NEW ZEALAND
FOREST OWNERS' ASSOCIATION INC.

NZ FOREST OWNERS ASSOCIATION

A REVIEW OF ISSUES RELATING TO THE USE OF DISTRICT ROADS FOR THE TRANSPORTATION OF FOREST HARVEST

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Table of Contents

1.0 EXECUTIVE SUMMARY

The Forest Owners Association has commissioned this report, which is intended as a reference document for its members.

Territorial Local Authorities (TLAs) have the responsibility for maintaining rural roads other than State Highways.

The increase in total vehicle numbers and, in some cases, a disproportionate increase in heavy vehicle numbers on rural roads has placed an increasing demand on some TLAs. This increased demand has been particularly evident in areas where production forests have entered the harvesting phase.

In these areas, this has resulted in pressure on the limited rating revenue that the TLAs have available for meeting the local contribution1 to rural road maintenance and upgrading. As a result, many TLAs have turned to forest owners as a potential source of additional funding, using mechanisms available to them under the Local Government Act and the Resource Management Act. In many cases this has resulted in forest owners being singled out for special contributions that are not sought from other land owners or road users.

This report includes a collation of the technical issues and discussion on the relevance of these in relation to rural roading. This information is provided as background and reference for forest owners who may be involved in discussion or negotiations with TLAs on this issue. The information contained in this report is a collation of information obtained from a number of sources and is also based on the opinions and experience of the authors. This material is not specific to any particular road or forest. Readers should seek expert advice or make their own judgement on the applicability of any information contained in this report before applying it to specific roads or negotiations.

The report also provides brief notes on the legal and funding issues as they currently apply. These processes are subject to significant change at short notice and expert advice should always be sought before acting in these areas. The technical issues, however, are well established and are not likely to be subject to significant change or variation.

During negotiations between forest owners and TLAs many arguments have been raised, some of which have been based on solid technical facts and others that are based on misunderstanding or prejudice.

This report includes technical information on road geometric design, pavements, traffic control and bridges so that negotiations can be based on a correct understanding of the technical issues. When this is done, opportunities for mutually beneficial cooperation between forest owners and TLAs can often be found. Within

[1] Transfund provides subsidies that are usually close to about 55%.

the report, options for forest owners and for TLAs have been identified where these may assist in reaching an arrangement that is appropriate for particular situations.

The legal and funding issues surrounding negotiations are specialist areas and are not covered in detail in this report. When negotiations with TLAs involve detailed debate on these issues, the engagement of specialist legal and planning services is recommended.

2.0 DEFINITIONS

AADT	**Annual Average Daily Traffic:** The annual traffic volume averaged on a daily basis.
Aggregate	The various layers of granular material making up a road pavement, excluding the seal and the ground itself.
Axle Tramp	The oscillation effect of truck dual driving axles on unsealed pavements that occurs when grades are climbed under power. Traction and load oscillates between each of the driven axles resulting in the formation of road corrugations. Axle tramp is more prevalent with unloaded or lightly loaded trucks.
Carriageway	The portion of road devoted to use by travelling vehicles, exclusive of shoulders. Note that Australian practice is to consider carriageway width to include the shoulders in the assessment of carriageway width.
CTI	**Central Tyre Inflation:** A system that permits the vehicle operator to vary tyre inflation pressures from within the cab while the vehicle is in motion.
Chip Seal	A wearing course consisting of a layer or layers of stone chips originally spread onto the pavement over a film of freshly sprayed binder and subsequently rolled into place.
District Roads	**Public r**oads, other than State Highways, within the territory of each TLA that generally provide access for landowners within the District. This includes all rural roads leading off the State Highway in a District as well as roads within the rural areas of City authorities. A large proportion of District Roads can be classified as Low Volume Roads.
EDA	**Equivalent Design Axle**: Defined as an axle with a dual-tyred wheel at each end and carrying a total load of 8 tonnes. Used as the unit of traffic load measurement
FOA	**NZ Forest Owners Association:** An industry organisation representing most plantation forest owners.
Formation	The final surface of the ground excluding any side batters after completion of the earthworks and upon which the pavement layers will be constructed. The formation extends from the top of the fill batter to the toe of the cut batter.

Geometry	The factors that determine the geometric shape of a road. This includes the width, grade, curvature, cross-fall, superelevation and other parameters involved during the formation of a road.
Grade	The slope or gradient (steepness) along the length of a section of road expressed in terms of percent or as a ratio of rise per distance (ie 1 in 8). Grade can be either adverse (uphill) or favourable (downhill) depending on the direction of the vehicle travel.
Heavy Vehicles	Trucks and trailers and articulated vehicles with or without trailers that have five or more axles in total. The Transfund Project Evaluation Manual defines six different vehicle classes ranging from passenger car to Heavy Commercial Vehicle II (HCV-II) as defined above. Trucks without trailers having three or four axles are defined as Heavy Commercial Vehicle I (HCV-I).
Light Vehicles	Passenger cars, vans, utilities and light trucks up to 3.5 tonnes gross laden weight. Two axle trucks without a trailer, over 3.5 tonnes gross laden weight are defined as Medium Commercial Vehicles. (MCV)
Low Volume Roads	Roads that carry relatively low traffic volumes in comparison to typical highways and motorways. Low Volume roads typically carry less than 100 vehicles per day, which may be any combination of heavy traffic and light traffic.
Off tracking	Term used to describe the effect when a vehicle passes around a curve where the rear wheels follow a track having a smaller curve radius that the front wheels. The rear wheels follow a path, which is inside that of the front wheels.
Pavement	That portion of a road placed on the underlying soil which is designed to support and to form the running surface for vehicular traffic. Pavement consists of constructed layers which disperse loads to over and area so that stress levels that are within the bearing capacity of the sub-grade soil.
Pore Water Pressure	The hydrostatic pressure of the water contained between the soil particles of a saturated or partially saturated soil. High pore water pressure causes the soil particles to be forced apart and the soil to have reduced shear strength.

Shoulders	The portion of the paved road that is contiguous and flush with the carriageway on either side of the road, which is not normally used by the travelling traffic.
State Highways	The road national road network that provides the arterial routes between regions. Because the State Highway network is used and provides benefit to users both within and outside a region, this road network is fully funded by Transfund without contribution from TLAs.
Sub-grade	The trimmed and prepared portion of ground (i.e. the in-situ material) upon which a road carriageway is constructed. This may be original ground or fill placed during the road formation process before the various layers making the road pavement are placed on it.
TLA	**Territorial Local Authority**: District Councils and City Councils that are empowered under the Local Government Act. TLAs have responsibility for the management and maintenance of roads other than State Highways within their territory.
Watertables	The side drains on each side of a road carriageway that are provided to carry surface water along the road to discharge points as well as to promote drainage of the pavement and sub-grade layers.

3.0 BACKGROUND

The NZ Forest Owners Association (FOA) represents the majority of production forest growers in New Zealand. As increasing areas of forest reach maturity, there is the increasing demand on the use of the district road network for the transportation of logs and timber. This increase is a result of:

- A steady increase in total harvest volumes nationally as new plantation forests reach the end of their first production cycle.
- An increase in the proportion of the harvest originating from smaller remote forest plantations rather than the large established forests.

In many cases, the significant increases in harvest volumes occur in rural regions where production forest harvesting has not previously been present and where the road infrastructure is of a low standard.

What is common to most of the harvest is that extraction of the timber will require the use of District Roads to transport the harvested volume to the State highways and then to processing facilities or export ports.

Additional demand on the District Roading networks has also arisen from significant changes in rural land use. These include:

- Increases in dairy farm yield as a result of improvements in farm and animal management practices.
- Conversion of land from dry-stock farming to dairy farming.
- Increased areas of land under cropping.
- Rural subdivision of land into lifestyle blocks resulting in increased population levels and associated vehicle movements.
- Significant increases in the size and weight of agricultural equipment that occasionally travels on rural roads.
- Changes in farm management regimes where large farms are managed with the input of contract resources, resulting in increased levels of machinery movement on roads.

Whilst the above effects have contributed to significant increases in the level of traffic on rural roads, production forestry is frequently cited as the major cause of the need for increased expenditure on public roads. In reality, forestry is one of several contributing factors to increased demand on rural roads. As result of the increased demand on the use of rural roads, a number of serious issues have arisen which threaten the potential for continued safe and economically viable harvesting of many plantation forests. These issues are characterised by the following:

- Many existing rural roads are of inadequate standard for the transport of high volumes of logs, particularly on a continuous or semi-continuous basis.
- Road safety may be significantly compromised as result of the use of inadequate roads by high volumes of logging traffic simultaneously with high use by other vehicles.

- Some TLAs have insufficient funding sources available to meet the local share of the cost of necessary road upgrading within their districts.
- The District Planning process and Resource Management Act are being used by some TLAs to control or limit production forestry or to coerce funding to cover increased road upgrading costs.
- Forest owners are coming under other forms of pressure from TLAs to contribute large sums toward road upgrading.
- The lack of an adequate district road network is inhibiting the economic harvest of forests in some areas.
- Relationships between Forest Owners and TLAs are, in many cases, becoming strained.

A clear understanding of the technical issues may help in discussions between FOA members and TLAs, and thus help avoid misunderstandings and facilitate fair and reasonable solutions to problem issues.

The FOA has commissioned this report, which is intended as a reference document for members. This report includes a collation of the technical and traffic management issues and discussion on the relevance of these. The report also notes some of the legal and funding issues that are associated with public road use and management. These matters are not covered in detail, as they often require specialist advice and are also subject to frequent change.

4.0 TECHNICAL ISSUES

4.1 Preamble

There are a number of technical issues that relate to the design, construction and operation of roads. An understanding of these is a pre-requisite for good planning, design, construction and management of roads that are required for the transport of logs. It is also a prerequisite for understanding funding issues and options.

This document is focused on rural roads that generally carry low volumes of traffic and are often constructed to a lower standard than State Highways or Motorways. Hence the technical issues noted below are those that are more likely to be relevant to Low Volume Roads rather than High Volume arterial District Roads or State Highways.

4.2 Road Design

4.2.1 Road Design Standards

Road design consists of determining the geometric layout of the road formation and the structure of the pavement on the carriageway portion of the road formation. Signage, signals and other driver information are also part of the design process.

Road designers are guided by standards that provide appropriate parameters for geometric design and procedures for pavement design. The Guide to the Geometric Standards for Rural Roads (NRB 1985) was used in the past as a basis for the design of many District Roads in use currently. More recently, Austroads standards have been adopted in New Zealand. The Austroads geometric standards have generally been developed in relation to the less mountainous terrain of Australia and hence these set higher geometric standards than the previous NRB standards.

Several TLAs have specified their own geometric standards for rural roads which form the basis for new road construction or upgrading. Most large forestry companies have also established road geometric design standards. These standards tend to be lower that those used for public roading for a number of reasons:

- in a forest there is usually greater control over users and the average driver ability is higher;
- there is less probability of unexpectedly encountering opposing vehicles; and
- forest owners, who meet all the costs of this roading, have no incentives to over-design and strong incentives to consider alternative management practices.

Pavement design has in the past followed Transit NZ design procedures and more recently makes use of the Austroads Pavement design models. Forest road pavement design follows similar procedures but tends to accept a higher risk of partial pavement failure with the associated lower serviceability standard.

4.2.2 Existing District Roads

Many existing District Roads have been developed as a result of progressive improvement over a long period of time. Often such improvements have been limited by the funding available to a TLA at the time and as a result, specific design standards have not always been used. Consequently the geometric standards of many existing District Roads are well below the standard that a TLA may now have established for new road construction within the District.

Similarly, the pavement construction of many District Roads, especially Low Volume District Roads is likely to be well below that which would be provided if Austroads design procedures were applied. Typically, many District Road pavements have lasted beyond their original intended life and are maintained in a serviceable condition by reactionary maintenance as deterioration occurs. For unsealed roads this consists of grading of the surface and application of thin surface layers of pavement aggregate. This is a similar approach to that used by most forest owners.

At the time of harvesting of forest land, many of the geometric and pavement deficiencies of existing District Roads become apparent as a result of the additional space requirements of higher numbers of heavy vehicles and the increased pavement loading. Note that while this may result is substantially increased maintenance costs over a period, the costs on a per tonne.km basis may be no higher than previously.

4.2.3 Appropriate Design

Selection of appropriate design parameters is a key initial part of road design. Whilst it requires less thought and political risk to adopt established standards within a District or standards such as Austroads for the geometric design for upgrading of District Roads for forest harvesting, use of such standards may result in highly conservative and un-economic solutions. This is particularly the case when log flows are relatively low or intermittent.

Selection of appropriate design standards should be the result of careful consideration of the existing traffic level and mix as well as the projected traffic level and mix. In the case of District Roads serving forest land, the future traffic flows can be easily forecast well in advance with a reasonable degree of accuracy. Since many of these roads will carry traffic levels well below the typical parameters on which the documented standards are based, a lower standard may be appropriate for Low Volume District Roads. Similarly, it may be appropriate to adopt a lower standard for road upgrading where agreement has been reached with a forest owner to manage traffic in one of several ways that reduces risk.

The need to consider alternative strategies is particularly critical where the logging traffic will be relatively short-term or intermittent.

4.2.4 Cost Effects of Inappropriate Design.

The cost of inappropriate design can be significant. In mountainous terrain, the choice of conservative geometric standards can result in extremely large earthwork volumes being necessary. The increase in carriageway width from 5.0m to 6.0m can often result in a 100% increase in the road formation earthworks volume, and hence a 100% increase in the road formation cost.

Use of conservative pavement design can increase costs as a result of use of high specification materials carried from remote sources, whereas a less conservative design may make use of lower cost local materials2.

Many District Roads have been provided with a relatively thin pavement with a chip seal surfacing. Whilst this has improved the serviceability for most road users and is adequate for modest traffic flows, such roads often quickly deteriorate when there is a significant increase in traffic flow such as occurs when forests are harvested. Such roads can only be upgraded by sacrificing the chip seal and re-constructing the pavement to an appropriate standard for the heavy traffic loading. Had these roads been provided with an appropriate thicker pavement prior to sealing, in anticipation of future forest harvesting, the total cost of upgrading would have been significantly less.

4.2.5 Alternative Strategies

The design standards that are appropriate for the intended use of a road are influenced by the management strategy that is adopted for the road. Use of alternative strategies allow the use of alternative design standards. These alternative strategies include:

- Limiting time of daily use;
- Radio control of traffic;
- Seasonal road use;
- Weather limitations on use;
- Risk sharing, e.g. maintenance costs;
- One-way traffic flows;
- Use of Central Tyre inflation;

4.3 Road Geometry

4.3.1 Road Geometry Factors

The factors that make up the geometric standards of a road include the following:

- Carriageway width
- Curve Radius
- Curve Widening
- Grade
- Sight Distance

There are other geometric factors taken into account in the design of a road formation such as cross-fall, drainage etc, however these are part

[2] Refer to the (yet to be released) Transfund report on the audit of the 2002/03 Development Roading Programme which specifically raises this point.

of normal good practice and are not discussed in detail in this document.

The selection of an appropriate design for a new road or the upgrading of an existing road involves the selection of appropriate parameters for the above factors.

4.3.2 General Requirements

The geometry requirements of a road are determined by what is necessary to enable the expected traffic to physically pass over the road whilst maintaining reasonable levels of safety for all vehicles using the road. This generally requires the provision of sufficient space for vehicle passage as well as for reacting to and passing opposing traffic. The geometric requirements of a road are determined by several factors including:

- Maximum traffic capacity
- Average daily traffic
- Peak traffic flow
- Direction of flow (one or two directions)
- Vehicle Type
- User expectations
- Prevailing Conditions (frequent fog or ice)

4.3.3 Traffic Capacity

Traffic capacity is determined by the traffic volume at which a road is saturated with vehicles and has reached its maximum carrying capacity in vehicles per hour. (Typically over 500 vehicles per hour). District roads very rarely reach maximum traffic capacity and the traffic capacity of a road is unlikely to be a factor in the geometric design of District Roads for forestry use.

4.3.4 Average Annual Daily Traffic

The average number of vehicles passing in each direction over a road in a 24hr period is expressed as the average daily traffic. This figure is averaged over a year to allow for seasonal effects to derive the Annual Average Daily Traffic (AADT). This a measure of the frequency of vehicles passing a given point and is used to determine the probability of on-coming vehicle conflict over a given length of road. AADT is an important factor in road geometry design because the frequency of on-coming vehicle conflict determines the need for additional traffic lanes.

4.3.5 Peak Traffic Flow

Peak traffic flow is the number of vehicles passing a point (expressed in vehicles per hour) during the part of a day that a road carries its highest traffic flow. Peak traffic flow on a District Road may occur between 7.30am and 8.00am if rural residents travel to a nearby town for employment. Similarly, peak flow may occur just before 7.00am on a District Road where logging crews as well as empty logging trucks arrive at the forest simultaneously. Forest owners may have an opportunity to control or limit peak traffic flows by managing forest operations so that forest generated traffic avoids conflict with peak flows from other sources.

4.3.6 Direction of Traffic Flow

Some District Roads may carry more traffic in one direction than another and this may vary throughout a day. Typically, a road providing access to a forest is likely to have forest traffic travelling toward the forest early in the morning whilst local traffic is travelling away from the forest toward local towns and schools. Determining the direction of traffic flow over time on a given road may enable forest operations to be managed in a way to reduce the potential for on-coming vehicle conflicts.

4.3.7 Vehicle Type

Vehicles range widely in width, length axle configuration, weight and turning characteristics. A typical light vehicle is comfortably capable of turning corners having a radius as low as 10 metres, however a typical truck and trailer requires a minimum curve radius of 18 metres or more for comfortable cornering even at very low speed. A transporter for shifting heavy equipment may have a larger minimum curve radius requirement and may also need flatter vertical curves at hill crests and dips to avoid grounding. Some agricultural equipment is very wide and may require additional carriageway width and bridge clearance width.

Improvements to road geometry are often necessary for the purpose of providing for logging truck and trailer units that may previously have not used a road. It is possible that limiting forest harvesting to the use of trucks without trailers would avoid the need for road geometric improvement in some cases, however this usually results in highly uneconomic transportation operations and increases the traffic numbers and potential vehicle conflicts. Often geometric improvements to the road are still necessary to enable haulers and other harvesting equipment to be transported to the forest on low loaders transporters.

4.3.8 User Expectations

The expectations of drivers on District Roads depends on their experience and capability. Landowners in remote rural locations in hill country have a relatively low expectation of road geometric standard because they are aware that the logistics and cost of providing a higher geometric standard is un-justified. However this acceptance of a lower standard is concurrent with the expectation that a road carries low traffic volumes.

In less remote locations where there are a number of lifestyle blocks, the expectation of landowners may be higher and driver capability lower, hence pressure for a higher standard of road with ample space for passing of opposing traffic.

Generally, the road geometric standard expectations of forestry traffic is low because the drivers of logging trucks and equipment have a high capability to negotiate internal forest roads and are satisfied with the minimum standard accommodate the vehicle and maintain safe stopping distances to opposing traffic.

4.3.9 Prevailing Conditions

Other conditions may be a consideration in the design of appropriate geometric standard for a District Road. These include the frequency of ice on the pavement, fog that may limit visibility, high rainfall that may increase braking distances. The presence of such factors may be reason to adopt higher geometric standards that would otherwise be used.

4.3.10 Carriageway width

Carriageway width is generally determined by traffic volume in terms of AADT. Austroads Rural Road Design recommends a carriageway width of 5m to 6m for Low Volume roads and 8.0m to 8.5m where traffic volumes are higher. Note that Australian practice is to define carriageway width as including shoulders, whereas NZ practice excludes shoulders from carriageway width. NZ NRB Guidelines recommend a 5.0m carriageway width where AADT is below 30 vpd and 7.5m width where AADT is up to 250 vpd.

There are examples where TLAs have agreed to accept lower carriageway width standards than those noted above in circumstances where upgrading to a higher standard can only be achieved at a high cost or is not justified for the intended use. Low Volume unsealed roads of 4.5m carriageway width can safely carry heavy traffic. Sealed roads of 7.0m carriageway width can be safely operated in a high-speed environment and a 6.0m sealed carriageway width has been found adequate in a low speed environment.3

The carriageway widths recommended above allow for safe use by heavy vehicles whilst allowing sufficient space for opposing vehicles to

[3] NB, The Transfund Audit report on the 2002/03 Development Roading Programme will make these recommendations.

pass in most places. On single lane carriageways, this may require one or both vehicles to track onto the road shoulder. Light vehicles are able to track onto a properly constructed road shoulder without difficulty or risk of pavement failure. Where there is likely to be frequent opposing heavy vehicles on a single lane carriageway, the provision of passing bays or a wider carriageway width is recommended. The road shoulder may not carry repeated wheel loads from loaded heavy vehicles and result in rutting and vehicle roll-over.

Limited knowledge of other vehicle locations may compromise the effective use of passing bays. Typically roads are constructed to have wider carriageways for sections having very short sight distance (ie corners) and effective use of passing bays is achieved where opposing vehicle locations are known. This then relies on visibility of the road section between passing bays or on radio communication between vehicles. Where there is no visibility between passing bays, there is likely to be the occasional opposing traffic conflict because not all vehicles on a public road will have radio communications.

4.3.11 Curve Radius

Curve radius is the centre-line radius of the circular arc of a road curve. Properly designed road curves have a transition from the tangent point to the start of the true circular curve, although this is not a significant feature for Low-Volume roads. Selection of an appropriate curve radius is determined by the physical capability of a particular vehicle to negotiate the curve as well as the design speed value of the curve. For Low Volume Roads where speeds are very low, the physical limits of the largest vehicle tends to dictate the required curve radius. For other District Roads, the design speed value will determine the required curve radius.

The following table taken from a forest road specification indicates typical minimum curve radius recommendations.

Table 1 – Minimum Curve Radius

Road Type	**Terrain Type**	**Minimum Curve Radius [m]**
Track	All	10
Spur Road	Flat, Rolling	25
Spur Road	Steep	18
Secondary Road	Flat, Rolling	30
Secondary Road	Steep	20
Arterial Road	Flat, Rolling	50
Arterial Road	Steep	30

Whilst most vehicles are capable of turning sharper curves that those shown in the table, these figures allow for occasional use by vehicles that have poor turning capability.

4.3.12 Curve widening

Additional carriageway width is required on curves having low curve radii and large changes in direction to allow for off-tracking of the trailing axles. This is to prevent the trailer wheels tracking off the edge of the carriageway onto the shoulder which, in extreme cases, can result in trailer roll-over.

The amount of curve widening required varies depending on vehicle axle configuration and turntable geometry. Tables can be derived for various vehicle types giving the additional carriageway width necessary depending on the curve radius and net change of direction through the curve.

Curve widening is necessary to properly provide for long transporter vehicles and also truck and trailer combinations such as logging trucks, milk tankers, stock trucks and fertiliser trucks.

4.3.13 Maximum Grade

The maximum grade limit of a road is governed by the power capability of vehicles to climb the grade and also the capacity to transfer this power to the pavement to gain traction.

Most vehicles have sufficient power to climb very steep grades at acceptable speed, hence power limitations seldom govern the determination of maximum grade for District Road design. (On some arterial District Roads and on State Highays, maximum grade may be limited to reduce the speed reduction and congestion caused by slow heavy vehicles climbing steeper grades).

The maximum grade on District Roads is generally limited by the ability of vehicles to achieve traction. Steep grades on unsealed pavements result in loss of traction of the driving axles and the need for the vehicle to be towed or pushed. This is rare for light vehicles on roads but is an occasional occurrence for heavy vehicles, particularly those with axle combinations which have a low proportion of the total vehicle weight distributed on the driven axles. The problem usually appears when the pavement is wet or has become unbound and hence has a low coefficient of friction.

Limiting maximum road grade is the preferred method of overcoming traction loss. Most truck and trailer combinations can climb grades on unsealed roads up to 1 in 8 (12.5%) without difficulty but some are likely to have difficulty on grades greater than 1 in 7 (14.3%).

Improvement of the coefficient of friction of the pavement by stabilisation or sealing can allow steeper grades to be negotiated without loss of traction.

4.3.14 Grade Uniformity

On long hill sections of District Road, the grade may vary significantly over the length of road which climbs the hill. Whilst this has little adverse effect on light vehicles, in heavy vehicles it necessitates the frequent changing of gear to maintain optimum engine speed.

This frequent gear changing can precipitate loss of traction and is also inefficient on truck operation. Good practice is to design new roads or upgraded roads with constant grades over hill sections. The exception to this is to provide reduced grade on sharp curves to offset the effect of steepening of the inside wheel track grade caused by the lesser radius of this wheel path and superelevation. Roads climbing over some distance on sharp corners should be designed with a maximum grade of 1 in 10 (10%).

4.3.15 Grade Effects on Maintenance

Where road grades are over 1 in 8 (12.5%) on unsealed roads, there is increased potential for corrugation of the surface due to Axle Tramp. This increases road maintenance costs and reduces road safety and comfort. The reduction in road comfort is typically more noticeable in light vehicles. It should be noted that corrugation of unsealed road surfaces occurs under medium commercial vehicle traffic as well as heavy vehicle traffic. The provision of a sealed surface to improve traction will reduce the maintenance requirements of steeper grades.

The use of CTI on the driving axles of trucks reduces the incidence of oscillating axle corrugations and hence reduces the frequency at which regular grading is required. This can be a significant cost saving for remote roads.

Where roads have steep grade, the water velocity in the side drains is higher and hence more prone to scour the formation. This requires more culverts to prevent excessive flows and scouring of water-tables. Roads having steep grades require more frequent maintenance than flatter roads, even if traffic volumes are very low.

Grade improvements to a District Road have a benefit to a TLA in the form of reduced maintenance cost.

4.3.16 Grade Effects on Safety

Roads having long sections of steep grade place a higher dependence on driver skill and vehicle condition. Brake wear or failure can result in vehicle loss of control on steep grades. Steep favourable grades require significant increases in stopping distances.

Grade improvements to roads result in increased safety for all road users.

4.3.17 Sight Distance

Sight distance determines the available time for reaction and stopping. This is particularly important on single lane unsealed roads where opposing vehicle conflict is the greatest hazard.

Austroads Rural Road Design provides the following stopping distances. (Rf=1.5 is appropriate where drivers are likely to be in an alerted state, ie conscious that extra care is needed).

Tabe 2 - Stopping and Manoeuvre Sight Distance [m]

Design Speed [km/h]	Normal Design R_f=2.0s	Restricted Situations R_f=1.5s	Manoeuvre Sight Distance
50	45	40	45
60	65	55	60
70	85	70	75
80	105		
90	130		

Stopping distances shown in the above table should be provided on District Roads for the safety of all users. Existing sight distances on District Roads are often much less than the figures in Table 2. Drivers should adjust their speed accordingly.

The lack of adequate sight distances becomes evident when traffic volumes increase. At low speeds on limited visibility roads, heavy vehicles often have shorter stopping distances than light vehicles due to their superior braking systems and high weight on braked axles.

It should be noted that the Road Code requires that drivers should at all times be able to stop within half the visible distance of road ahead of them.

4.4 Pavement

4.4.1 Pavement

A road pavement is the means of transferring the relatively concentrated loads from wheel contact points to the underlying soils which generally have low load bearing capacities. A pavement achieves this transfer of load by distributing the point loads from wheels over a larger area of subgrade. A road or track with little or no pavement can carry a small number of vehicle passes directly on the sub-grade soil when the wheel loads are low or when the sub-grade soil is dry[4] and has a high load bearing capacity.

4.4.2 Pavement Design

The design of pavements to effectively carry predicted traffic loads and volumes over known soil conditions is a process for which there are established design procedures.

Whilst local knowledge and experience is often used during pavement design, there are well established design methods that can be used to increase the level of confidence in ensuring a particular pavement will remain serviceable under the expected traffic loading.

4.4.3 Flexible Pavements

Flexible pavements are the predominant pavement type in New Zealand. They usually consist of an aggregate layer (or layers). The aggregate pavement is designed to spread the high pressure under the wheel loads over a much larger area of sub-grade at the base of the pavement. This pavement layer is designed to deform elastically under load. It is often covered with a thin flexible chip seal which is designed to provide water-proofness and also skid resistance. Flexible pavements are relatively low cost and if suitably designed, constructed and maintained, can have a long life.

4.4.4 Rigid Pavements

Rigid pavements have a stiff structural layer, usually asphalt or concrete, and are designed to act as structural slab. The bending stiffness of the slab is used to distribute wheel loads over a wider area of sub-grade. The cost of a rigid pavement is usually considerably higher than that of a flexible pavement. Rigid pavements are usually only cost-effective on high traffic volume roads such as motorways or in log yards where very heavy wheel loads are carried in concentrated locations.

[4] Note that stabilisation techniques (cement, lime, bitumen, etc.) aim to maintain this “dry” strength by protecting a cheaper material from the effects of moisture, i.e. by “stabilising” the dry strength.

4.4.5 Standard Design Axle

Conventional pavement design uses a "standard" design axle as the basis for design. The "standard axle" is defined as being a twin tyred axle carrying eight tonnes. All vehicles are measured in terms of this Equivalent Design Axle (EDA). This allows various combinations of axle loads to be compared in terms of EDA's.

4.4.6 Relationship Between Different Axle Weights (4th power rule)

The fourth power rule states that the wear due to any axle load is in proportion to the wear caused by a standard axle raised to the fourth power of the relative axle weight. This rule has its origins in ASSHTO test undertaken in North America in the period 1956-61 on sealed flexible pavements. Recent research in NZ by John Du Pont of TERNZ and at the University of Canterbury has indicated that a 2nd power rule may be more appropriate for unsealed Low Volume roads.

To illustrate the effect of the power rules, a 12 tonne axle has 1.5 times the weight of an 8 tonne axle but has as an EDA of 5.06 (using a 4th power rule) or an EDA of 2.25 (using a 2nd power rule).

What this means is that at a particular point on a road one passage of a 12 tonne axle is equivalent to between 2.25 and 5.06 passes of an 8 tonne axle at that same point.

4.4.7 Pavement Damaging Effect

The amount of wear of flexible pavements resulting from the passage of an axle (pavement damaging effect) is considered by most widely accepted pavement design models to be a function of the EDA of that axle. Hence an axle that carries twice the load of another will cause between four and sixteen times the wear of another. Similarly, a truck that is overloaded by 10% will cause between 21% and 46% more damage than a truck loaded to its normal load. For this reason, light vehicles generally cause a negligible amount of pavement wear or damage on normal, properly constructed, road pavements.

4.4.8 Flexible Pavement Design Methods.

The design of flexible pavements is generally based upon the summation of EDAs that is expected over the design life of the pavement. For a given value of total design EDA and sub-grade strength, the required thickness of pavement to provide a serviceable pavement is derived from a design procedure, given predetermined acceptable limits on deflection, deformation or rutting.

4.4.9 Pavement Depth

Conventional pavement design (on flexible roads) calls for a depth of suitable aggregate to be provided as the road pavement. This aggregate serves a number of purposes including:

- Maintenance of a suitable road shape and cross-fall.
- Load spreading from the surface through the pavement depth to and sub-grade to ensure the pressures applied to the sub-grade are within its load capacity.
- Drainage of water entering the pavement from the surface or from the sub-grade.

The provision of aggregate to form pavements is usually a major portion of the cost of road construction. Selection of the minimum pavement depth that will provide the required performance is a key factor in cost-effective road design.

4.4.10 Pavement Requirements for Increased Traffic and Loading.

The additional pavement thickness required for an increase in pavement loading in terms of EDA is not linear. Under a typical design method, a 1000% increase in traffic loading would require an additional pavement thickness of only 25% above the original pavement if this was adequately designed for the original traffic loading. Hence the net effect of providing an adequately designed road pavement for an increased traffic level is much less than a direct proportion of the additional traffic loading in terms of DEA or tonnage carried or numbers of vehicles.

This effect means that the incremental cost of providing a suitably designed road pavement for forest harvesting is often not much more than the cost of providing a properly designed pavement for the non-forestry traffic.

4.4.11 Cost of Pavements

The cost of providing a road pavement is directly proportional to the thickness of pavement provided. A design procedure usually results in selection of the minimum thickness of pavement that will meet the design criteria.

4.4.12 Cost Effective Pavement Design

For Low Volume roads, it is often acceptable to use a higher risk approach to selection of a design pavement. In this approach, a thinner pavement depth is used in the design together with the acceptance that in some locations there may be pavement damage within the design life. If the road is unsealed, it is a relatively simple matter to add additional pavement depth to any localised failed areas when they appear. This often results in a lower overall cost than would have been incurred if a more conservative pavement design had been adopted at the outset. This approach has the potential to significantly reduce the cost of upgrading Low Volume District Roads.

4.4.13 Subgrade Stength

The strength of the underlying sub-grade soils on which a road is constructed depends on the soil type and the moisture content of that soil. During dry periods the strength of the sub-grade soil will be higher, hence it is more capable of supporting vehicle loads than it would be during wet seasons. Roads with relatively weak pavements can be used successfully to carry logging traffic if the period of harvest is limited to dry periods.

Where the sub-grade soil has a very low strength, an option is to excavate the weak material and replace it with a better strength material that may be available nearby. Alternatively, the sub-grade soil strength may be increased by soil stabilisation. Stabilisation can take a variety of forms including the use of geotextiles or geogrids, or the use of cement, lime or other stabilising agent to bind soil particles together and increase the shear load capacity.

4.4.14 Heavy Traffic Capacity of Existing Pavements

A large proportion of existing rural road pavements are capable of carrying light traffic and comparatively low numbers of heavy vehicles. They have performed satisfactorily under this loading with maintenance that was within the financial resources of the TLA. As traffic levels and the frequency of heavy traffic increases, many of these pavements are now inadequate to carry the current traffic loadings without increased pavement deterioration giving rise to a need for additional maintenance.

This situation has arisen because many TLAs have had insufficient funding to reconstruct pavements to recognised design models and have been forced to provide lesser pavements in the acceptance that earlier pavement failure may occur and higher levels of maintenance will be necessary. Whilst this higher-risk approach to pavement provision is sensible and sustainable in the short-term, it is unforgiving in situations where there is a significant permanent increase in traffic loading. Such roads often exhibit rapid pavement failure when subjected to a sustained increase in traffic loading from forest harvesting.

Many existing rural road pavements are however capable of carrying short term increases in heavy traffic if such spikes in loading occur during periods when pavements are dry and the pavement and sub-grade strengths are high.

4.4.15 Strength of Pavement Layers

The stress from axle loads decreases with depth within a pavement, hence a less durable lower-cost aggregate may be used in the lower layers of a pavement. This approach allows lower-cost, and possibly local, weaker aggregate to be used as the sub-base layers of a pavement. The upper layers of a pavement however require full strength regardless of the axle loads.

4.4.16 Pavement Deterioration Over Time

Flexible road pavements by their very nature, deteriorate through use and eventually fail. This failure can be classified into two groups:

- Structural failure is where the structural capacity of the road can no longer support the wheel loads without severe rutting caused by shear failure of the sub-grade soil or the pavement layers. The road becomes impassable, at least to light vehicles, within a very short time.
- Functional failure, where the road serviceability falls below a safe acceptable level. Serviceability relates to user comfort and is a function of roughness. Heavy vehicle road users can usually tolerate a higher levels of roughness than light vehicle users.

A road can have failed functionally but still be structurally sound.

4.4.17 Pavement Rutting

Rutting may initially be caused by compaction of an existing pavement or sub-grade material when the type and weight of vehicle using it changes. This rutting may be seen as the onset of failure, but in fact could be improving the sub-grade strength through compaction. A repair of the surface layers of such a pavement may then give rise to a far better pavement. Unfortunately rutting is sometimes left too long and the pavement collapses under shear failure before the benefits of compaction are captured.

4.4.18 Relative Pavement Deterioration

Pavement deformation of a chip seal surfaced unbound granular pavement (flexible pavement) will, under certain levels of sub-grade and pavement strength, be elastic and will recover after vehicle passage. However under heavier loads when sub-grade and pavement strengths are lower, very small amounts of permanent deformation occur due to sub-grade rutting and compaction of the granular layer. The accumulation of these deformations will cause surface rutting and roughness. Rehabilitation will be required when the roughness exceeds a certain criteria. Structurally, nothing has changed in the unbound granular pavement and the rehabilitation treatment simply involves smoothing with a marginal increase in thickness to cater for the future traffic volumes.

Other pavement types with bound layers (rigid pavements) suffer by fatigue. At the end of their life the bound layers would have cracked through and the structural integrity of the pavement substantially reduced. Rehabilitation of this type of road is substantial, as the original structural integrity needs to be restored and an increase in future traffic volumes may need to be catered for. A major change in pavement type from the unbound granular could result in a significant increase in rehabilitation costs 30 years from now.

For the above reasons, the use of rigid pavements with bound layers is unlikely to be a cost effective or sustainable option for Low Volume rural roads.

4.4.19 Seasonal Effects

Extremes of weather, either wet or dry, may detrimentally affect a road pavement depending on the materials used in its construction as well as the traffic loads being carried. Seasonal effects are most noticeable on roads that have not been specifically designed for use during a particular season or weather extreme.

In the case of roads carrying heavy loads, such as those used by logging trucks, pavement problems arising from seasonal effects are mostly due to wet conditions, which lead to:

- Ingress of water into the sub-grade[5] and pavement aggregate resulting in reduced strength.
- Surface deterioration and slushing of wet unsealed roads.
- Poor drainage of the pavement, often caused by poor compaction during construction. Pavement movement under wheel loads then causes mixing with unsuitable materials (eg clay) from the sub-grade and consequently a reduction in pavement strength.
- Poor skid resistance due to clay material on seal or wet uncompacted surfaces on unsealed roads.

In some situations there may be potential for forest owners to limit the use of a District Road by forestry traffic during wet seasons thus allowing a lower standard of road pavement to be used without incurring the type of damage that would normally be expected during wet periods. This may be a cost-effective alternative to upgrading a road to a standard where it will remain serviceable in all conditions.

[5] Note that this will be much less of an issue when the subgrade has been stabilised.

Such restrictions on heavy traffic use should be based on evaluation of pavement strength characteristics and likely pavement damage in wet conditions rather than be allowed to become a mechanism to limit forestry activity in general. Seasonal restrictions may take the form of agreeing to a reduced axle loadings during periods when soil saturation levels are above a certain level.

For larger forests that are under continuous harvesting cycles, seasonal limits may be more difficult or costly to implement. Commercial sale commitments for specific species or log grades may also make this option difficult.

4.4.20 Effects of Frequent Heavy Passes in Quick Succession

Where there is a significant amount of moisture present in pavement aggregate or sub-grade soil, the effect of heavy axle loading in quick succession is believed to be more damaging than the same number of axle passes spread over a longer time period.

This effect is sometimes observed on rural roads having thin low quality pavement construction over saturated soils. On such sub-grades, an occasional heavy vehicle pass causes only minor damage, but an activity that gives rise to several heavy vehicles passing in a short time period results in more significant damage.

This effect is the result of the development of positive pore water pressure under a rapidly applied loads.

If successive loads are applied before the pore water pressure has time to dissipate and reach equilibrium, the pore water pressure continues to increase with each successive loading. Excessive pore pressure reduces effective shear strength resulting in permanent deformation of the pavement or sub-grade material.

This effect is a function of the time-period between successive loads and the permeability of the pavement or sub-grade material. Research conducted by Transfund in NZ and other overseas research appears to associate this effect with situations where there are large number of load cycles with a frequency between loadings ranging up to a few minutes. This effect is unlikely to be a factor in Low Volume District Roads except where the sub-grade soils or pavement are extremely impermeable or where the road is subjected to a large number of load repetitions in very quick succession (ie only minutes apart).

When road pavements or sub-grades are saturated, provided heavy vehicle passes are separated by a time period of 30 minutes or more, it is unlikely that pore water pressure increase will be a factor in road deterioration. It should be noted that road pavements and sub-grades that are prone to this effect are likely to be in poor condition and in a state that is inadequate for carrying any significant levels of heavy traffic regardless of pore pressure increase effects.

Other than on very inadequate roads (as described above) that are liable to deteriorate with even infrequent heavy traffic, there is no evidence to support the theory that frequent heavy passes will causes more damage to rural roads that the same traffic over a more extended period.

4.4.21 Use of Central Tyre Inflation

Central Tyre Inflation systems for lowering the tyre pressure of truck wheels (CTI) have become quite common on logging trucks. Approx 20% of logging trucks in use in NZ have CTI systems fitted to the driving axles. These systems allow tyre pressure to be reduced and increased from within the truck cab whilst travelling.

Currently in NZ CTI is used predominantly on the driving axles of trucks to increase the tyre contact area with the pavement and hence increase the coefficient of friction. As a result these trucks are able to climb steeper grades without traction difficulties.

4.4.22 Effect of Reduced Tyre Pressure

Tyre pressure is one of the primary parameters underlying most pavement design procedures. Pavement design traditionally is based on the assumption that heavy vehicles will have tyre pressures at 100 psi. Recent studies show considerable benefit from lower tyre pressure when associated with heavy loading.

Practical trials show that for unsealed roads in particular, modest levels of reduced tyre pressure have significant benefits to the vehicle operator as well as reduced road wear including the following:

- Less punctures in heavy vehicles on unsealed roads
- Smoother ride
- Less stress on suspension and mechanical components
- More driver comfort
- Corrugations and surface ruts are healed by the low pressure tyres in a similar fashion to that achieved by passes of a rubber-tyred compactor.
- Testing at the Nevada Automotive Test Centre found that lowering tyre pressures reduced traffic related road maintenance by up 80% and healed existing ruts on unpaved roads. This test also found that truck component damage was reduced by as much as 85% on a rough road course when lowered tyre pressures were used. Reductions in tire wear and punctures were also noted.

If forest harvesting transport were to be fitted with CTI on all axles and lower tyre pressures are used on District Roads, pavement wear can be expected to be significantly reduced. There is potential for roads with weaker pavements to be used for forest harvesting on the basis that all logging trucks using the road are fitted with CTI on all axles.

The cost of fitting CTI to truck is significant for a transport operator. The benefit of having CTI fitted accrues to the forest owner as well as the transport operator. If the forest owner were to contribute to this cost (either directly or through an adjusted transport rate for CTI fitted trucks) then the availability of trucks fitted with CTI would increase. The result would be a significant reduction in road wear both in the forest and on District Roads.

The effects of lower tyre pressure on sealed roads have not been as extensively researched. There are suggestions that lower tyre pressures may actually damage the chip seal commonly used on roads in New Zealand.

Use of reduced tyre pressures at high speeds or over long distances results in heating of the tyre walls and increased tyre wear. Hence this option is only suitable for only a few kilometres of low standard road.

4.4.23 Acceptable Surfacing

The acceptability of a road surface is a subjective matter. Drivers of light vehicles prefer the ease and comfort of sealed roads, however these are more expensive than unsealed roads to initially construct, upgrade and may be more expensive to maintain.

Users of heavy vehicles will generally accept unsealed surfaces more readily than the general public. This is due to a number of factors but the prime ones are:

- Heavy traffic drivers usually have higher driver skills;
- Drivers of heavy vehicles experience less deterioration of driver comfort on unsealed roads than do the drivers of light vehicles; and
- Drivers of heavy commercial vehicles are likely to accept that use of unsealed roads is a necessity for their work.

Forestry roads are predominantly unsealed and generally use large size crushed rock as a surface. The use of a wearing surface layer consisting of a smaller sized aggregate and fines, on unsealed roads can increase the comfort level for truck drivers and light vehicle users as well as providing a much better medium for the maintenance of the road surface

Where road upgrading is necessary to increase pavement strength for forestry traffic, it is often not economically justified to provide a chip seal surface, even if the road had a chip seal surface prior to upgrading. In other situations where harvesting is to take place over a limited period only, there is merit in maintaining the road in an unsealed state until after harvesting is complete. This enables localised failure of the pavement to be easily repaired during the harvesting period.

4.5 Bridges

4.5.1 Bridge Load Evaluation

Bridges on District Roads have load limits assessed as per the evaluation procedures in the Transit NZ Bridge Manual. This evaluation is based on analysis of the capacity of the bridge to carry Highway Normal and Highway Overload (HN-HO-72) standard vehicle loads with the required load factors. A standard Highway Normal load consists of two 12 tonne axles spaced at 5.0m acting simultaneously with a deck uniformly distributed load of 3.5 kN/sq m.

Class 1 loading is equivalent to 85% of the HN load. The load capacity of the bridge beams normally determine the percentage of Class 1 loading that can safely be carried by a bridge. Bridge decks are also assessed as part of an evaluation. Deck capacity to carry wheel loads is expressed as the weight in kg per axle.

4.5.2 Bridge Load Posting

Load Posting defines the capacity of the bridge using normal live load factors or stress levels.

The calculations take into account bridge structural span length, beam material, size and condition and also the possible eccentricity and impact loading of heavy vehicles passing over the bridge. In some cases, the maximum vehicle speed on a bridge is limited to reduce the impact loading.

Load Posting on bridges is displayed on signage to the standard Transit NZ format which has the words "Heavy Vehicle Load Limits" and the percentage of Class 1 loading permitted followed by any limits on axle loading and vehicle speed.

Bridges that have a 100% Class 1 load capacity are deemed to be suitable for the passage of heavy vehicles meeting the normal requirements of the Heavy Motor Vehicle Regulations. Because the axle configuration and loading of heavy vehicles varies widely, the actual bridge stresses for a particular fully loaded heavy vehicle may be less than the stresses that arise from the passage of a standard Class 1 vehicle. In certain cases it is possible to show that some fully loaded heavy vehicles may pass over a particular bridge that has less that 100% Class 1 Load Posting without exceeding the safe load limits. This is dependent on bridge span length and the truck axle spacing and weight. This must be evaluated on a case by case basis for any bridge.

4.5.3 Bridge Overweight Rating

Bridge overweight capacity rating is determined as per the Transit NZ Bridge Manual and is based on calculation using reduced load safety factors compared with those used for normal Load Posting. This is because overweight use of a bridge is infrequent and can be carried out under controlled conditions. Bridge overweight capacity is generally significantly higher than the normal load posting and enables the occasional passage of overweight loads. A bridge that is designed to HN-HO-72 loading has an overweight capacity that can allow the passage of vehicles up to twice the normal bridge Load Posting capacity.

The TLA can issue overweight permits for the passage of heavy vehicles over specific bridges. Applications are made on a case by case basis and require the provision of heavy vehicle axle spacing and axle load data. This enables the TLA to determine if the proposed heavy vehicle can safely cross the bridge within the overload load safety factors. Sometimes special conditions will be imposed to control the alignment and/or speed of the vehicle during its passage over the bridge.

Overweight capacity enables the occasional use of bridges by overweight loads and allows large equipment such as haulers to cross bridges, subject to the loads being within the assessed overweight capacity.

4.5.4 Options for Low Capacity Bridges

When the normal load capacity of a bridge is below that required to carry fully loaded heavy vehicles, the following options may be available:

- Use an alternative transport route (if available)
- Limit the payload on the heavy vehicle
- Upgrade the bridge
- Install a temporary bridge over the existing bridge (if heavy vehicle capability is required for a short period only)

When the overload capacity of a bridge is insufficient to carry a proposed overweight vehicle, the following options may be available:

- Use an alternative transporter that has a more favourable axle configuration (eg a transporter with a “dolly” trailer)

- Temporarily prop the bridge during the overload use.
- Form a ford or low level crossing adjacent to the bridge.
- Reduce the weight of the load by removing parts from the equipment (ie remove the pole and cables from a hauler)

5.0 TRAFFIC MANAGEMENT

5.1 Preamble

The safe management and operation of a District Road can be influenced by the method of transport management adopted. In the absence of any special management, the traffic rules contained in the Road Code apply. In many cases the adoption of special traffic management measures can enable an otherwise inadequate road to be used safely for forest harvesting. Traffic management can take a number of forms as outlined in this section.

5.2 Information Signage

Information signage consists of signage advising road users of specific hazards they may encounter on a road. The most common of these is the advisory speed, intersection and curve signage found on highways. Installation of such signage on District Roads to inform drivers of hazards can improve safety. More frequent use is being made of signage to advise of the use of roads by logging traffic and to recommend caution. These are a cost effective alternative to what may be expensive road upgrading. Care is needed to ensure that signs are clear and current, and are only in place while the alerted conditions exist.

5.3 Regulatory Signage

Regulatory signage imposes compulsory controls on the use of a District Road.

These may take the form of traffic behaviour restrictions such as speed limits or may consist of vehicle type and weight restrictions. Vehicle restrictions create operational barriers to landowners and require the passing of a By-law before they can be imposed, unless they are of a temporary nature and are imposed to mitigate hazards, ie traffic speed on a failed pavement section.

Traffic behaviour restrictions in the form of stop signs, give way signs and speed restrictions can contribute to traffic safety. Speed restriction signage is however of limited value since speed limitations are often exceeded by many drivers. It is likely that information signage that is directly relevant to the hazards on a particular road will be more effective that standard speed restriction signage.

5.4 Vehicle Communications

Effective management of logging traffic can be achieved by implementing communication between logging trucks. Although it depends on the facilities in an area, most logging trucks have good radio communications. It is common practice for trucks travelling within a forest to notify their location by radio telephone and to listen for the location of other trucks.

There are a number of instances where such communication has enabled the safe use of a public road by logging trucks simultaneously with public traffic. Such communication virtually eliminates opposing truck conflicts on narrow road sections and reduces the frequency of unexpected light vehicle encounters because truck operators report the presence and direction of public vehicles to other truck operators. With good communication, a road of narrow carriageway width can be operated safely provided there are adequate passing bays. An important underlying principle is that all drivers must expect (and drive accordingly) to meet traffic which may not have communications equipment installed.

There are instances where a radio has been supplied by forest owners to a school bus to allow communication with logging traffic. A consequence of implementing communication between vehicles on a road is the increased awareness of traffic safety issues among drivers.

5.5 Community Communication

This involves consultation and communication with the other landowners and users on a particular road to identify hazards and develop operating procedures that reduce risk of conflicts and hence increase the safety of operation of the road. Whilst this approach relies on a community which is supportive of the forestry activity and a cooperative approach, there are examples where this is working effectively. Rural communities are always concerned particularly where school bus safety involved. Genuine efforts by forestry companies to manage operations to minimise risks can generate good community support.

This is due in some cases to good communication of the intention to use the road and by carefully explaining the circumstances and the reasons the particular action being taken. In cases where this is working well it is almost invariable that appropriate early contact was made and communication was maintained throughout the time.

5.6 Piloting of Heavy Vehicles

In instances where harvesting takes place over a short period and the length of inadequate standard District Road is short, successful use has been made of a pilot vehicle travelling in front of all logging trucks on a public road. Traffic is limited to one way and the road cleared by the pilot vehicle when it reaches each end of the road. The pilot then turns around to pilot traffic in the other direction. Innovative schemes such as this can work well when there is good cooperation between forest owners and other land owners who make use of a road.

5.7 Traffic Control Signalling

This operates similarly to that used frequently a road works sites. Where the length of an inadequate section of District Road is relatively short, manual or automatic traffic signalling can be installed to limit the section of road to one way traffic. With the removal of any potential opposing traffic confrontation, narrower carriageway width and reduced sight distances can be tolerated.

Traffic signalling is unlikely to be suitable for any period of time on sections of road where the public AADT is high, but can be a very cost effective approach when traffic volumes are low.

5.8 Regulating Forest Operations

Voluntary control by the forest owner on time of use of a District Road by logging trucks is a option for improving the traffic safety. Given a forest owner usually has some level of control over harvesting activity, regulating logging traffic is reasonably easy to achieve if forest harvesting and transport is well planned. Regulation of forest traffic may be a particularly suitable mechanism when other traffic patterns are regular and its timing is well understood.

Another option that may be available to some forest owners is to control the entry and exit points to the forest such that loaded trucks exit via a different District Road than that used by un-loaded trucks on entry. This removes the opposing truck conflicts and also confines the loaded heavy vehicle use to one road only.

At intersections where visibility is poor, the use of mandatory left-turns is often an appropriate alternative to the provision of the necessary visibility for safe right-turn manoevoures. Trucks can then, if necessary, do a U-turn at a suitable turning place. Where volumes are low or intermittent, this is much cheaper than undertaking major improvements to increase sight distances.

5.9 Road Closure

Closure of a District Road by a TLA as a means of protecting public safety is rare. It is used predominantly in the event of storm damage or other exceptional event that renders a road unsafe for use or where a TLA believes that unacceptable damage will occur if the road is used by any traffic. Permanent road closure requires a public consultation process and is unlikely to be used by a TLA as a means of controlling forest transportation.

Temporary road closure has been used to achieve adequate safety during logging operations in close proximity to a District Road. Such temporary closures are established as a result of cooperation between forest owners, the TLA and other landowners who use the road.

5.10 Vehicle Restrictions

Local By-laws may be used by a TLA to impose regulatory controls on road use. These have been used to prohibit the use of engine brakes in certain areas, to impose vehicle weight limits and to impose vehicle type limits on certain roads.

Before passing a By-law restricting a particular vehicle the Local Government Act of 2002 requires that TLAs follow the special consultative procedure as determined by the Act. This enables forest owners and other land owners to make submissions on any proposed restrictions.

Any restriction of vehicles cannot discriminate against any particular landowner. A vehicle type or weight restriction must be applied equally regardless of whether a heavy vehicle is carrying timber, milk or livestock.

It is believed that in some instances, TLAs have introduced vehicle restrictions that have been outside their jurisdiction or they have not followed the correct processes. Where restrictions appear to be discriminatory or unjustified, it is recommended that legal advice be sought on the validity of such restrictions.

6.0 LEGAL ISSUES

6.1 Preamble

As a result of the increasing prominence of the issue of use of District Roads by forestry traffic, greater use is being made by the TLAs of legal mechanisms to limit or restrict activity or to extract funding from parties to cover the cost of road upgrading.

The relevant legislation is as follows:

- Local Government Act 2002 (LGA)
- Resource Management Act (RMA)
- Land Transport Act (LTA)
- Heavy Motor Vehicle Regulations

Detailed knowledge of these Acts and Regulations is necessary if they are proposed as a means of controlling forestry use or to extract funding from forest owners. Seeking advice from appropriately qualified and experienced legal and planning services is recommended in such circumstances.

6.2 Local Government Act

The LGA sets out the legislation under which TLAs have the authority to collect rates from land owners and the responsibilities of TLAs in relation to the management of public amenities. The LGA details the basis on which TLAs can set rates for various land classifications. It also details the basis on which By-laws can be established which may be used to control use of particular roads.

In the event of any TLA proposing the introduction of differential rating or By-laws that are in-equitable for forest owners, it is recommended that legal advice be sought to check the LGA for the validity of such proposals. There have been occasions when proposed rating and limits on road use by TLAs have been legally challenged and found to be outside the authority of the TLA.

6.3 Resource Management Act

The RMA empowers the Regional Councils to regulate activities for the purpose of protecting non-renewable resources such as soil and water. As such, the Regional Councils cannot impose funding requirements on Forest Owners for the purpose of upgrading of District Roads. However in the course of issuing a Resource Consent for controlled activities they may impose conditions that are aimed at reducing any potential adverse effects on non-renewable resources.

District Councils are empowered under the RMA to issue Resource Consents for controlled activities relating to Land Use or where a change in Land Use classification is sought. Such Consents may include as conditions, a requirement for Forest Owners to make payments to the District Council for the purpose of mitigating adverse effects. This mechanism is being increasingly used to require Forest Owners to fund improvements to District Roads where forest harvesting will increase the traffic loading.

TLAs are required within their District Plans to classify Land Uses and identify Permitted Activities, Controlled Activities and Prohibited Activities for each Land Use classification. What has become evident in recent years is that draft District Plans are being prepared which make forestry a Controlled Activity rather than a Permitted Activity in many rural land use classifications. This then forces forest owners into having to apply for a Resource Consent under the RMA to carry out activities relating to forest harvesting. This mechanism is being used to enable the TLA to obtain funding from forest owners for public road upgrading.

Active involvement by Forest Owners is necessary at District Plan drafting stage to resist moves to make forestry a controlled activity on rural land where production forestry is an appropriate land use.

This process requires Forest Owners to allocate adequate resources to keep account of the proposed District Plans and ensuring that appropriate submissions are lodged together with supporting information.

The lodgement of submissions to Draft District Plans and of Resource Consent applications is a subject that is beyond the scope of this report and it is recommended that Forest Owners obtain the advise of specialist Resource Planners and legal advice for these activities.

Heavy Motor Vehicle Regulations

The Motor Vehicle Regulations are enacted under the Land Transport Act and provide a mechanism to influence the safety of the road network. These include rules covering vehicle mass and dimensions.

Recent changes to allowable lengths of logging trucks in particular will lead to more stable trucks and trailers. Unfortunately the time and effort involved in making these changes to vehicles is so significant, that the effectiveness is limited.

7.0 FUNDING ISSUES

7.1 Preamble

The awareness of issues relating to demand on district roads for forest harvesting typically arises as a result of:

- Communication by a forest owner to the TLA in relation to requirements for upgrading of a particular road for proposed harvesting
- A Land Use Consent application by a forest owner in respect of harvesting or work associated with harvesting which is other than a permitted activity on a particular land holding.
- Awareness by a TLA that pending harvest of forested areas will increase traffic loading on particular roads to the extent that upgrading is necessary to maintain safety or serviceability standards.
- Response to deterioration in road serviceability or reductions in road safety as a result of forest harvesting already taking place.

Most forest owners and TLAs have attempted to take a pre-emptive approach to addressing issue. This has consisted of the following measures:

- Direct communication and negotiation between the forest owner and TLA to reach agreement on the required upgrading or controls and to agree on relative contributions to funding.
- Imposing requirements or restrictions as conditions of a Land Use Consent where these are required for a harvesting operation.
- Instigation of regulatory controls on roads by TLAs
- Introduction of differential rating at the time of District Plan review as a means for TLAs to gain additional funding from forest owners to address the roading issue.

The relative merits and issues surrounding the above measures is discussed below.

7.2 Transfund Role

7.2.1 State Highway Funding

Transfund is the Government Authority that allocates central government funding for the purpose of maintaining and developing the road transport network. Transfund provides 100% funding of State Highway maintenance and capital projects. This is distributed on the basis of projects being ranked in priority as per the Benefit/Cost ratio as derived from the Transfund Project Evaluation Manual. The allocation of funding for Transfund supported projects is guided by the funding allocation framework as set out in the National Land Transport Stretegy. As well as consideration of the Benefit/Cost, other factors are taken into account including:

- Congestion relief
- Road Safety
- Promotion of walking and cycling
- Regional development
- Passenger Transport
- Alternatives to Roading

7.2.2 District Road Funding

Transfund also provides funding contribution to TLAs for both the maintenance and upgrading of District Roads. The funding provided for maintenance is a function of the length of District Roads maintained. Funding provided for capital upgrade projects is allocated on the basis of the benefit/cost ratio for such projects using the same Transfund Project Evaluation Model as used for State Highway projects as well as other local factors. The balance of funding for road maintenance and for capital projects is provided from TLA funds raised from rates within the District or loans or user contributions or some combination of these.

Any capital projects that do not meet the threshold Benefit/Cost to qualify for Transfund funding, have to be fully funded by the TLA or from other sources within the District such as direct contribution from an interested party such as a forest owner.

7.2.3 Transfund Rules on Uneconomic Roads

Transfund rules prohibit the provision of funding to TLAs for "renewal, reinstatement, or structural upgrading" of any roads classed as "uneconomic". Transfund classifies a road as uneconomic where the ratio of the total cost of the work to be undertaken per AADT is greater than or equal to $5,000 per vehicle.

When a forest is in its growing phase and not being harvested, many access roads would fall into this "uneconomic" category resulting in the TLA being unable to obtain any funding from Transfund to upgrade the road. Only when harvesting begins is the road likely to rise out of the "un-economic" category. By this stage, it is often too late to instigate a project to undertake the necessary upgrading except at a substantially increased cost due to the need to keep the road open for trucks. The Transfund Rules are un-sympathetic to the needs for upgradng of District Roads in preparation for forest harvesting. Early communication with TLAs before harvesting could assist in resolving this situation and the possibility of presenting a joint proposal to Transfund could yield benefits to the TLA as well as the forest owner.

(In one such example, a collaborative approach with the Hastings District Council, resulted in the District Council assisting in obtaining Transfund funding for the upgrade of District Council Roads into Ngatapa Forest. Council agreed to upgrade the road to the last resident, the forest company upgraded the narrow road through the farm to the Mohaka River. The District Council expected the Forestry Company to demand that they upgrade all the road. When the collaborative approach was confirmed they were very helpful in completing the project. This was an interesting case as the rates for about 2/3rds of the forest fell in Wairoa District Council, and the road in Hawkes Bay District.)

7.2.4 Regional Development Roading Fund

In 2002, the Government established a Regional Development Roading Fund which is administered by Transfund. The fund was made available in recognition of the inability of TLAs in these regions to fund the necessary infrastructure development to facilitate forestry and wood processing development.

The fund is available initially to TLAs in the Northland and Tairawhiti Regions and, in special circumstances, to other regions. The Government is currently considering the possible extension of the term and applicability of the fund.

Regional Development Funding is available to TLAs to undertake improvements to District Roads in advance of increases in traffic flow that relate to significant regional developments. This provides a 100% funding for upgrading works that meet the criteria of the Regional Development Fund

The priorities for provision of funding from the Regional Development Roading Fund are as follows:

- To provide improved access.
- To reduce transport costs
- To mitigate adverse effects on the environment and amenity arising from increased traffic.

Within the first priority noted above, funding allocation is ranked in the following order:

- Work relating to the development of new wood processing.
- Work relating to the expansion of existing processing.
- Work relating to expansion of log exports.

The provision of the Regional Development Funding provides an opportunity for TLAs in Northland and Tairawhiti to upgrade roads to a design standard that is appropriate for the expected traffic levels without having to make significant compromises because of funding limitations. Such upgrading enables a shift in road management regime from one of high annual maintenance cost in reaction to pavement deterioration to a regime of regular maintenance at a much lower annual cost.

7.3 TLA Role

7.3.1 Rate Contribution By Forest Owners

Forest Owners contribute rates to TLAs based on land value in the same way as other landowners. Whilst forestry land values tend to be lower than land used for dairy farming or cropping, the rate sums paid annually by forestry companies are very significant.

Large areas of plantation forest were established by the NZ Forest Service in the 1970s & 1980s. Whilst as a Government Department, the NZ Forest Service was exempt from the requirement of paying TLA rates, a "Grant in lieu of Rates" was paid to TLAs by the NZ Forest Service for all plantation forest land. This payment was made at exactly the same rate as would have been paid by any private owner of the same land.

During the establishment and growing phases of a plantation forest, the forest owner makes little demand on TLA services. This is because the traffic generation from such land is very low and because forestry land in the growing phase tends to be sparsely populated, there is a low level of demand on other Council services.

At the time of harvest, forest owners place a significant demand on TLA resources in the form of an expectation that District Roads are adequate for transport of timber from the forest.

It is reasonable to expect that the many years of rate payments made prior to harvesting will be considered as advance payment toward the demand on Council services that arise at the time of harvest.

7.3.2 TLA Ability to Invest Funds

In the past there were no mechanisms available to TLAs to invest funds for future projects, hence rate payments from forest owners were used for other projects within Districts.

Now, in terms of Section 105 of the Local Government Act of 2002 TLAs are now permitted to invest as long as they have an declared investment policy from which they can then receive dividends and interest payment. While in the short-term this does not help forestry owners, it could become the basis for a long-term solution to funding of forest access roads from rates paid by forest owners.

In the meantime, it is reasonable to expect that contributions to rates made by forest owners be taken into account when considering funding arrangements for District Road upgrading for forest harvesting.

7.3.3 TLA Funding of Depreciation

Even where 100% subsidy is available under the Development Roading Programme, some TLAs express concern about the impact of the requirement to fully fund depreciation on the new assets. The LGA requires TLAs to raise an amount from rates that includes the full cost of depreciation on assets. Therefore an increase in asset values requires an increase in rates.

The fallacy in this argument is that the amount raised from the depreciation charge is available to fund capital expenditure on assets and so reduces the amount of rates or borrowings for capital works by exactly the same amount.

There is no additional burden on TLAs or other ratepayers as a result of expenditure under the Development Roading Programme.

To the extent that such works reduce maintenance costs, there could in fact be a significant reduction in the burden on ratepayers.

7.4 Differential Rating

7.4.1 Differential Rating

Differential rating describes the application of a multiplier on a TLAs general rate which applies to specific land uses. This mechanism is proposed by some TLAs as a means of acquiring additional funds from a group of ratepayers that the TLA believes makes a higher demand on Council services.

Differential rating is proposed in some Districts as a means of obtaining additional rates from forest owners for the purpose of funding upgrading and maintenance of the District Roads that will be used as a result of forest harvesting.

The validity of a differential rating system lies in the demonstration that a particular land use places a higher demand on TLA services than other forms of land use.

Some of the TLAs that have considered use of Differential Rating as a means of collecting increased funding from forest owners have subsequently rejected this as an option.

7.4.2 Relative Traffic From Different Land Uses

The traffic generated from rural land is partly related to the production yield from that land. Data provided by MAF in 1991 indicated the following typical yields from different land uses:

Table 3 Rural Land Production Yield [tonne/ha/yr]	
Dairy Farming	9
Kiwifruit	17
Forestry	22
Pip Fruit	40

Since 1991, improvements in pastoral farming practice have resulted in even higher yields being achieved. Some dairy farms achieve yields of 11 tonnes/ha/yr.

Research commissioned by the Waikato District Council in 2002 resulted in the following annual average estimates of truck movements per hectare per year for various land uses in the Waikato District:

Table 4 Truck Movements [trucks/ha/yr]	
Sheep	0.02
Mixed Sheep/Beef	0.09
Forestry	0.80
Beef	0.81
Dairy Farming	1.94

The higher level of truck movements associated with dairy farming arises from the collection system from dairy farms which involves milk collected from farms being accumulated in tankers and hence being transported to several properties before being taken to a processing facility.

The above tables indicate that some other land uses give rise to similar and higher traffic volumes in terms of vehicle numbers than forestry and that some cropping activities have higher yields per hectare per annum than forestry.

7.4.3 Timing of Traffic Generation

Most rural land uses operate on an annual production cycle, hence production tonnages from a property is regular each year. Forestry however has a long production cycle (typically 25 to 30 yrs). During the growth period, there is no yield from a forest (except in the case of production thinning) and hence demand on the District Road network takes place after a long period of little or no demand.

Given that forest owners make rate contributions throughout the growing cycle of a forest with little demand on council services, there is a long period during which funds can be accumulated by TLAs in preparation for road improvements needed for forest harvesting. Applying discounted cash flow principles, an equivalent annual yield can be derived that takes account of the long cycle nature of production forestry. Applying a 10% discount rate over a 25yr forestry cycle results in the time adjusted annual yield from production forestry being 5.6 tonnes/ha/annum or approx 0.22 trucks per yr. This places the demand on rural roads from forestry well below that from dairy farming and only slightly higher than mixed sheep/beef farming.

Unfortunately, the rate funds collected during the growing period of many forests has been used by TLAs for District Road improvements in locations other than where it is eventually needed for forest harvesting.

7.4.4 Inequity of Differential Rating

There is no evidence that suggests the demand on Council services from forest land is significantly higher than that of other land uses when the full growth cycle of a forest is taken into account. This indicates that the application of a differential rate on forestry land is inequitable and disadvantages a single land use to the benefit of others.

7.4.5 Disadvantages of Differential Rating

The use of Differential rating as a means for a TLA to collect funding to upgrade District Roads for forestry use has a number of disadvantages. These include:

- Inequity between ratepayers and inequity between forest owners.
- Differential rating detracts from the incentive to search for a more cost-effective alternative solution for forestry road use.
- Differential rating discourages the use of alternative transport options such as barging.

- Differential rating discourages cooperation between forest owners to develop transport network strategies where several forests owners have forests in the same locality.
- Differential rating detracts from a cooperative approach between forest owners and TLAs to the forest transport issue.
- Differential rating fails to take account of the benefit arising to other ratepayers as a result of road upgrading for access to forestry land.

7.5 Resource Management Act

7.5.1 Consent Requirements

Production forestry is a Permitted Activity on rural land in many Districts. Hence there is no requirement for the application of a Land Use Consent to carry out activities associated with forestry. There is however a requirement to obtain Land Use Consents for some of the activities necessary to establish infrastructure to enable forest harvesting such as bulk earthworks for the construction of roads and works adjacent to water bodies.

Where production forestry is a Conditional Activity in certain zones within a District, a Land Use Consent is required for a number of activities associated with forest operation.

7.5.2 Use of the Consent Process

Where Land Use Consents have been required for forest harvesting under the RMA, the impact of forestry traffic on District Roads has been considered by the TLA planners as an affect of the activity. Consequently, conditions have been included in Land Use Consents which either place restrictions on the forest owner or require contribution of funding.

There has been an increasing trend by TLAs to make use of the Resource Consent process to force forest owners to contribute funds as part of the Consent Conditions. Where the contribution amount is agreed as a result of consultation with the forest owners and an evaluation of other cost effective alternatives to road upgrading, the use of the RMA in this way is reasonable.

There is however a risk that the RMA process is used as a means for a TLA to extract funds from an applicant for a particular activity under the guise of mitigation of adverse effects.

7.6 Direct Contribution by Forest Owners to TLAs

7.6.1 Contribution Arrangements

Our survey of forest owners shows many are contributing financially, over and above rate payments, toward the upgrade of District Roads on a case by case basis. The amounts being contributed vary from a few hundred dollars toward maintenance to hundreds of thousands of dollars for substantial road upgrade works.

Contribution arrangements are reached as a result of communication and negotiation between forest owners and the TLA. This process works best when there is cooperation and a willingness to find appropriate and cost effective solutions and there is recognition of past contribution by way of rates.

Forest owners usually agree to making direct contribution to TLAs for the following reasons:

- Forestry transportation over a road in its original state would not be possible due to pavement or geometric inadequacies.
- The cost of upgrading and maintenance is high in comparison with past and current rate payments.
- High operational costs would be incurred if upgrading were not carried out.
- Use of a District Road by forestry transport without the road being upgraded would cause a significant reduction of the pavement life and reduction in serviceability. The forest owner chooses to avoid these adverse effects for the benefit of future access to his own forest as well as to maintain good relations with other landowners and the TLA.
- When a Land Use Consent is required by the forest owner for harvesting activity, the TLA has the opportunity to impose a condition requiring funding contribution. In such circumstances, the forest owner has no option but to make the contribution in order to be able to uplift the Consent.

7.6.2 Factors Taken Into Account

The value of the funds contributed are dependent upon a number of factors including:

- The initial condition of the road
- The number of other users of the road
- The lead time that is available for road upgrading prior to a forest owners intended harvest
- Previous contributions by way of rates
- Previous lump sum contributions to the TLA
- Maintenance and upgrade history of the road

- Voluntary limitations on road use by forestry traffic made by the forest owner (eg agreement to limit hours of use or to limit harvesting to the dry season only)

7.6.3 Benefits of Direct Contribution

Many of the forest owners we have surveyed indicated that a direct contribution to a TLA has been a successful solution to the issue. Benefits arising from this approach include:

- Once a road has been upgraded for heavy vehicle use the TLA can usually fund the continued maintenance from Council resources without the need for further forest owner contribution.
- The forest owner enjoys the benefit of an improved road which is reflected in reduced operating costs
- Community relations are improved.

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