Issues Paper

Transit New Zealand Proposals for Higher Mass and Dimension Limits

2 July 2001

Contents

EXECUTIVE SUMMARY

To determine whether mass and dimension increases (over the existing 20-metre long / 44-tonne envelope) for heavy vehicles should be included in the proposed *Land Transport Rule: Vehicle Dimensions and Mass* (the rule), the Minister of Transport has advised the Land Transport Safety Authority (LTSA) to release details on a submission from Transit New Zealand (Transit) via this Issues Paper.

In September 2000, Transit made a submission on the red draft of the rule requesting that:

- Existing vehicles and vehicle combinations be allowed to operate on the whole public road network at mass limits up to 14% higher (maximum 50 tonnes) than currently permitted, but subject to the introduction of appropriate performance-based standards, a specific compliance regime, and no increases in vehicle dimensions. This is known as Scenario A.
- Specific vehicle combinations be allowed to operate at an increased mass (maximum 62 tonnes) and dimension (up to an overall length of 25 metres) on a selected network of upgraded heavy routes subject to certain measures. This is known as Scenario B.

This paper is an opportunity for the public, local authorities, and industry groups to comment on Transit's submission and to ensure that the progress of the rule, which contains many other important provisions, is not delayed. Written comments on any section of this paper are invited and can be sent to:

Rules Team
Land Transport Safety Authority
PO Box 2840
Wellington

If possible, please e-mail your comments to info@ltsa.govt.nz or send them on floppy disk to the above address, clearly indicating they are 'Comments on Mass and Dimensions Issues Paper'. The deadline for comments is 3 September 2001. The results will be presented to the Minister of Transport by the LTSA for his consideration.

Transit based their submission on a comprehensive study that concluded that benefits from increased mass and dimension limits had the potential to materially improve New Zealand transport cost competitiveness. The original reports relating to this study are available from Transit (www.transit.govt.nz). The study indicated that Scenario A would result in a benefit to cost ratio of 9, and Scenario B a benefit to cost ratio of 6. The study suggested that as all vehicles operating at the new limits would be subject to an additional compliance regime, these benefits could be achieved without compromising safety whilst also making an overall reduction in exhaust emissions and fuel consumption. Transit has submitted that these measures could ensure that positive safety and environmental outcomes would complement the economic benefits.

The following estimates were determined in Transit's study. They include the principal costs and benefits that would ensue from the impacts of heavier vehicles on bridges;

pavements (ie road surfaces); safety (ie change in crash rates); the environment (mainly through reduced CO_2 emissions); industry benefits (through performing the current freight task by fewer truck trips at higher mass limits); and road widening costs (through widening corners to accommodate longer vehicles).

The estimates do not include the following costs which Transit believes to be of lower magnitude: industry costs to meet new compliance schemes or additional vehicle requirements; additional enforcement costs; and costs to provide additional passing lanes or urban street improvements. Transit has indicated that the viability of the study's proposals would not be affected by further work that is still required to define and cost vehicle specifications, compliance regimes, and checking of the roading infrastructure to enable vehicle access.

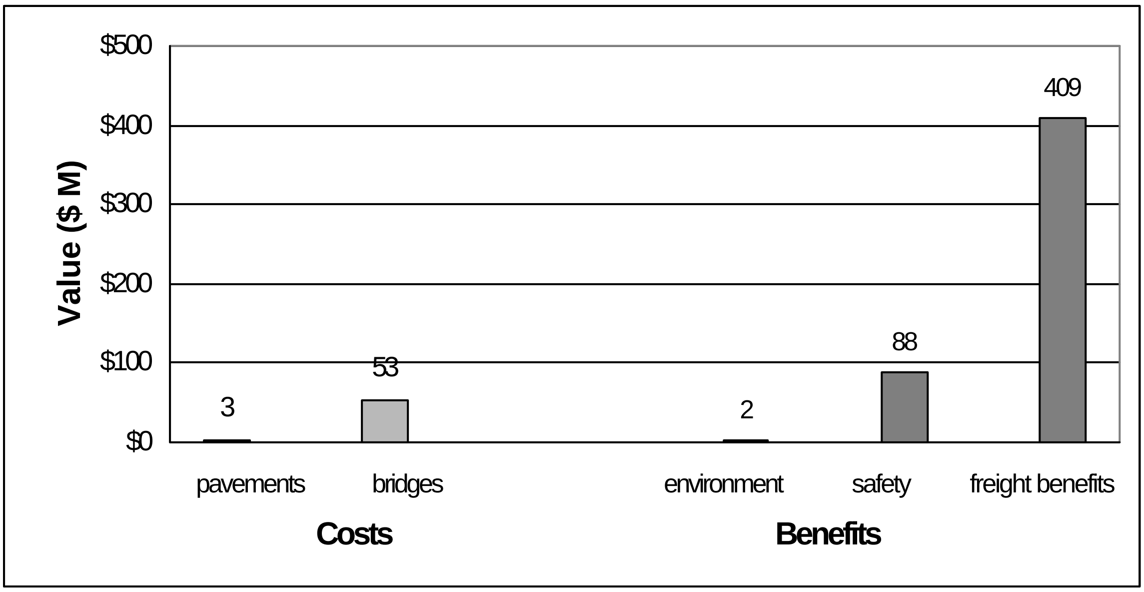
Benefits and costs are summarised below together with the benefit-to-cost ratio calculation used for presenting proposals to Transfund.

Scenario	**Total Benefits**	**Total Costs**	**Indicative Benefit/Cost Ratio**
Scenario A	$499M	$56M	9
Scenario B	$470M	$82M	6

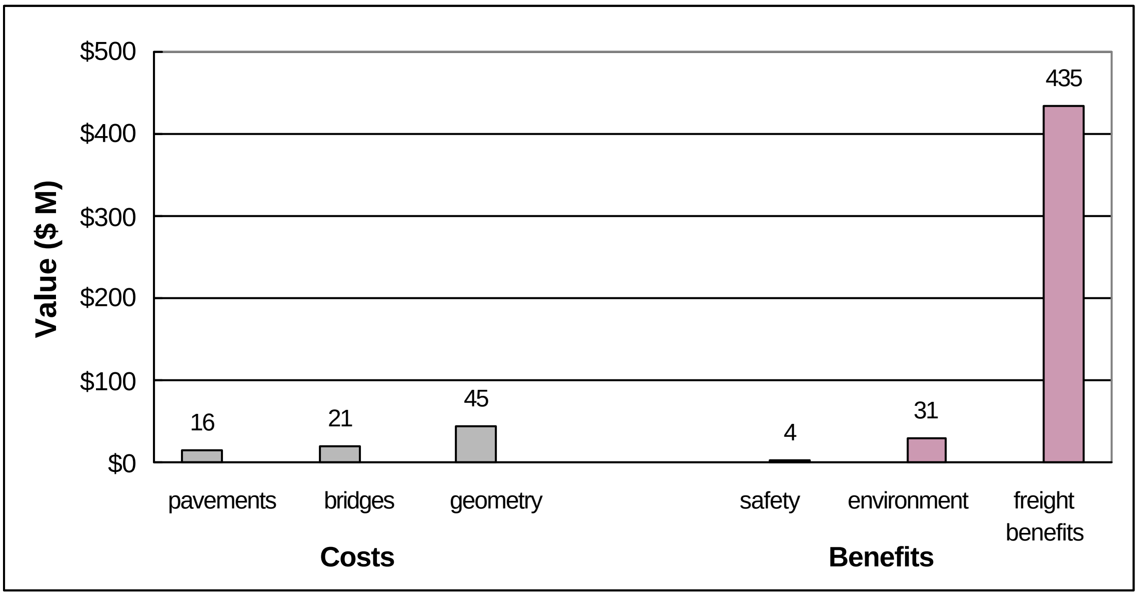
The benefits and costs for Scenario A and B have been calculated on the basis that they are independent projects. If both scenarios were combined there is some overlap of costs and benefits (if Scenario B follows on from Scenario A the overall indicative BCR for Scenario B would reduce to 4; if Scenario A followed on from Scenario B the indicative BCR for Scenario A would reduce to 6).

Preliminary benefits and costs from the study are shown below in Net Present Values using a 10% discount rate.

Scenario A



Scenario B



There are two parts to this paper. **Part One** covers the key points relating to Transit's submission and **Part Two** lists certain proposed requirements that will form part of the draft legislation depending on the Minister's decision on this submission. Views are sought on both parts. The issues covered in each part include:

Vehicle requirements

The performance measures (for example, stability and the ability to maintain a specified speed on a given road grade) and equipment (for example, road-friendly suspension and equipment ratings) required on each vehicle.

Route and access requirements

Road width requirements, the proposed bridge-testing programme, funding for upgrading and maintaining road surfaces or bridges to handle road wear, and diversions in the event of road closures.

Compliance schemes

Route compliance (ensuring these vehicles avoid using bridges or culverts that lack the strength to support the increased mass, or routes where the road-controlling authority has specified a weight restriction) and mass compliance (ensuring vehicles are not overloaded and stability is maintained).

Part One Key points from the proposals

1.0 Background

Transit has a statutory interest to ensure that mass limits for the State Highway network contribute to the safe and efficient operation of the network. Transit recognises the importance of the roading network to the economy, and the desire among the transport and export industry sectors for increased productivity. Transit has been conducting comprehensive investigations into the potential benefits of raising weight limits since 1992. Previous studies conducted by Transit have shown that it is not economically feasible to upgrade the whole road network to accommodate longer and/or heavier vehicles. This is because of significant road widening costs. The purpose of the latest study was to investigate the feasibility of allowing existing vehicles to operate at higher mass on all public roads, and allowing specific vehicles to operate at higher mass and larger dimension limits on selected upgraded routes.

In September 2000, following the completion of the study, Transit presented a submission to the LTSA that recommended mass and dimension limit increases called Scenario A and Scenario B. Scenario A would permit existing vehicles to operate on the whole of the public road network at mass limits up to 14% higher than those currently permitted, subject to the introduction of appropriate performance-based standards designed to reduce truck crashes, a specific compliance regime, and no increase in vehicle dimensions. Scenario B would permit vehicles to operate on a selected network of upgraded routes at increased mass (maximum 62 tonnes) and dimension (maximum overall length of 25 metres) subject to certain measures.

To determine if this submission from Transit should become government policy, the Minister has requested the LTSA to release details for public consultation. Once the comments and technical queries raised in this paper have been analysed by the LTSA, the results will be presented to the Minister of Transport.

2.0 Proposals from the study

The new mass limits proposed for heavy motor vehicles (other than those operating on overweight permits) are indicated in Tables 1-5 of Part Two of this paper. A diagram showing the possible mass increases based on wheelbase length is given in Appendix One, whilst the resulting changes for common vehicle configurations is given in Appendix Two.

Under Scenario A, where the wheelbase of the vehicle remains constant, then (subject to specified measures) vehicles that comply with the current dimension limits will legally be able to operate at approximately 14% higher gross vehicle mass on all public roads with the same number of axles and axle groupings as currently used.

Under Scenario B, if the wheelbase is extended due to the increase in vehicle dimension permitted (subject to certain measures), then these longer vehicles will legally be able to operate at approximately 41% higher gross vehicle mass on selected routes utilising the same higher axle mass limits proposed for Scenario A vehicles.

Any increase in the mass limits under either Scenario A or B will be limited by:

- The ability of the vehicle to meet the stability and other performance requirements as proposed in the rule together with additional requirements proposed in this paper. As an example, the yellow draft of the rule proposes that all vehicles must meet a minimum Static Rollover Threshold (SRT) value of 0.35g based on safety at reasonable cost. SRT is the steady-state level of lateral acceleration that a vehicle can sustain during turning without rolling over. Although only 15% of the vehicle fleet have an SRT of less than 0.35, they are involved in approximately 40% of the rollover crashes. Generally, the higher the centre of gravity of the load (dependent on load height and load density), the lower the SRT.
- Whether the vehicle rating is sufficient for the higher axle limits.
- Any gross or axle mass restrictions applied to certain routes and bridges by road-controlling authorities to prevent additional damage to the roading assets from the increased mass limits.

Transit based their submission on a comprehensive study that concluded that benefits from increased mass and dimension limits had the potential to materially improve New Zealand transport cost competitiveness. The original reports relating to this study are available from Transit (www.transit.govt.nz). The study indicated that Scenario A would result in a benefit to cost ratio of 9, and Scenario B a benefit to cost ratio of 6. The study suggested that as all vehicles operating at the new limits would be subject to an additional compliance regime, these benefits could be achieved without compromising safety whilst also making an overall reduction in exhaust emissions and fuel consumption. Transit has submitted that these measures could ensure that positive safety and environmental outcomes would complement the economic benefits.

The following estimates were determined in Transit's study. They include the principal costs and benefits that would ensue from the impacts of heavier vehicles on bridges; pavements (ie road surfaces); safety (ie change in crash rates); the environment (mainly through reduced CO_2 emissions); industry benefits (through performing the current freight task by fewer truck trips at higher mass limits); and road widening costs (through widening corners to accommodate longer vehicles).

The estimates do not include the following costs which Transit believes to be of a lower magnitude: industry costs to meet new compliance schemes or additional vehicle requirements; additional enforcement costs; and costs to provide additional passing lanes or urban street improvements. Transit has indicated that the viability of the study's proposals would not be affected by further work that is still required to define and cost vehicle specifications, compliance regimes, and checking of the roading infrastructure to enable vehicle access. Based on the extensive use of sensitivity analysis, Transit is confident that the cost estimates, whilst still preliminary, are robust.

Industry benefits from operating at higher mass limits assume that the current fees for road user charges would prevail.

The study showed that the economic results were sensitive to the bridge evaluation assumptions that were based upon experience gained from previous bridge testing in Australia and New Zealand. In particular the benefit to cost ratio for Scenario A would fall from 9 to 3 if bridge testing was not adopted. Proposals for bridge testing are discussed in Section 4.1 of this Issues Paper.

The main benefit arising from a weight limit increase is a saving in freight transport costs. This benefit has been evaluated in the study by a detailed analysis of existing and expected future freight transport patterns, and of transport costs. For Scenario A the main assumption for estimating freight changes is that increased heavy vehicle limits will enable fewer fully laden and partly laden trucks to perform a specified road freight task, by carrying increased payloads. The vehicle kilometres travelled (known as VKT) for trucks carrying weight-constrained loads decrease due to the reduced number of trips/trucks. The extent of reduction depends upon how much the truck is allowed to increase in weight, and how the industry would respond to the opportunity taking into account the higher operating costs and road user charges.

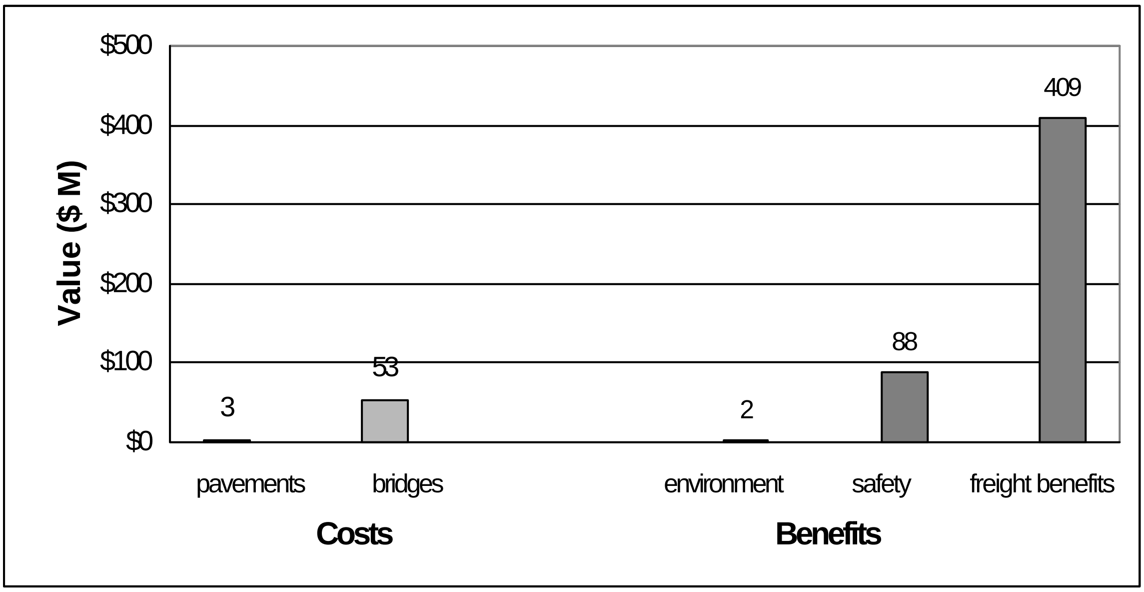
The methodology for the Scenario B evaluation is similar to that for Scenario A, except that Scenario B required the estimation of the benefits as they accrued to industry over time rather than the instantaneous 'snapshot' comparison of take-up with the current situation as in Scenario A. The other two differences from Scenario A are:

- The potential increase in vehicle dimensions as well as weights; and
- The restriction of these vehicle combinations to selected routes in the national road network.

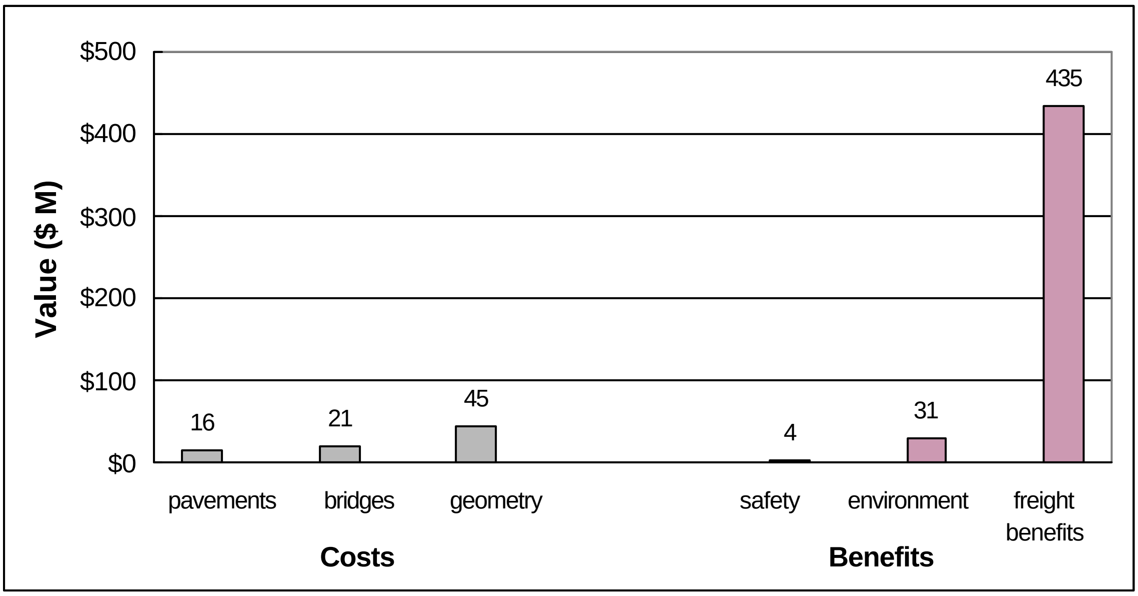
Freight growth, potential national fleet mix, VKT reduction and the vehicle operating cost savings of Scenario B for each year of analysis were estimated year by year. Under both Scenario B vehicle options considered in the study, the more realistic take-up rates over several years increased the importance of the growth rate and discount rate used in the discounting, with a higher freight growth rate providing more impetus for take up.

Preliminary benefits and costs are shown below in Net Present Values (NPV) using a 10% discount rate. NPV refers to the value today of some future cost/benefit (eg a benefit of $110 in one year's time is valued at $100 today using a 10% discount rate).

Scenario A



Scenario B



The benefits and costs for Scenario A and B have been calculated on the basis that they are independent projects. If both scenarios were combined there is some overlap of costs and benefits (if Scenario B follows on from Scenario A the overall indicative BCR for Scenario B would reduce to 4; if Scenario A followed on from Scenario B the indicative BCR for Scenario A would reduce to 6).

Scenario	**Total Benefits**	**Total Costs**	**Indicative Benefit/Cost Ratio**
Scenario A	$499M	$56M	9
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3.0 Vehicle requirements

3.1 Road-friendly suspension and load sharing

Transit's study did not allocate any benefits arising from the use of road-friendly suspension (RFS) by heavy vehicles. However, Transit expects reduced road wear and improved safety from vehicles fitted with RFS. Reduced road wear would increase the benefit-cost ratio, as pavement costs would be reduced.

Equivalent Standard Axle (ESA) loads are a measure of the relative road wear responsibilities of different loads on different axles. ESAs for a vehicle can be calculated by:

$$ESA = \left(\frac{\text{load}}{\text{reference load}}\right)^4$$

The reference load for a standard dual-tyred axle = 8.2 tonnes. As this equation uses a fourth power rule, ESAs are significantly higher for a fully laden vehicle and lower for an empty vehicle.

Scenario A

Transit believes that RFS should not be imposed on the existing vehicle fleet operating at up to 50 tonnes gross mass limit, in view of the study's predicted national increase in ESA loading of less than 2% for Scenario A. The actual change in ESAs will be dependent on the ability of the vehicles to reach the Scenario A mass limits but is likely to fall in the range of 0 to 2%.

Scenario B

Transit's study indicates a national increase in ESA loading of between 8-15% would occur under Scenario B. Transit proposes that RFS should be applied as an entry-level requirement to all new Scenario B vehicles operating above the 50 tonnes gross mass limit to reduce road wear and improve vehicle safety. There is a considerable body of international research that points to the link between road wear and vehicle suspension performance. Transit has noted in particular the findings of the OECD DIVINE Research Study 1992-96 and the Australian Mass Limits Review 1996 (http://www.nrtc.gov.au/publications/reports.asp?lo=public).

Operators would arrange for the testing of the suspension system to be performed by an independent certifying agency. Successful test results would be presented in support of applications before access is granted to an approved route.

There would be no requirement for in-service or roadside testing, as Transit acknowledges that this is unlikely to be cost-effective. Transit believes that the risk of non-compliance appears to be relatively small given that the industry has an incentive to maintain suspension systems in a good condition to minimise vehicle wear. Instead, Transit propose that the Australian Road Transport Suppliers Association (ARTSA) *'Air Suspension Code - Guidelines for Maintaining and Servicing Air Suspensions for*

Heavy Vehicles, May 2001' be incorporated into the road transport industry's unit training standards as an alternative to in-service testing.

Transit proposes that the load sharing split on axle groups with RFS for vehicles operating above 50 tonnes gross be set at 10%.

Possible issues for comment

1. Research opinion is divided as to whether fitting RFS to a vehicle compensates for any increase in the ESAs where vehicles operate at higher axle limits. If vehicles are permitted to carry additional mass under Scenario B, should operators comply with other measures (such as tyre pressure or minimum tyre size) to minimise any road damage caused by the predicted ESA increases? If so, please nominate the measure, possible values, and the research that shows its application in reducing road wear independent of RFS.

2. Australian research (i.e. Federal Office of Road Safety) has highlighted that fitting RFS can have a detrimental effect on the stability and handling of certain vehicles. These vehicles generally have tractor units with wheelbase over 4.5 metres, air suspension on the drive axle group, higher-powered engines and hauling semi-trailer at open-road speeds. Should any additional performance measures (as noted in 'Section 3.2 - Possible issues for Comment') be imposed on Scenario B vehicles to counter these safety concerns if they are permitted to operate at the proposed higher mass limits? If so, what measures and why?

3. As poorly maintained suspension systems can lead to increased road wear, should there be an in-service requirement on RFS?

4. The definition for RFS proposed by Transit differs from that developed in the Australian National Road Transport Commission (NRTC) 1999 Mass Limits Review relative to the Load Sharing Requirement. Should the NRTC definition of 5% be used, as opposed to the 10% proposed by the yellow draft of the rule and Transit?

3.2 Performance-based standards

Transit is aware that several overseas jurisdictions are using performance-based standards (PBS) to evaluate the impact of long combination vehicles on safety and infrastructure. The list of potential performance standards included elsewhere in this Issues Paper has been produced in a comprehensive study currently being performed in Australia in which Transit is an active participant. Transit believes that appropriate performance based measures should be included to ensure improvement in truck safety.

The following requirements are additional to those being proposed by the LTSA in the yellow draft of the rule.

3.2.1 Startability and gradeability

Transit recognises that concerns will be expressed about slow moving heavy trucks disrupting traffic flow on the selected route network. Transit proposes to apply some of the performance-based standards developed in the NRTC PBS project (http://www.nrtc.gov.au/publications/report-58.asp?lo=public) to Scenario B vehicles. Transit does not propose any additional requirements for vehicles operating under 50 tonnes.

Transit proposes that Scenario B vehicles be tested and certified as an entry requirement only (ie no in-service requirement) for compliance with the following measures:

- Vehicle combinations should be capable of starting forward movement from rest on an uphill gradient of 10%.
- Vehicle combinations should be capable of climbing at a constant speed of 70km/h on an uphill grade of 1%.

Compliance will be determined either by physical tests or computer-based modeling.

3.2.2 Static rollover threshold (SRT)

Transit suggests that vehicles operating at the higher gross mass envelope proposed in the study should meet additional safety performance standards in order to minimise any crash risk. Transit has proposed that truck-trailers and B trains exceeding 44 tonnes, and 6 axle articulated vehicles exceeding 39 tonnes could perhaps be required to meet a SRT of 0.38g compared to the yellow draft of the rule which requires all vehicles (unless exempted) to meet or exceed 0.35g. Transit would support further investigations and discussions with the industry to determine the feasibility of this suggestion.

Possible issues for comment

1. The Industry Economics report completed for Transit noted that:
   "*The Road User Charges also encourage operators to use truck trailer combinations which are not as popular in some jurisdictions because of their stability concerns. The take-up analysis in this study predicts relatively little scope for B-train configurations to substitute for truck trailers. Only a small component of the potential benefits accrue to B-trains. The emerging large truck trailer configurations based on the R22 prime movers are predicted to be as cost efficient as B-trains. This could have significant safety implications.*"

   Vehicles operating at either an SRT value of 0.35 (as proposed in the yellow draft of the rule) or 0.38 (as proposed by Transit) still have a greater risk of rollover compared to the rest of the vehicle fleet. Given that high values of SRT tend to limit the potential mass increases (and therefore the economic benefits), what value of SRT is considered appropriate and why?

2. Transit acknowledges that there is a high level of public concern about heavy vehicles, mainly resulting from recent high profile accidents. The NRTC in Australia has developed 21 PBS measures (plus 2 more that require further

work) covering key safety concerns associated with longer or heavier vehicles. (***http://www.nrtc.gov.au/publications/report-58.asp?lo=public***) As detailed in Appendix Three, these 21 measures are intended to have a minimum of overlap. For example, the definitions for Startability and Gradeability do not ensure that Scenario B vehicles can safely clear intersections or railway crossings, instead there is a separate measure called Intersection Clearance Time. Within the yellow draft of the rule, the LTSA has specified a number of prescriptive or performance requirements to ensure that vehicles meet specified values for PBS measures 7-9, and 11-16 when operating up to the existing mass and dimension limit envelope of 44 tonnes/20 metres. Should additional PBS measures in addition to Startability, Gradeability, and SRT be required for vehicles and operators wishing to use either Scenario A or B mass limits? If so, which of the following measures would be supported, and why?

Potential Performance Standards Developed to a Usable Level

	SAFETY RELATED		
		Longitudinal Performance (Low Speed)	
1~			Startability
2~			Gradeability
3			Intersection Clearance Time
		Longitudinal Performance (High Speed)	
4			Overtaking Time
5			Tracking Ability on a Straight Path
6			Braking Stability on a Straight Path
		Directional Performance (Low Speed)	
7+			Low-Speed Offtracking
8+			Frontal Swing
9+			Tail Swing
10			Steer Tyre Friction Demand in Low-Speed Turn
		Directional Performance (High Speed)	
11~*			Static Rollover Threshold
12+			Rearward Amplification
13+			Load Transfer Ratio
14+			Yaw Damping
15+			High-Speed Transient Offtracking
16+			High-Speed Steady-State Offtracking
17			Handling Quality (Understeer/Oversteer)
18			Braking Stability in a Turn
	INFRASTRUCTURE RELATED		
		Pavements	
19			Gross Mass per Standard Axle Repetition
20			Horizontal Tyre Forces
		Bridges	
21			Maximum Bridge Stress

Note: "~" Indicates a measure covered by performance requirements within Transit's proposal
"+" Indicates a measure covered by prescriptive requirements within yellow draft of rule
"*" Indicates a measure covered by performance requirements within yellow draft of rule

4.0 Route and access requirements

4.1 Bridge-testing programme

The bridge evaluation component of Transit's study identified significant economic benefits from the implementation of a bridge-testing programme (BTP) compared to the existing bridge design manual procedures (BMF). The technology for bridge testing exists and is recognised in New Zealand. The economic benefits are applicable to managing New Zealand's bridge infrastructure both under current heavy vehicle mass limits and the possible increased mass limits that may be implemented. To ensure these economic benefits are realised, it is important to develop an effective strategy to implement a nationwide BTP. This is required to allow the economic benefits of the programme to be realised and to ensure the safety of the transport system and travelling public with respect to bridges on behalf of all road-controlling authorities in New Zealand. The key is to develop a programme to implement the technology efficiently to achieve the desired outcomes. Although they are the roading infrastructure manager for the State Highway network only, Transit are willing to manage the nationwide BTP required and suggest that Transfund be responsible for funding the project.

One of the key components to the successful implementation of the BTP is to integrate the programme into a wider implementation process for higher heavy vehicle mass limits. A process for implementing higher heavy vehicle mass limits on bridges has been developed by Transit. A BTP-based analysis of critical bridges has also been developed together with a programme and budget for the implementation of higher mass limits and bridge testing.

The implementation process for higher mass limits outlined by Transit includes:

- Gathering data on bridge inventories.
- A basic analytical evaluation to determine the category for each bridge. Categories include bridges cleared for higher mass limits without further investigation, further investigation required, and replacement or rehabilitation required.
- Bridges acceptable for higher mass limits without further investigation would be cleared immediately for higher mass limits.
- Work would commence on bridges requiring replacement or rehabilitation with risk management measures implemented until work is completed if required.
- Bridges requiring further investigation would be subject to detailed investigation or bridge testing as appropriate.

An analysis of bridges based on the methodology used in the final bridge evaluation report was conducted to determine the number of bridges that are expected in each action category. For the State Highway bridge inventory it is expected that around 70% of bridges may be cleared for higher mass limits with no further investigation required. With detailed analysis a further 11% of bridges may be cleared and 16% may be cleared after a testing programme. Transit expects that 2% of State Highway bridges may require replacement or rehabilitation. For the local authority bridge inventory 42% may be satisfactory for higher mass limits with no further investigation, 14% may require detailed analysis, 30% may require testing, and 14% are expected to require replacement or rehabilitation.

Short span reinforced concrete bridges feature heavily in the bridges requiring detailed analysis and testing. There are also some short span steel bridges and some longer span prestressed concrete bridges in these categories, and for local authorities, timber bridges will be represented.

Based on this analysis a BTP was developed to suit the bridge characteristics identified as requiring testing. This programme includes destructive testing/research programmes, proof load testing, and health monitoring/behavioural testing.

Budgets were developed for the costs associated with implementation of higher mass limits and bridge testing based on various assumptions. The budgets do not include costs associated with the replacement or rehabilitation of bridges. These costs are included in the analysis of costs associated with higher mass limits detailed in the final evaluation report on bridges. The budget and programme developed allow the BTP to be implemented incrementally. The programme proposed commencing with Scenario B bridges, then the remaining Scenario A State Highway bridges, followed by local authority Scenario A bridges. Because of the incremental nature of the programme, most of the establishment costs and the costs associated with the destructive testing are included in the Scenario B budget. The findings from the Scenario B programme would then be successively transferred into the following programmes. The budgets for each programme assume that the previous programme proceeds.

The estimated total budget required for the implementation and bridge testing for each of the proposed scenarios ranges from $3.9 million (Scenario B) to $16.2 million (Scenario A). The high cost associated with Scenario A is due to the high number of bridges involved, and the costs associated with the posting of these bridges.

The programme developed for the implementation and BTP spans over five years. Bridges would be progressively cleared for increased mass limits starting in the second quarter of the first year.

There are some critical issues associated with the implementation of higher mass limits and bridge testing. These include local authority bridge inventories, and programme issues associated with rehabilitation and replacement. These issues require further investigation.

It is also noted that there will be a high degree of coordination, cooperation and management required for the programme to succeed. It is recommended that the formation of a national committee may be necessary for the satisfactory progression and completion of the programme.

4.2 Road width

Transit operates three cross-section standards that are used as guidelines for new or reconstructed State Highways. These are attached to this paper as Appendix Four. The guidelines are applied using traffic volumes together with local variations to take account of engineering and economic considerations.

Scenario A
Transit believes that as the vehicle dimensions would remain constant, no geometric road improvements would need to be carried out to allow the vehicles to operate.

Scenario B
The network of selected routes that would be upgraded to accommodate longer vehicles is based upon state highways currently being used by heavy vehicles, together with some short sections of local road connections in urban areas. The maps in Appendix Five show the preliminary network that was developed for research purposes. Further work and consultation will be required to define these routes.

Transit's research study based the economic analysis of the impacts of longer vehicles on the assumption that there would be no seal widening on the proposed route network other than for the reduction in clearance caused by additional off-tracking of longer vehicles on corners. This assumption is further explained as follows.

The geometric evaluation portion of the study involved estimating the cost of modifying a specific network of roads and roundabouts in New Zealand to accommodate scenario B vehicles, which are longer and heavier than vehicles currently permitted on New Zealand roads. These longer vehicles take up more road space than the current fleet having greater off-tracking when cornering.

Analytical models were used to calculate the extent of off-tracking for vehicles when cornering. A field test using a 62 tonne, 26.5 metre long B-train was undertaken to verify the validity of these models. The measured off-tracking was in good agreement with that predicted by the models.

The secondary geometric impact of increased trailing fidelity of longer vehicles on straight sections of road was predicted to be less than 50 millimetres, and this effect was ignored in the research study. Only intersections along the specific routes controlled by a roundabout were considered.

To determine the costs for modifying the network of routes, the following assumptions were made for an alternative defined as the "Original" alternative:

- The current network of routes is satisfactory for existing vehicles. If a trial vehicle was found to off-track x metres more than a vehicle typical of the current fleet on a particular curve then, to maintain the same clearances, that corner should be widened by $2x$. However, if $2x<0.25$ metres, then it was assumed that widening would not be required.
- Also, if $2x>0.25$ metres, then widening would still not be necessary as long as two trial vehicles travelling in opposing directions could pass with 1 metre clearance between their swept paths and 0.5 metres clearance to the edge of the road.

To test the sensitivity of the cost to these assumptions, four further alternative sets of assumptions were included in the economic analysis. It was found that the costs are very sensitive to the assumptions used, with geometry costs varying from $44M for the original assumption to $292M for the most conservative assumption about available clearance.

Because of concern about the choice of assumption, extensive work to define a relationship between crash rate on corners and the level of geometric widening was performed by Transit's consultants. This work was inconclusive in that no relationship was found to support or refute whether those highway curves that currently have less than the assumed available clearance between opposing vehicles lead to more truck crashes.

The original assumptions were independently reviewed for Transit by another consultant and found to be valid. This consultant did not believe there was any justification for Transit to use an alternative assumption for corner clearances or include any additional widening costs other than for the reduction in clearance due to additional off-tracking.

4.3 Passing lanes

If Scenarios A and/or B are implemented Transit's study suggests that there will be fewer trucks, and hence fewer conflicts and delays to motorists. However, Transit is well aware of the high priority that road users place on passing lanes, and the current National State Highway Strategy indicates a firm commitment to providing more passing lanes and slow vehicle bays on all state highways. Three research projects are currently in hand that may allow Transit to more easily justify passing lanes and hence comply with the strategy, where funding permits. Consequently Transit expects that more passing lanes will eventuate on the main state highway network regardless of whether higher mass and dimension limits are introduced.

Transit's study proposes that Scenario B vehicles meet performance-based standards covering minimum power-to-weight ratio as proposed in the vehicle requirements section.

4.4 Impact of longer vehicles in urban areas

Transit's study proposes that improvements in urban areas would be made to enable longer vehicles not meeting current turning circle standards to manoeuvre safely.

Transit has presented templates that demonstrate the impact of the proposed 25-metre long vehicles on urban areas. The templates indicate that the longer vehicles would require up to approximately 18% more swept path width (i.e. 1.2 metres) to perform standard turning manoeuvres compared with the current long combination vehicles.

Overseas studies indicate that tractor units will need higher power/weight ratios to safely negotiate urban intersections and rail level crossings. Transit's study proposes to cover this within a performance-based standards approach by introducing requirements for gradeability and startability.

4.5 Contingency plans

Transit has developed the following protocol with the New Zealand Police and RTF. VicRoads Commercial Vehicle Operations and the State Police in Victoria, Australia, who jointly control the movement of 62-tonne 25-metre B-doubles, have advised Transit that they have not experienced any difficulties in over 10 years of operation of the national policy on selected routes in their state.

Procedures for dealing with road closures could be included as a contingency plan in the transport company's quality management systems. It seems likely that these will be required for compliance purposes for all Scenario B operators as mentioned earlier in this paper.

Emergency closure due to crash/weather etc

Transit propose that either:

- Operators proceed at the sole discretion of the Police. In this situation, the operator might adjust their load by dropping one trailer to comply with the legal limits for all roads, or
- Operators remain stopped until the police receive formal confirmation from the road-controlling authority for the use of alternative routes. In this situation, the operator could seek this approval in writing beforehand to show they were entitled to be there. For major highways (for example, State Highway One) it is likely that disaster management plans would have been drawn up that include alternative routes where these are available.

Planned closure

Transit proposes that the operator make alternative arrangements before making the trip. This could include applying for overweight and overdimension permits for alternative routes noting that in general divisible loads are not normally eligible. Operators would need to carry the necessary documentation in the vehicle to ensure compliance if stopped by the Police.

Possible issues for comment

1. There are concerns with how sections of local authority roads and State Highways are physically coping with vehicles operating at the existing mass limits (for example, logging traffic). Government subsidies for roading maintenance and upgrades are collected from road users through RUC, petrol taxes and similar. Transfund pays these subsidies to road-controlling authorities. Local authorities receive a subsidy from Transfund for maintenance of local roads at an average of 50% (with the balance paid by the ratepayers) while Transit receives 100% for the State Highway network. How should the upgrading of roading assets where required (such as strengthening bridges or widening signalised intersections) be funded and who should be then be responsible for controlling these assets? Please indicate whether your response refers to Scenario A, Scenario B, or both.

2.	Which of the proposed protocols for contingency plans for emergency closure is acceptable and why?
3.	What width and geometric standards should a given route meet before approval is given for Scenario B?
4.	How should the Scenario B routes be tested for compliance with the width and geometric standards referred to in your response to 3 above?

5.0 Compliance schemes

The costs to provide better compliance were not included in Transit's study. This is because the level of compliance was not defined and agreed at the time. It is expected that the requirements for these compliance regimes will impose additional costs on operators, however, these costs were not included with the economic analysis.

To gain confidence in the transport industry's performance, Transit has proposed to introduce two levels of mass limits compliance for vehicles utilising the increased limits. Transit and the industry would like to develop these schemes during the implementation phase based on the Mass Management Scheme produced by VicRoads and now imposed in many Australian States.

5.1 Mass compliance

Scenario A
Transit believes that a mass compliance scheme for Scenario A vehicles operating above the current gross mass envelope is appropriate. However, it has at this time been unable to document and agree the details with the industry. Should the higher mass limits be accepted in principle by government, Transit would be prepared to work with the industry to prepare the details of an appropriate system in time to coincide with the introduction of higher mass limits.

Scenario B
Transit propose full accreditation and third party auditing of a mass management scheme for Scenario B operators using a scheme based on the Australian National Heavy Vehicle Accreditation Scheme.

5.2 Route compliance

Transit propose that the operators of Scenario B vehicles will be subject to a paper-based permit route compliance scheme that will be based on the relevant sections of the New South Wales Roads and Traffic Authority Interim Guidelines for the Introduction of B Doubles June 1988. This scheme will be introduced and administered by Transit and will apply from the introduction of the rule.

Transit proposes to replace this initial system with a GPS-based route compliance solution for Scenario B vehicles once the technology and other matters have been fully demonstrated and proven feasible.

Mass management accreditation for Scenario B can be ready for introduction by the time the first routes are available and bridges are substantially cleared for use at the end of next year. Route compliance based on the Australian B-double model can be introduced at the same time, with the timing of the GPS-based route compliance scheme uncertain at this stage.

Transit proposes to develop documents covering these compliance schemes over the next 12 months to coincide with this timeframe.

Possible issues for comment

1. Who is the appropriate body to monitor the compliance schemes proposed?

2. What details do operators and road asset managers require in these proposed schemes before they would indicate their support for this submission?

3. The Police and the LTSA note from enforcement action that operators who already use on-board weighing systems or volume-measuring systems still knowingly exceed the current mass limits. What additional measures should be imposed to encourage compliance with the higher mass limits proposed?

4. There is a concern that some existing weighbridges would require modification to cater for Scenario B vehicles. Please nominate weighbridges that you use (private or Government owned) that would require modification for the purposes of weighing the proposed Scenario B vehicles.

6.0 Timing and funding

6.1 General

The decision to provide funding for the bridge and selected route upgrading and additional road and bridge maintenance would be made by Transfund, noting the Government's decision following the public consultation on this paper. Transfund would have to prioritise this funding request with other competing ones based on a benefit/cost ratio and other factors as noted in their Project Evaluation Manual.

6.2 Bridges

As stated earlier the implementation of the new weight limits can be introduced progressively once a substantial portion of the bridges have been cleared for the higher mass limits. At the end of the analysis and testing period (perhaps 18 months for most state highways), sections of the Scenario B network could be made available for vehicles to operate at these increased mass limits. In the case of Scenario A, Transit expects that road-controlling authorities would restrict movement of higher mass vehicles on their part of the entire road network until bridges are cleared or strengthened. This has been the practice overseas with the Australian Mass Limits Review and the United Kingdom's adoption of the European Union 11.5 tonne axle mass limit. Completion of the BTP is expected to take five years.

6.3 Scenario B network

The detailed design of geometric improvements would not commence until funding was approved in the first year of the required three-year construction period. Before this Transit would review the proposed network in consultation with stakeholders, and identify any sections that appeared to be uneconomic. A request for funding of the Scenario B network would have to be made to Transfund early in the first year.

The network would be completed in a period of three years in accordance with the economic analysis conducted in Transit's study. Vehicles would be introduced progressively as routes were upgraded. It is unlikely that the first sections would be available until the end of the first year from introduction of the new mass limits.

Possible issues for comment

1. The Industry Economics report completed for Transit noted that: *"Scenario A assumes instantaneous take up of vehicle configurations with higher weight limits, whereas Scenario B results are shown for realistic take up periods – 'best estimate', 8 years or 15 years. This also explains why the Scenario A cost savings (with weight increases alone) are somewhat exaggerated and appear almost as great (or greater than) the Scenario B cost savings (which are based on vehicle weight and dimension increases). In reality, Scenario A would be less attractive than the results suggest as the Net Present Values would be considerably less with realistic (slower) take up of certain vehicle configurations."* Do you have any information that would suggest the take-up assumptions used are unrealistic?

Part Two Technical requirements applying to new mass limits

1 Road friendly suspension and load sharing

RFS means a suspension system meeting specified criteria fitted to a heavy vehicle.

RFS requirements will be applied as an entry requirement only to Scenario B vehicles.

Transit proposes that the test method for RFS be based on the NRTC '*Certification of Road-Friendly Suspension Systems*' with the following amendments:

- Load sharing should be set at 10%.
- Vehicles will be tested by an independent certifying agency and at the operator's cost before first registration in New Zealand.
- Certification will be a prerequisite to operation for Scenario B.
- There will be no in-service performance requirement.

2 Startability and gradeability

Startability means the maximum uphill gradient, expressed as a percentage, on which the vehicle is capable of starting forward movement from rest.

Gradeability means the maximum uphill gradient that the vehicle can climb at a specified constant speed.

Vehicles (excluding vehicles operating on overweight permits) that are permitted to exceed the 50 tonne gross mass limit on selected routes must comply with the following performance requirements:

- Startability must be at least 10%.
- Gradeability must be at least 1% at a speed of 70 km/h.
- Vehicles will be tested before first registration in New Zealand.
- There will be no in-service performance requirement.

3 Static rollover threshold (SRT)

Vehicles that exceed the current gross mass limits of 39 tonnes (tractor-semi-trailers) and 44 tonnes (other vehicle combinations) must meet an SRT value of 0.38g. The definition, method of testing, and certifying process will be as specified in the yellow draft of the rule.

4 Mass limits compliance

4.1 Industry registration scheme

4.2 Accreditation scheme

The operators of Scenario B vehicles will be subjected to a scheme administered by Transit and the LTSA and based on the Australian National Heavy Vehicle Accreditation Scheme Mass Management module. In addition to the features mentioned in the industry scheme above, this scheme will also include:

- Third party auditing of compliance.
- Accreditation by Transit and LTSA.

5 Route compliance

The operators of Scenario B vehicles will be subjected to a paper-based permit route compliance scheme introduced and administered by Transit that will be based on the relevant sections of the New South Wales Roads and Traffic Authority Interim Guidelines for the Introduction of B Doubles June 1988.

6 Transit's proposed mass limit tables

Table 1 Maximum mass on individual axles

Type of axle	Mass (kg)
1 Single standard tyres:	
(a) in a twin-steer axle set, or in a tandem axle set with a twin or large tyred axle	5400
(b) in any other axle set	6000
2 Single large tyred:	
(a) in a twin-steer axle set	5400
(b) in a tandem axle set with two single tyred axles or in a tri-axle set	6600
(c) in any other axle set	7200
3 Twin tyred:	
(a) in a tri-axle set	7300
(b) in any other axle set	8800
4 Oscillating axle, in any axle set	9500

Table 2 Maximum sum of axle mass on two axles in a tandem axle set

Type of axle	Mass (kg)
1 Two single standard tyred axles:	
(a) in a twin-steer set	10,800
(b) not in a twin-steer set	11,000
2 Two single large tyred axles:	
(a) in a twin-steer set	10,800
(b) not in a twin-steer set	13,000
3 Two twin tyred axles:	
(a) spaced less than 1.3 m from the first axle to the last axle	15,000
(b) spaced 1.3 m or more from the first axle to the last axle	16,000
4 Single standard tyred axle with an oscillating axle	13,000
5 Single standard tyred axle with a single large tyred axle	12,000
6 Single standard tyred axle with a twin tyred axle	13,300
7 Single large tyred axle with a twin tyred axle	15,000

Table 3 Maximum sum of axle mass in a tri-axle set

Type of axle	Mass (kg)
Three oscillating axles, three twin tyred axles, or three large tyred axles:	
(a) spaced 2 m or more and less than 2.4 m from the first axle to the last axle	16,000
(b) spaced 2.4 m or more and less than 2.5 m from the first axle to the last axle	18,000
(c) spaced 2.5 m or more from the first axle to the last axle	20,000

Table 4 Maximum sum of mass on any two or more axles that together do not constitute a single tandem axle set or single tri-axle set, where distance from centre of first axle to centre of last axle is 1 m or more but less than 2.0 m (including maximum gross mass)

Type of axle	Mass (kg)
1 Two single standard tyred axles	10,800
2 Two single large tyred axles	12,000
3 A single standard tyred axle with a single large tyred axle or a twin tyred axle	12,000
4 Any other two or more axles	14,500

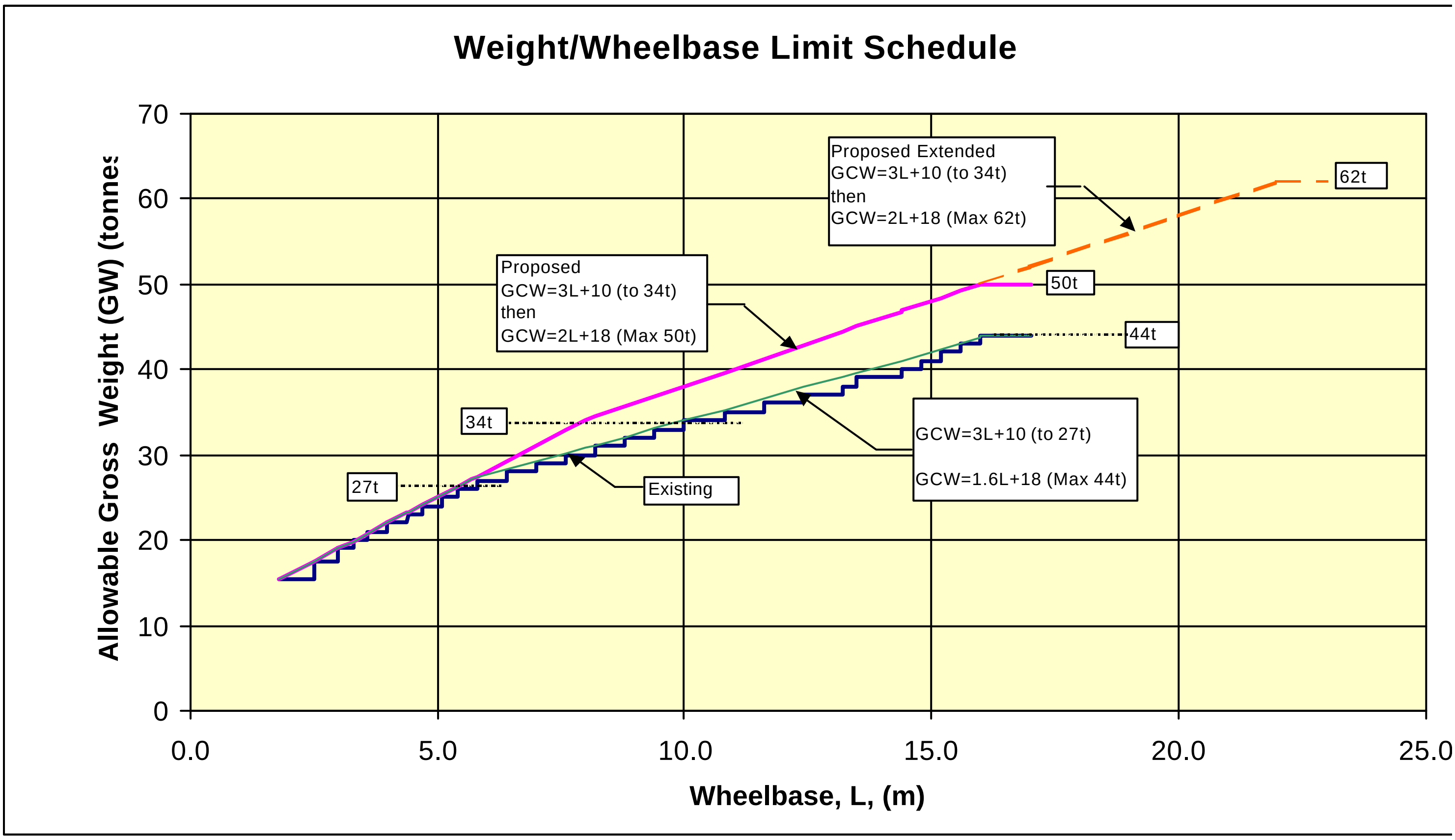
Table 5 Maximum sum of mass on any two or more axles that together do not constitute a single tandem axle set or single tri-axle set, where distance from centre of first axle to centre of last axle is 2.0 m or more (including maximum gross mass)

Distance from the centre of the first axle to the centre of the last axle	Mass (kg)
2.0 m but less than 2.5 m	16,000
2.5 m but less than 3.0 m	17,500
3.0 m but less than 3.5 m	19,000
3.5 m but less than 4.0 m	20,500
4.0 m but less than 4.5 m	22,000
4.5 m but less than 5.0 m	23,500
5.0 m but less than 5.5 m	25,000
5.5 m but less than 6.0 m	26,500
6.0 m but less than 6.5 m	28,000
6.5 m but less than 7.0 m	29,500
7.0 m but less than 7.5 m	31,000
7.5 m but less than 8.0 m	32,500
8.0 m but less than 8.5 m	34,000
8.5 m but less than 9.0 m	35,000
9.0 m but less than 9.5 m	36,000
9.5 m but less than 10.0 m	37,000
10.0 m but less than 10.5 m	38,000
10.5 m but less than 11.0 m	39,000
11.0 m but less than 11.5 m	40,000
11.5 m but less than 12.0 m	41,000
12.0 m but less than 12.5 m	42,000
12.5 m but less than 13.0 m	43,000
13.0 m but less than 13.5 m	44,000
13.5 m but less than 14.0 m	45,000
14.0 m but less than 14.5 m	46,000
14.5 m but less than 15.0 m	47,000
15.0 m but less than 15.5 m	48,000
15.5 m but less than 16.0 m	49,000
16.0 m but less than 16.5 m	50,000
16.5 m but less than 17.0 m	51,000
17.0 m but less than 17.5 m	52,000
17.5 m but less than 18.0 m	53,000
18.0 m but less than 18.5 m	54,000
18.5 m but less than 19.0 m	55,000
19.0 m but less than 19.5 m	56,000
19.5 m but less than 20.0 m	57,000
20.0 m but less than 20.5 m	58,000
20.5 m but less than 21.0 m	59,000
21.0 m but less than 21.5 m	60,000
21.5 m but less than 22.0 m	61,000
22.0 m or more	62,000

Notes to Table 5

1. General freight vehicles wishing to operate above a gross mass limit of 50 tonnes and overall length of 20 metres may be permitted to travel on a specified network of routes covered by approvals issued by the Land Transport Safety Authority and Transit New Zealand or local road-controlling authorities. These vehicles will also be required to meet specified mass limits and route compliance requirements, together with evidence of certification to road friendly suspension requirements.
2. Movement of specified vehicles and indivisible loads above the limits of 50 tonnes and 20 metres may be granted by these authorities depending on compliance with overweight and overdimension policies and protocols.

APPENDIX 1: TRANSIT'S PROPOSED WEIGHT/WHEELBASE LIMIT SCHEDULE



APPENDIX 2: POSSIBLE MASS LIMIT CHANGES BY VEHICLE CONFIGURATION

Table 1: Present and possible limits on axle sets (note: note all possible axle sets are shown)

Description	Present limit	Possible limit
Single axle single tyres	6.0 tonnes	6.0 tonnes
Single axle dual tyres	8.2 tonnes	8.8 tonnes
Tandem axle group 1 single and 1 dual tyred	12.0 tonnes	13.3 tonnes
Tandem axle group 2 dual tyres	15.0 tonnes	16.0 tonnes
Triaxle group with dual tyres	18.0 tonnes	20.0 tonnes

In Table 2 Scenario A is represented by Levels 1 and 2. Level 2 is based on the principle that any vehicle operating at the new gross mass envelope (i.e. truck-trailers and B trains exceeding 44 tonnes gross mass, and 6 axle articulated vehicles exceeding 39 tonnes) should meet additional requirements. This is where the uptake under Scenario A will take place. We did not feel that it was appropriate that shorter wheelbase vehicles marginally in excess of current gross mass limits by virtue of higher axle set limits should meet these additional requirements. These vehicles are shown as Level 1.

Table 2 shows an anomaly with the 5 axle truck trailer, which can gross 39.6 tonnes under the possible limits. This is certainly a worse vehicle than the 6 axle articulated at the same weight limit. However, we do not see that very many operators will take advantage due to the high RUCs imposition. We have assumed that 7 and 8 axle truck trailers are not eligible for Level 3 (Scenario B).

Table 2: Gross mass limits for different compliance levels (note: note all possible vehicles are shown)

Description	Axle layout	Maximum gross mass for different compliance levels (tonnes)			
		Existing	Level 1	Level 2	Level 3
2 axle rigid	O O	14.2	14.8	na	na
3 axle rigid	O OO	21.0	22.0	na	na
4 axle rigid	OO OO	25.8	28.0	na	na
3 axle truck/trailer	O O – O	22.4	23.6	na	na
4 axle truck trailer	O O – O O	30.6	32.4	na	na
5 axle truck trailer	O OO – O O	37.4	39.6	na	na
6 axle truck trailer	O OO – O OO	44.0	44.0	46.8	na
7 axle truck trailer	O OO – OO OO	44.0	44.0	50.0	na
8 axle truck trailer	OO OO – OO OO	44.0	44.0	50.0	na
3 axle articulated	O O O	22.4	23.6	na	na
4 axle articulated	O O OO	29.2	30.8	na	na
5 axle articulated	O OO OO	36.0	38.0	na	na
6 axle articulated	O OO OOO	39.0	39.0	42.0	na
5 axle B-train	O O OO O	37.4	39.6	na	na
6 axle B-train	O O OO OO	44.0	44.0	46.8	na
7 axle B-train	O OO OO OO	44.0	44.0	50.0	54.0
8 axle B-train	O OO OOO OO	44.0	44.0	50.0	58.0
9 axle B-train	O OO OOO OOO	44.0	44.0	50.0	62.0

Existing with LTSA proposals

- Present axle and gross mass limits apply
- Vehicle certified to Static Rollover Threshold = 0.35g as per LTSA's yellow draft rule PBS proposals
- Access to all public roads unless posted by road-controlling authority

Level 1 = Scenario A

- New axle mass limits apply
- Vehicle still operates within existing gross mass envelope (i.e. wheelbase curve)
- Existing dimension limits apply
- Vehicle certified to SRT = 0.35g
- Access to all public roads unless posted by road-controlling authority

Level 2 = Scenario A

- New axle and gross mass limits apply
- Gross mass exceeds 44 tonnes (truck trailers and B trains) or 39 tonnes (tractor-semitrailers)
- Existing dimension limits apply
- Vehicle certified to SRT = 0.38g
- Industry Registration Scheme for mass compliance
- Access to all public roads unless posted by road-controlling authority

Level 3 = Scenario B

- New axle and gross mass limits apply
- Gross mass exceeds 50 tonnes
- Overall length exceeds 20m. New maximum = 25m for B double trailer combinations
- Vehicle certified to SRT = 0.38g
- Accreditation Scheme for mass compliance
- Paper-based permit scheme for route compliance
- Vehicles certified as meeting road friendly suspension requirements
- Vehicle certified as meeting startability and gradeability requirements
- Movement restricted to specified routes approved by Land Transport Safety Authority and road-controlling authority

APPENDIX 3: POTENTIAL PERFORMANCE BASED STANDARDS

These have been extracted from the NRTC report "Definition of Potential Performance Measures and Initial Standards – April 2001". Alongside each measure is the NRTC estimate of what it may cost and what resources (suitably qualified/certified providers) and input data are required to evaluate a vehicle against each of the individual proposed potential performance standards.

Cost:

- Low (up to $1,000);
- Medium (from $1,000 to $5,000); and
- High (more than $5,000).

Resource availability:

- High (readily available);
- Medium (a moderate number of providers currently available); and
- Low (very few providers currently available).

Input data requirements:

- Low (limited data required);
- Moderate (data available in the public domain; reports and/or product brochures);
- Significant (partial set of parameters required); and
- Substantial (full set of parameters and specialist input required).

1 Startability

The maximum uphill gradient, expressed as a percentage, on which the vehicle is capable of starting forward movement from rest.

- Not less than 15% for unrestricted access to the entire network;
- Not less than 10% for arterials and major freight routes; and
- Not less than 5% for remote areas.

Cost:	High[a]/Low[b]
Resource Availability:	High[a,b]
Data Requirements:	Low[a]/Moderate[b]

[a] – physical testing
[b] – calculation or computer-based modelling

2 Gradeability

The maximum uphill gradient, expressed as a percentage, on which the vehicle can climb at a specified constant speed.

<u>Low-Speed Environment (maximum grade, at any speed)</u>

Unrestricted access to the entire network:	25%
Urban roads of higher standard:	20%
Urban roads in remote areas:	8%

<u>High-Speed Environment (minimum speed on a 1% gradient)</u>

Unrestricted access to the entire network:	80km/h
Remote areas:	50km/h

Cost: High[a]/Low[b]
Resource Availability: High[a,b]
Data Requirements: Low[a]/Moderate[b]

[a] – physical testing
[b] – calculation or computer-based modelling

3 Intersection Clearance Time

The time taken for the rear of the vehicle to clear a given intersection (either straight through or turning) with the vehicle starting from rest with its front immediately behind the intersection stop line.

Unrestricted access to the entire network:	no more than 12s
Arterials and major freight routes:	no more than 15s
Routes designated for long combination vehicles:	no more than 25s

Cost: High[a]/Medium[b]
Resource Availability: Medium[a,b]
Data Requirements: Low[a]/Moderate[b]

[a] – physical testing
[b] – calculation or computer-based modelling

4 Overtaking Time

The time taken for another vehicle to safely overtake the vehicle.

Total overtaking time, T_{OT}, as defined by Eqn (2b), and as specified in Table 2 for the relevant road class, not to be exceeded.

Cost: High[a]/Low[b]
Resource Availability: Medium[a]/High[b]
Data Requirements: Low[a]/Low[b]

[a] – physical testing
[b] – calculation or computer-based modelling

5 Tracking Ability on a Straight Path

Amount of variation in the lateral position of the trailing unit (last trailer) measured relative to the path or track followed by the hauling unit (rigid truck or prime mover).

Lane width requirement

Urban arterials:	in the range 3.1 to 3.5m (route specific)
Rural and regional roads:	no greater than 3.5m
National highways and freeways:	in the range 3.5 to 3.7m (route specific)
Remote areas:	no greater than 3.7m

Cost:	High[a,b]
Resource Availability:	Low[a,b]
Data Requirements:	Low[a]/Substantial[b]

[a] – physical testing
[b] – computer-based modelling

6 Braking Stability on a Straight Path

The vehicle's ability to stay within a traffic lane under heavy braking on a straight path.

Vehicle remains within a 3.5m wide lane under heavy braking.

Cost:	Medium[a]/Medium-to-High[b]
Resource Availability:	Medium[a]/Low[b]
Data Requirements:	Low[a]/Substantial[b]

[a] – physical testing
[b] – computer-based modelling

7 Low-Speed Offtracking

Maximum distance that the rear axle of a vehicle or combination tracks inside the path taken by the steering axle in a low speed turn.

Maximum width of the swept path

Local roads:	5m
Arterial roads:	7.4m
Major freight routes:	10.1m
Road train areas:	13.7m

Cost:	Low[a]/Low[b]
Resource Availability:	High[a]/Medium[b]

Data Requirements: Low[a]/Moderate[b]

[a] – physical testing
[b] – computer-based modelling

8 Frontal Swing

The maximum lateral displacement between the path of the front outside corner of the vehicle (or vehicle unit) and the outer edge of the front-outside steered wheel of the hauling unit during a small-radius turn manoeuvre at low speed.

Unrestricted access to the entire road network: 1.5m

Cost: Low[a]/Low[b]
Resource Availability: High[a]/Medium[b]
Data Requirements: Low[a]/Moderate[b]

[a] – physical testing
[b] – computer-based modelling

9 Tail Swing

The maximum lateral distance that the outer rearmost point on a vehicle moves outwards, perpendicular to its initial orientation, when the vehicle commences a small-radius turn at low speed.

Not greater than 0.5m

Cost: Low[a]/Low[b]
Resource Availability: High[a]/Medium[b]
Data Requirements: Low[a]/Moderate[b]

[a] – physical testing
[b] – computer-based modelling

10 Steer Tyre Friction Demand in a Low-Speed Turn

The maximum friction level demanded of the steer tyres of the hauling unit in a tight-radius turn at low speed.

No greater than 80% of the maximum available tyre/road friction

Cost: High[a]/High[b]
Resource Availability: Low[a]/Low[b]
Data Requirements: Low[a]/Substantial[b]

[a] – physical testing
[b] – computer-based modelling

11 Static Rollover Threshold

The steady-state level of lateral acceleration that a vehicle can sustain during turning without rolling over.

Road tankers and buses: at least 0.40g
All other heavy vehicles: at least 0.35g

Cost: Medium-to-High[a,b]
Resource Availability: Low[a,b]
Data Requirements: Low[a]/Significant-to-Substantial[b]

[a] – tilt testing (may be difficult for long combination vehicles)
[b] – computer-based modelling

12 Rearward Amplification

Degree to which the trailing unit(s) amplify or exaggerate lateral motions of the hauling unit.

No greater than 2 using the SAE J2179 lane change manoeuvre.

Cost: Medium-to-High[a,b]
Resource Availability: Low[a,b]
Data Requirements: Low[a]/Significant-to-Substantial[b]

[a] – physical testing
[b] – computer-based modelling

13 Load Transfer Ratio

The proportion of vertical load imposed on the tyres on one side of a vehicle unit that is transferred to the other side of the vehicle unit during a standard lane change manoeuvre. *(Note: There is a difference in the lane change manoeuvre used for this test between Australia and NZ which means that the values used in the yellow draft of the rule do not match those shown below.)*

No greater than 0.6, however, in environments where speed is less than 75km/h a value of 0.75 could be considered acceptable on a provisional basis, pending the outcome of further research.

Cost: High[a]/Medium-to-High[b]
Resource Availability: Low[a]/Low[b]
Data Requirements: Low[a]/Significant-to-Substantial[b]

[a] – physical testing
[b] – computer-based modelling

14 Yaw Damping

The rate at which "sway" or yaw oscillations of the rearmost trailer decay after a short duration steer input at the hauling unit.

Not less than 0.15

Cost:	Medium-to-High[a,b]
Resource Availability:	Low[a,b]
Data Requirements:	Low[a]/Significant-to-Substantial[b]

[a] – physical testing
[b] – computer-based modelling

15 High-Speed Transient Offtracking

The lateral distance that the last-axle on the rear trailer tracks outside the path of the steer axle in a sudden evasive manoeuvre.

No greater than 0.8m

Cost:	Medium-to-High[a,b]
Resource Availability:	Low[a,b]
Data Requirements:	Low[a]/Significant-to-Substantial[b]

[a] – physical testing
[b] – computer-based modelling

16 High-Speed Steady-State Offtracking

The lateral distance that the last-axle on the rear trailer tracks outside the path of the steer axle in a high-speed steady turn.

Unrestricted access to the entire network:	no greater than 0.3m
Arterials and major freight routes:	no greater than 0.5m
Low-volume roads in remote areas:	no greater than 0.7m

Cost:	Medium-to-High[a,b]
Resource Availability:	Low[a,b]
Data Requirements:	Low[a]/Significant-to-Substantial[b]

[a] – physical testing
[b] – computer-based modelling

17 Handling Quality (Understeer/Oversteer)

Ratio of the response to steering (change of vehicle direction) to the steering wheel input, and its dependence on vehicle speed and severity of the manoeuvre.

Three-point measure:

First point: 0.5 < understeer coefficient < 2.0 deg/g
Second point: a_y > 0.2g (transition from understeer to oversteer)
Third point: understeer coefficient > K_{ucr} as given by Eqn (7b)

Cost: Medium-to-High[a,b]
Resource Availability: Low[a,b]
Data Requirements: Low[a]/Significant-to-Substantial[b]

[a] – physical testing
[b] – computer-based modelling

18 Braking Stability in a Turn

Amount of loss of control when braking in a turn.

Able to stop within a 3.66m (12ft) wide lane as per FMVSS 121. Both laden and unladen conditions are considered.

Cost: Medium-to-High[a,b]
Resource Availability: Medium[a]/Low[b]
Data Requirements: Low[a]/Significant-to-Substantial[b]

[a] – physical testing
[b] – computer-based modelling

19 Gross Mass per Standard Axle Repetition

The Gross Mass (GM) of a heavy vehicle divided by the Standard Axle Repetitions (SARs) applied to the pavement by a single pass of the vehicle.

For granular pavements with thin surfacing*

All heavy vehicles: 8.3 tonne per SAR

* Different levels, yet to be determined, will apply to other pavement types.

Cost: Low
Resource Availability: High[a]
Data Requirements: Low-to-Substantial[b]

[a] – once revised "Traffic Design" chapter of the Austroads Pavement Design Guide (Austroads 1992) is published.
[b] – depending on availability of information on pavement type and configuration.

20 Horizontal Tyre Forces

Degree to which horizontal forces are applied to the pavement, primarily in a low-speed turn and at constant speed on uphill grades, by the tyres of multi-axle groups (drive-axle group tyres in particular) and the effect on remaining pavement life.

Pavement wear for PBS vehicle for a particular freight task no greater than for the same task being performed by conventional vehicles.

Cost: High[a,b]
Resource Availability: Low[a,b]
Data Requirements: Low[a]/Significant-to-Substantial[b]

[a] – physical testing
[b] – computer-based modelling as described in Prem et al (2000)

21 Maximum Bridge Stress

The maximum stress that a bridge can sustain under repeated loading without incurring damage.

General heavy vehicles:	a load factor of at least 1.8
Vehicles carrying indivisible loads:	to be determined

Cost: High
Resource Availability: Low
Data Requirements: Substantial[a]

[a] as many bridge records are no longer available, it is unlikely that sufficient information would be available to enable a complete assessment of all bridges in Australia.

APPENDIX 4: TRANSIT'S CROSS SECTION GUIDELINES BY TRAFFIC VOLUME

APPENDIX 5: SCENARIO B ROUTES INVESTIGATED BY TRANSIT


Nelson
Picton
Blenheim
Westport
Greymouth
Christchurch
Timaru
Dunedin
Invercargill