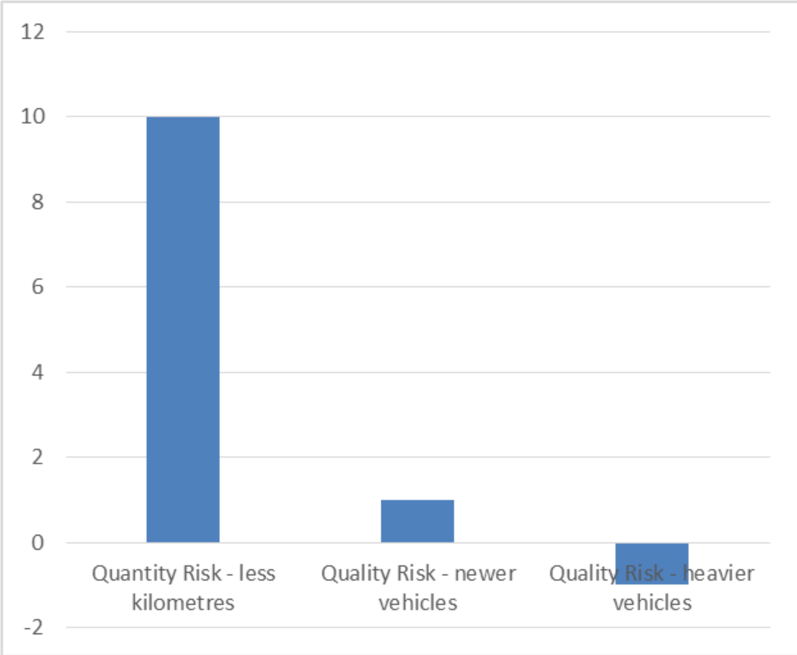
- **The Quantity Risk**: A freight task over a thirty year period involves an amount of trips (or tonne kilometres) to undertake the task. If less kilometres are required to undertake the task then there are less trucks on the road. This means there is less 'quantity risk' as any truck on the road presents a known average risk to the operator and other road users.
- **The Quality Risk:** Each individual vehicle does not present the same level of risk. We make several assumptions about this when assessing VDAM rules. A heavier truck presents more risk, other things equal. A newer truck presents less safety risk, other things equal, as standards generally improve.

A typical outcome in a scenario therefore is when a relaxation of VDAM rules leads to:

- An increase in productivity which leads to less trucks on the road which reduces the quantity safety risk and therefore safety costs at the rate of the known risk exposure
- An increase in fleet turnover as newer trucks are purchased and brought into the fleet to take advantage of the new configurations reducing the safety risk per vehicle
- An increase in average payloads as the newer heavier trucks begin to grow within the fleet increasing the safety risk per vehicle

These three effects can be shown graphically in Figure 4.4 below:

Figure 4.4: Safety Risks and Scenario Costs



In this typical case the quantity risk dominates the outcome and safety is enhanced overall. The quality risk from newer but heavier vehicles is much smaller in magnitude and the effects cancel each other out which implies that a heavier newer vehicle does not pose an increased safety risk compared to an older lighter truck. Less trucks on the road overall however creates a large safety benefit.

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