4.1 INTRODUCTION

An extensive rural and town roading network exists in all three Wairarapa districts. The roading network has been divided into four entities to reflect the jurisdiction of the four autonomous road controlling authorities in the area. They are Masterton District Council, Carterton District Council, South Wairarapa District Council and Transit New Zealand.

The most important role of the transport system in an emergency is to provide adequate internal and external links for emergency service providers during and immediately after an event.

The geography of the Wairarapa may dictate how long the area will need to be self-reliant, especially if access to the south is lost. In this instance, air links will be important.

With no port facilities along the 165 kilometres of coast there are no risks to be considered.

Because the Wairarapa is relatively isolated, storage and accessibility of an adequate fuel supply is an important issue and has therefore been considered in this report.

4.2 STATE HIGHWAYS

NETWORK DESCRIPTION

State Highway No 2

State Highway No 2 is the major arterial route traversing the Wairarapa. The Wairarapa section runs from Mount Bruce in the north to the Rimutaka Summit in the south and passes through the towns of Masterton, Carterton, Greytown and Featherston. At Mount Bruce Summit, the highway is 333 metres above sea level (ASL) and it is 40 metres ASL at Featherston. Between Mt Bruce and Featherston the route crosses all of the major rivers from the eastern Tararua Ranges in the Ruamahanga catchment. From Featherston the highway rises to 555 metres ASL at the summit of the Rimutaka Hill road (**Figure 4.1**).

Figure 4.1. SH2 Rimutaka Hill road looking towards the summit from the Abbots Creek twin bridges.

The Rimutaka Hill road provides access to Wellington and its port for daily commuters, primary and processed produce, tourists, health services and farm services. To the north, State Highway 2 provides access to Hawkes Bay, the port of Napier and the Manawatu.

Average daily traffic volumes (1997) vary along the highway and in the towns as shown in **Table 4.1** and **4.2**.

State Highway 2 Section	Vehicles per day
Mt Bruce – Masterton	3200
Masterton – Carterton	8000
Carterton – Greytown	7000
Greytown – Featherston	4500
Featherston – Rimutaka Summit	4000

Table 4.1. Average daily traffic volumes along sections of State Highway 2.

Town	Vehicles per day
Masterton (Chapel Street)	18,000
Carterton (High Street)	12,000
Greytown (Main Street)	8,000
Featherston (Fitzherbert Street)	5,000

Table 4.2. Average daily traffic volumes in Wairarapa towns.

State Highway 53

State Highway 53 is the arterial route between the towns of Featherston and Martinborough. The highway traverses flat topography and crosses the Tauherenikau and Ruamahanga rivers.

External regional connections

Masterton north to Manawatu and Hawkes Bay, via Mt Bruce

The vulnerability following an earthquake will depend on the stability of the slip at Mt Bruce, movement on the Wairarapa fault scarp at Miki Miki and to a lesser extent the fault scarp at Opaki. Other factors could be damage to the Ruamahanga Bridge (**Figure 4.2**) and the alternative route via Mauriceville or Whangaehu Valley Road via Alfredton.

Figure 4.2. Ruamahanga Bridge at Mt. Bruce. This 'arch span' structure is a key component of Wairarapa's road links to the north.

Damage to the Waipoua Bridge is less critical, as alternatives are available at Colombo Road and the bypass. Although movement via Chapel Street may become limited, there are many alternative routes by which Masterton traffic could gain access to the State Highway, the bypass, or State Highway 52. Construction of a ford would also be possible subject to river flows.

Several days could elapse before assessments could be made and restrictions imposed on the Ruamahanga and Waipoua bridges. These bridges may be available to foot traffic or light vehicles only.

Featherston to Wellington via Rimutaka Hill

The Rimutaka Hill road's vulnerability from earthquake would depend on the stability of the slopes above and below it. Following an earthquake there could be slips onto the road and dropouts and slumping where the road is built on scree material. Failure of walls constructed to support the road might also occur (See Wellington Regional Council Publication WRC/PP-T-95/10, *Earthquake Induced Slope Failure Hazard State Highway 2 Upper Hutt to Featherston*).

It would probably take a few days to assess the damage. Several weeks might be needed to restore a one lane roadway across the hill – depending on the degree of dropout damage, the priority for restoration, and availability of resources.

Bridges 1, 2 and 4 crossing Abbots Creek have a low likelihood of damage except for Rimutaka No. 4 southbound, which is duplicated. They are, however, close to the Wairarapa Fault.

Access across Abbots Creek could readily be restored by heavy machinery via fords at bridge sites. Likewise, any access blocked by movement of the Wellington/Wairarapa fault could be restored relatively quickly.

Inter-town connections

Masterton – Carterton

Two elements affect the vulnerability of this section of highway to earthquake damage. The Waingawa Bridge, built in 1989 to full code requirements, ranks of high importance, as the detour via Gladstone is 33 kilometres. While the risk of damage is low, the impact of such damage could be high, and some days might pass before damage could be assesed and traffic restrictions put in place. Any repair would be long-term. A ford could be constructed if the river flow allowed this.

There is a fault scarp at Clareville, where damage to the pavement would be minimal and could be readily restored after an earthquake.

Carterton – Greytown

The major risk element on this route is the Waiohine Bridge, which, if damaged, would force a 57 kilometre detour via Ponatahi. The risk of damage is high and several days could pass before damage was assessed and decisions made on traffic restrictions. Repairing the bridge or constructing a temporary bridge could take one week to several weeks, depending on priority and resources. Depending on the river flow, a ford could be constructed, but it would be very vulnerable to damage by this large river.

The other major factor is the high probability of liquefaction occurring on the whole length of road between Dalefield Road in Carterton and North Street in Greytown. This section of highway could be readily restored to permit vehicle movements, although aftershocks, a high water table level or bad weather conditions might slow progress.

Greytown – Featherston (SH2)

There is a high risk of damage to the Tauherenikau Bridge, where any damage would have a high impact. Several days would be needed to assess any damage and decide on access restrictions. Alternative routes are via the lower Tauherenikau Bridge on SH53, or the east-west access south of Lake Wairarapa. Damage would take several weeks to repair. A ford could be constructed, depending on river flow.

At the south end of Featherston, the ground is subject to liquefaction. Repair would take a short time, depending on after-shocks, ground water and weather conditions. Alternative streets would be available.

Featherston – Martinborough (SH53)

Three elements on this section are at risk from earthquake damage. Areas between Camp Road and Merwoods, and on the river flats east of the Waihenga Bridge, could suffer from liquefaction. Restoration time could be relatively short, but again subject to after-shocks, water table and weather conditions. Both the Lower Tauherenikau Bridge and Waihenga Bridge have high impact-of-damage ratings.

Alternatives to the Lower Tauherenikau are via the Tauherenikau Bridge on State Highway 2 and via the east-west access south of Lake Wairarapa. The extent of damage to the Tauherenikau and Waihenga bridges would depend on how deep the bridge piles are embedded and the length and nature of their exposure to floodwaters.

In both cases, assessments and traffic restrictions could take several days, and temporary repairs could take between several weeks and several months. The priority at the Lower Tauherenikau Bridge would depend on the status of the Tauherenikau Bridge on State Highway 2. Construction of a ford at the Lower Tauherenikau is possible, subject to river flow.

Return to normality

Two major components of the network could have long impacts if they were damaged. These are the Ruamahanga Bridge at Mount Bruce and the Waingawa Bridge. The Waingawa Bridge risk is low, whereas at the Ruamahanga Bridge the risk is high and, to some extent, unknown.

Several State Highway 2 bridges have medium ratings for impact-of-damage. They include:

- Opaki Overbridge
- Waipoua Bridge
- Waiohine
- Tauherenikau, SH2 and SH53
- Lower Tauherenikau
- Waihenga Bridge.

There might also be long delays in returning to normal in the Mt Bruce area and on the Rimutaka Hill from No. 6 Bridge to the summit. Slips, dropouts and slumping would be determining factors. Levels of service might be reduced if resources need to be allocated to areas of higher importance.

Major snow storm

The areas most likely to be affected by snowfall are Mt Bruce and the Rimutaka Hill. Although rare, heavy snowfalls have also occurred in the Masterton and Carterton sections and near Featherston. The pattern of fall is somewhat unpredictable and roads could be impassable due to white-out during the event. While snowfalls generally last less than a few hours, there is the possibility a single event might last a few days.

Mt Bruce and the Rimutaka Hill have steep gradients and large vehicles can lose traction very suddenly, blocking the carriageway and halting traffic. Emergency services need early access to rescue of people trapped in their vehicles.

Immediately after a snowfall causing road closure, network contractors would begin clearing using graders and loaders. Where icing occurs, grit can be spread. Delays might be caused by hazardous conditions on the hill section. Adequate lighting and traction would be needed for efficient operations in a safe working environment. In the period following a snowfall, further clearing from edges and gritting on the hill sections would probably be necessary.

Transit New Zealand's network maintenance contracts include provision for dealing with road closures, snow clearance and frost gritting. A recent problem is the desire to 'sight see' in 4WD vehicles without chains. Transit New Zealand has erected barrier gates either side of the Rimutaka Hill to prevent access to dangerous areas.

Flooding

Areas where the state highway network is vulnerable to flooding are:

- Waipoua Bridge approaches
- Hodders Road – Mangatarere Bridge
- Waiohine Bridge
- Waiohine Bridge – North Street, including the Apple Barrel floodway
- Donalds Bridges SH2 and SH53
- Rimutaka No1 and 2 bridges

- Lower Tauherenikau Bridge
- Waihenga Bridge

Crib walls retain the Waipoua Bridge approaches. Any further degrading of the riverbed will undermine and collapse the walls. Slumping occurred during flooding in the 1970s. The riverbed profile near the bridge is maintained by three river weirs: two downstream and one upstream. The lower weir has recently been rebuilt, using a rock ramp design.

The section from Hodders Road (Waihakeke Road) to North Street in Greytown is subject to flooding. Plans are well advanced by the Wellington Regional Council to alleviate this hazard. While the problem is complex, the main elements are lack of capacity under the Waiohine Bridge and downstream river channel, and the road to spill excess flood waters via the Apple Barrel floodway. Should a major event occur in the meantime, then the scenarios could be damage to the Waiohine Bridge, rupture of the stop banks between the Waiohine Bridge and Kuratawhiti Street, excessive water at the Apple Barrel floodway and overtopping of the state highway between Hodders Road and Mangatere Bridge. **Figure 4.3** shows the Apple Barrel floodway during severe flooding from the Waiohine River.

Figure 4.3. SH2 north of Greytown. View from the Apple Barrel floodway in the foreground towards the Waiohine 'Black Bridge' in the distance. The road was closed in November 1994, due to flooding of the Waiohine River. *Photo courtesy of the Wairarapa Times Age.*

State Highway 2 is liable to closure during relatively low return period floods causing superficial damage to the carriageway. In a major event, such as a stop bank rupture, the repair of the road may take more than a day. Detours are via Ponatahi, an extra 57 kilometres to Greytown or 47 kilometres to Featherston, and the Masterton to Martinborough Road being an additional further nine kilometres. These detours would not always be available during major events.

Localised flooding has occurred in Donalds Creek, affecting the area at the northern end of Featherston on both state highways 2 and 53. The flooding has usually been of short duration, with road closures of a couple of hours. Similar flooding occurs with overflows from the Tauherenikau River on State Highway 53. The recently completed Donald's Creek detention dam and stopbanks should eliminate future flooding in this area.

The river channel at the Rimutaka Nos. 1 and 2. bridges is sometimes affected by excessive bed loads and side scour, which may undermine the abutments.

Flooding of the Ruamahanga River at Waihenga and the Jenkins Dip floodway have been a major concern. The bypass bridge over Jenkins Dip floodway has alleviated the major access problem. Debris rafts still present problems on the Waihenga Bridge.

Highway carriageways could be restored immediately after a damaging flood, with the exception of Waiohine and Waihenga bridges. Assessment of damage and estimation of loading restrictions should be made prior to reuse of the structures. This may take between one and several days, depending on the flood stage of the rivers and whether access is available for detailed damage inspections.

Repairs in the period following would be subject to availability of temporary bridging and resources. Return to normal could be long term (i.e. weeks to months).

MITIGATION MEASURES

Earthquake

Bridges

The report on the seismic screening of state highway bridges (5C 2727.02 – Region 9, Wellington) has developed a risk ranking. The ranking is based on the Rough Order Cost (ROC) to retrofit, compared with the current depreciated value of the bridge.

Bridges ranked in the Wairarapa are:

- DSAP Tauherenikau – column jacketing
- DSAP 3/2 Ruamahanga – deck linkage
- DSAP 14/3 Waipoua No. 2 – pier piles – external jacketing under passing and retrofit pile cap beam linkage
- DSAP 15/4 Ruamahanga – jacketing pier legs top cross beams and beam column joints

- DSAP 17/6 Waihenga – jacketing pier piles

These bridges are shown on the state highway vulnerability charts. The Seismic Assessment Priority (SAP) Wellington/ Wairarapa is:

9/1 Tauherenikau

10/2 Ruamahanga

11/3 Waipoua

The next step is to confirm the assessments and determine the risk of losing the bridge and the justification for retrofitting.

NB: Other factors may alter these priorities e.g. the risk ranking of local authority bridges, the services carried and the access to critical facilities, hospital, fire stations, food supplies etc.

Roads

Mitigation measures are not possible in the case of fault ruptures. In areas subject to liquefaction, any lowering of the watertables by selective drainage could have serious effects on adjoining farmland and would probably not be cost effective.

In the case of the landslide area at Mt Bruce, regular monitoring of the hillside and removal of oversized pine trees along the riverbank has somewhat reduced the risk. However, monitoring needs to continue to ensure that risk factors remain low.

Over the Rimutaka Hill, the extent of road built on scree material has not been quantified. There are numerous tied-back crib and stone gabion retaining walls. These have also not been quantified and in some places they are concealed. These structures need to be identified and their risk assessed before mitigation measures are developed.

General

Major windstorm

Prevailing windstorms are from the northwest, southwest and southeast quarters. The sections of state highway most vulnerable to wind storms and local wind effects are:

- Mt Bruce to Paierau Road
- Masterton to Carterton
- Tauherenikau to Featherston
- Rimutaka Hill on SH2
- Featherston to Lower Tauherenikau Bridge on SH53

During an event, which may last between one and several hours, it will be necessary to close the highway to protect road users from live electrical power lines and wind effects.

In the hours following the event, clearance of debris, trees, fallen power lines, communication cables and overturned vehicles will be required before permitting traffic to use the highway. If heavy rain accompanies or follows the wind, the Rimutaka Hill road may be closed for several hours.

In some areas where the highway is protected from strong winds by trees, there may be a counter effect if the trees are uprooted and blown across the highway. Locations where trees adjoin the highway include:

- Mt Bruce old slip to Ruamahanga Bridge
- Trimble Trust to Pines Rest Area plantations
- Redwood tree on High Street, Masterton
- Redwood tree, Carterton
- Historic gum tree, Greytown
- Arbor Day trees, South Greytown
- Isolated trees, Greytown –Tauherenikau
- Trees south of Tauherenikau Bridge

Regeneration of Rimutaka Hill vegetation has lessened the effect of wind on the highway. Continuing the policy of allowing regrowth along the outside of the state highway, and constructing steel guard-rails, will reduce wind hazards and increase safety.

District schemes provide set-back distances for plantations beside road corridors. Only a few large trees adjoin the highway,and should large branches fall and block the highway, short detours are available to bypass the obstructions. Some of the large trees beside the highway are now protected under district plans. However, regular inspections should be made to ensure that these trees are relatively sound and do not become a hazard.

Waipoua Bridge

Reconstruction of the lower weir has helped stabilise the river reach below the bridge. Monitoring and maintenance of the river weir immediately below the bridge will need to continue to ensure that the crib walls can withstand a 100 year return period flood.

Waiohine River system

Wellington Regional Council is developing a Waiohine flood plain scheme to alleviate flooding in this area. Liaison between the Council and Transit NZ needs to continue, to establish the benefits of developing mitigation measures.

Maintaining an efficient channel under the Waiohine Bridge is essential.

Rimutaka No. 1 and 2 and Lower Tauherenikau

Annual bridge inspections and inspections following flood events need to be carried out. River channelling work also needs to be carried out as required.

Waihenga Bridge

Transit NZ's network maintenance contractors carry out regular patrols during flooding. Safe removal of debris during flooding is not always possible. Appropriate long term river management policies could reduce riverbed debris.

4.3 LOCAL ROADS

NETWORK DESCRIPTION

The road networks in the three districts are summarised in **Table 4.3**.

	MDC	CDC	SWDC
Total rural roads (km)	694	418	598
Sealed rural roads (km)	406	247	293
Unsealed rural roads (km)	288	171	305
Urban streets (km)	106	20	53
Bridges and major culverts (No)	243	103	134

Table 4.3. Summary of road lengths in the Masterton,Carterton and South Wairarapa Districts.

Important routes

The screening criteria used to determine the important routes was:

1. Routes which are essential for the transport of plant, equipment, spares and resources, required for the restoration and repair of engineering lifeline networks and engineering lifelines in a particular community.
2. Routes which provide access, or alternative means of access, between districts and regions.
3. Routes on which important industrial or commercial facilities are located or which are essential for the transport of raw materials to supply industries within or outside of the region.

Figure 4.4 shows the important routes which have been selected. These routes have been ranked in accordance with WELA Note 5. Road sections and bridge components have been rated highly if they are essential to the network and if large parts of the network would be disrupted if the components failed or were damaged. The importance factor has been reduced if the component had alternatives, could be bypassed, caused only localised disruption or was low in the network hierarchy. The total length of important route for the three districts is presented in **Table 4.4**.

Masterton district	320 km
Carterton district	115 km
South Wairarapa district	306 km

Table 4.4. Total length of important route in the Masterton, Carterton and South Wairarapa districts.

Masterton district

All emergency services and mechanical plant resources likely to be required in an emergency are located in the urban area or on the urban fringe.

Police and Fire are located on the outskirts of the Central Business District and the Ambulance service is operated out of Masterton Hospital, on Te Ore Ore Road. The hospital is located on the north side of town over the Waipoua River, which makes the two bridge crossings important to lifelines.

Powerco's infrastructure is maintained out of its Ngaumutawa Road depot.

Heavy roading equipment and materials are available from contractors located immediately south of the Waingawa River on State Highway 2 within the main urban area, and also on the Masterton-Castlepoint Road (main east access), immediately east of the Ruamahunga River. Again, because of the location of these facilities, bridges critical to the lifelines are those over the Ruamahunga River, Waipoua River and Waingawa River on Te Ore Ore Road, Colombo Road, Queen Street and State Highway 2.

Pastoral farming and forestry industries to the north and east of Masterton would depend greatly on lifelines after a disaster. Each year the forestry industry generates about 7,500 laden logging truck movements from the eastern forests, plantations and farm-lots. Trucks from Ngaumu Forest to the Juken Nissho mill, immediately south of the Waingawa River on State Highway 2, account for most of the current movements. This is expected to increase over the next thirty years to a peak of 27,000 loads per annum.

The town water supply relies on maintaining access to the Upper Plain Road plant eight kilometres west of the urban area.

Maintaining four wheel drive access to the Telecom station on the Rangitumau Hill is important to the telecommunications network.

Carterton district

Several factors were considered when determining the most important routes in the Carterton district. The main factors were the need to provide alternative routes to State Highway 2 for north-south traffic and the need for inter-district travel between the

Important Roads

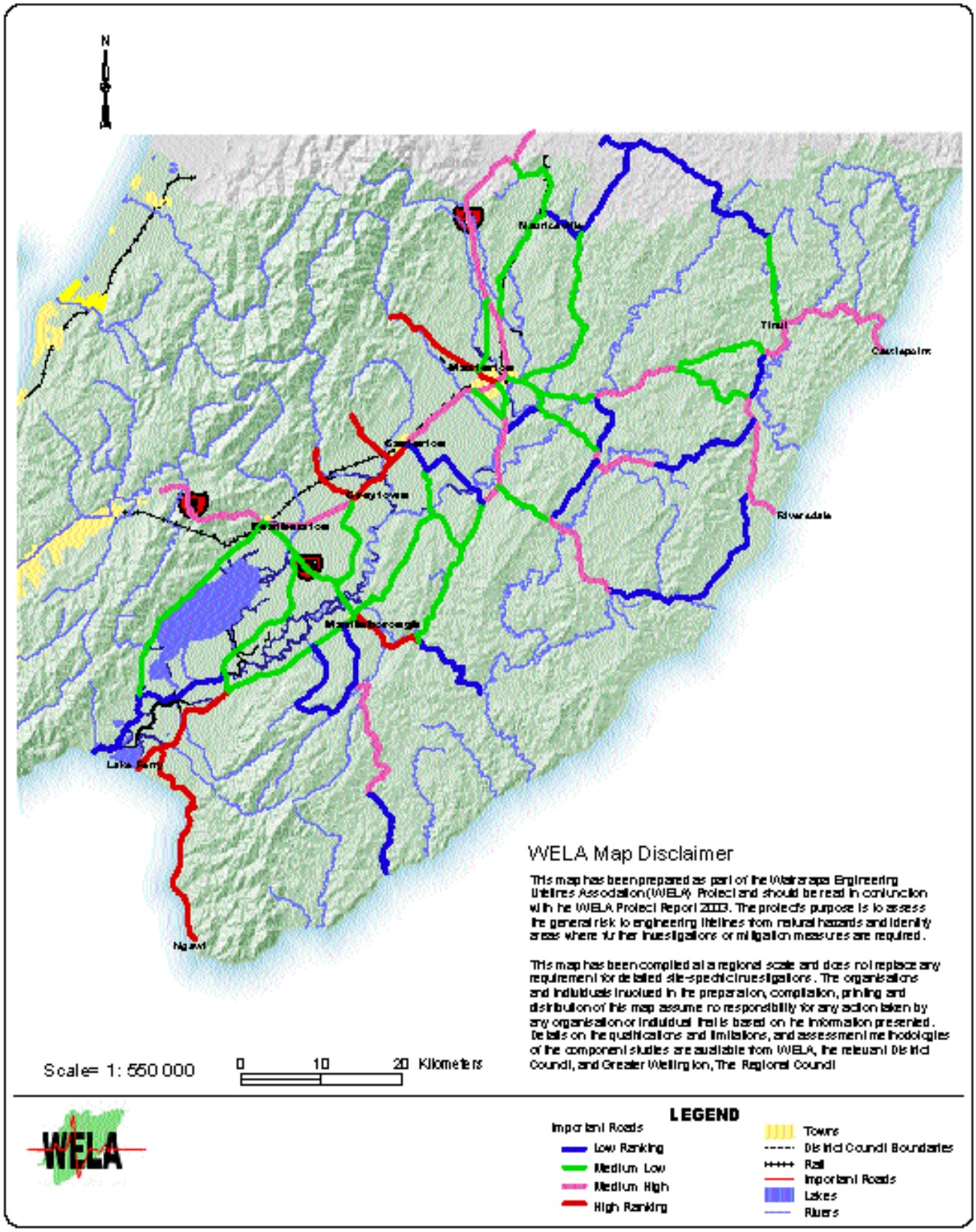

Figure 4.4. Important routes and their rankings (1-4) for the three Wairarapa districts.

Masterton and South Wairarapa districts. Other important considerations were alternative access to Riversdale and Castlepoint and servicing for the pastoral farming and forestry industries following new plantings on the east coast. The main water supply for Carterton relies on road access to the dam and the treatment plant and storage on the Kaipaitangata Stream in the foothills of the Tararua Ranges. The 115 kilometres of important routes represent about half of the rural roads in Carterton district.

Other critical elements of the important routes to the north and east are the bridges over the Ruamahanga and Taueru rivers at Kokotau on the Carterton-Longbush road, at the Gladstone Hotel on the Carterton-Gladstone road, and at Taueru on the Martinborough-Masterton road.

South Wairarapa district

The important roads in the South Wairarapa district are those supporting the dairy industry, pastoral farming to the south east and also in the west, and the fishing industry around Palliser Bay and to a lesser extent on the east coast. The roads to Tora in the east, and Cape Palliser and Ocean Beach to the south, are also important tourist and holiday routes. The 306 kilometres of important routes represent about half of the rural roads in the South Wairarapa District.

Within the district, the bridges over the Ruamahanga River, at Waerenga and at Tuhitarata, are critical elements for the important routes to the south and east.

Inter-district road links

Some inter-district boundaries are crossed in the network of important routes. These are:

- Opaki-Kaiparoro Road, Whangaehu Valley Road and Castlehill Road between the Masterton and Tararua districts.
- Kaiwhata Road, Westmere Road and Masterton-Martinborough Road, between the Masterton and Carterton districts.
- Masterton-Longbush Road, Martinborough Road and Carterton-Ponatahi Road between the Carterton and South Wairarapa districts.

It is noted that the assessment in each vulnerability chart is only to the neighbouring boundary. The integrity of the alternate route depends on the neighbouring section of the road.

Transport interchange

There is very little requirement for air and rail interchange facilities with roads. However, good roads service the railhead and Hood Aerodrome. Helicopter landing facilities on the Masterton Hospital grounds are also adjacent to good roads for emergency access. The logging industry could be disrupted if the railheads at Masterton Station or the Juken Nissho mill were unavailable for an extended period.

VULNERABILITY ASSESSMENT

Ground shaking

The probabilistic earthquake ground motion study of the Wairarapa region has been used to provide information on the vulnerability of the road system to ground shaking.

The 142 year return period (10 per cent probability of exceedance in 15 years) is commonly used as the appropriate hazard level for an Operating Basis Event (OBE). The results of the study predict an MM intensity of 8.0-8.5 and peak ground accelerations (PGA) of 0.33-0.35 g with a tendency for lower values in eastern and northern coastal areas. At MMVIII, some damage and 'drop type' failures can be expected to early (1920 vintage) reinforced concrete bridges, which were designed and built as single span structures and whose superstructures are not well tied together by restraint linkages. Damage can also be expected to later composite and other type beam bridges, which rely purely on holding-down bolts for restraint.

The 475 year return period (10 per cent probability of exceedance in 50 years) is commonly used as the appropriate hazard level for a Design Level Event (DLE). It coincides with the hazard level of the New Zealand Loadings Code (NZS 4203.1992). MM intensities in the range 9-10 and PGA in the range 0.5 to 0.7 are predicted, with the degree of hazard increasing across the region from east to west. The highest hazard areas are in the west and northwest of the area.

Liquefaction

Zones of undifferentiated floodplain alluvium have been identified and used as the basis for assessing potential zones of liquefaction on the transportation network. Only general details of water table depth are available for agricultural purposes. The local road vulnerability charts could be further refined if more detailed information were available.

Masterton district

The most extensive zone of undifferentiated flood plain alluvium identified in the Masterton district runs from Annedale Road, down Manawa Road through Tinui and Whareama and down through Homewood Road and Kaiwhata Road. The Tinui Bridge (**Figure 4.5**) is located in this zone.

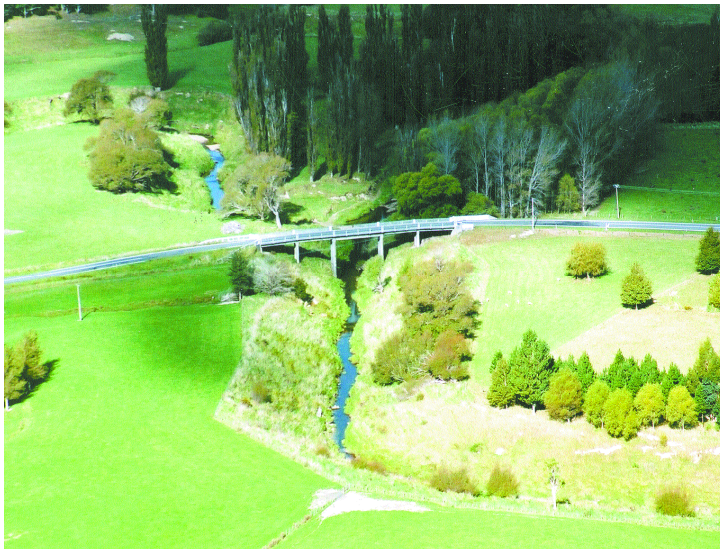

Figure 4.5. The Tinui Bridge on the Masterton-Castlepoint Road. This single lane structure is sited on an area of high liquefaction potential.

There are other extensive potential liquefaction zones, encompassing Bluff-Rangitumau Road, Opaki-Kaiparoro Road between Kopauranga and Mauriceville, much of Whangaehu Valley Road, Te Ore Ore-Bideford Road and the start of the Masterton-Castlepoint Road. Many small potential liquefaction pockets could affect access to places of strategic importance such as the waterworks, the Akura Road bypass or centres of rural population such as Riversdale and Castlepoint.

Significant proportions of the valley floors on which important routes are located are therefore potentially vulnerable to liquefaction. Because earthquakes in the east are expected to be less intense, the impact of damage to bridges might be expected to also be less. No significant impacts would be expected on the road sections in the northern plains area; however some flow failure might occur in the eastern hill country.

Carterton district

There are extensive areas of flood plain alluvium (soft sediments) to the west and east of Carterton; where the water table is between 1.0-2.5 metres below the surface. The western area generally follows the flood plain of the Mangautarere Stream, starting in the northwest of the District and extending to the Waiohine River in the south. The eastern area follows the course of the Ruamahanga River from above Gladstone in the northeast to almost Papawai in the south. There are also narrow bands which follow the river valleys in the hills to the east. It should be noted that not all the soft sediments shown on the map are necessarily liquefaction prone.

Important routes in the district likely to be affected by liquefaction are Dalefield Road, Carterton-Longbush, Masterton-Martinborough, Carterton-Gladstone, TTW Road and Kaiwhata Road.

South Wairarapa district

The South Wairarapa district contains by far the largest areas of soft sediments of any of the three districts. These are located mainly to the north and east of Lakes Wairarapa and Onoke. Again there are narrow bands of soft soils along the river valleys in the hills to the east, which could affect routes which follow these valleys to the coast.

Important routes likely to be affected by liquefaction are Greytown-Bidwills, Featherston-Crosscreek, Western Lake, Kahutara Road, Martinborough-Pirinoa, Pirinoa Road, Whatarangi Road, White Rock No. 2, Tora Road, Ponatahi, Martinborough-Longbush and Oystershell Road.

The Tuhitarata Bridge on the Ruamahanga River was damaged by liquefaction and lateral spread in the 1942 earthquake (**Figure 4.6**).

Figure 4.6. The Tuhitarata Bridge over the Ruamahanga River in the South Wairarapa District. Liquefaction damage occurred to this important structure in the 1942 Wairarapa Earthquake.

Fault displacement

The probabilistic earthquake ground motion study of the Wairarapa Region and subsequent surface fault-mapping studies have identified the area's known active faults and their movement characteristics. However, because of the widespread occurrence of soft mudstone bedrock, it may be that not all active faults in the area to the northeast of the region have been located. Damage to roads caused by fault displacement is likely to be easily repaired, at least as an interim measure.

Extensive damage to bridges is not expected unless the fault line is located within 50 metres of the structure.

Masterton district

The main active faults likely to impact on the local road network are:

- The Carterton Fault, running parallel to Masterton-Castlepoint Road for about 20 kilometres, between Maungahina Road and the head of the Mangapakeha Valley. The section between Blairlogie and Hangmans Bridge is considered to be especially susceptible to damage because of the susceptibility to earthquake-triggered landslides. The assumed average single event displacement is around two metres and the average recurrence interval is 1,000 years *(Begg et al, 2001)*.
- The Mokonui Fault, crossing Upper Plain Road, Paierau Road and then Opaki-Kaiparoro Road at Double Bridges. The close proximity of the Double Bridges makes them vulnerable to damage should any fault displacement occur at that location. Both Paierau Road, as the main bypass north to State Highway 2, and Upper Plain Road, as the access road to the Towns Water Supply, are very important lifeline routes.
- The Wairarapa Fault, which also crosses through Upper Plain Road in the vicinity of the town water supply headworks, and then runs parallel to Opaki Kaiparoro Road for approximately 10 kilometres from Kopuaranga to Mauriceville. This road is important because it is an alternative to State Highway 2. The fault has an average single displacement of 12 metres and average recurrence interval of 1,500 years. At its northern end it meets the Kowhai Fault, which passes across Dreyers Rock Road and Opaki-Kaipororo Road near their intersection
- The Masterton Fault skirts through many of the western and northern residential streets of the town. The average single displacement is two metres, and average recurrence interval is 1,000 years *(Begg et al 2001)*.
- The Tinui Fault runs relatively close to Masterton-Castlepoint road in the vicinity of the Ekenui Bridge, for a distance of approximately two kilometres. It has been assigned a single event displacement of two metres and average recurrence interval of 5,000 years *(Berryman et al 1998)*.
- The Flat Point Fault runs parallel with Homewood Road and Kaiwhata Road for their full length from the Riversdale Road intersection (approximately 15 kilometres). It crosses Riversdale Road immediately east of the intersection. The average single event displacement is four metres, and an average recurrence interval of 10,000 years has been assigned *(Berryman et al 1998)*.

The vulnerability to fault displacement and the impact of damage on the Masterton district road network has been assessed on the basis of these known active faults and their characteristics. In general the level of damage would not be expected to be significant.

Carterton district

As well as the Wairarapa fault located at the western edge of the valley floor, in the west of the district there are three east-north-east-striking faults: the Mokonui, Carterton, and Masterton faults. All of these faults are likely to impact on the local road network.

In the east of the district are the Dry River, Huangarua, Kaumingi, and Flatpoint faults.

Active faults likely to affect important routes are:

- The Carterton fault, which traverses the valley floor to the west of Carterton and crosses Dalefield Road, as well as local roads in the area and State Highway 2.
- The Mokonui and Masterton faults to the north-west of Carterton, which cross Norfolk Road.
- The Mokonui fault, which has a single event displacement of 750 millimetres and a preliminary recurrence interval between 950 and 7,000 years. (Townsend et al, 2002).
- The Dry River and Huangarua faults which cross, run parallel to and in parts coincide with the Martinborough/Masterton Road and also cross the Carterton/Longbush Road.
- The Dry River fault, which has an inferred single event displacement of three metres and an average recurrence interval of 500 years. *(Berryman et al 1998)*.
- The Flatpoint fault, which crosses the Kaiwhata Road near the coast.

South Wairarapa district

In the west of Martinborough are the Wairarapa, Martinborough and Bidwill faults. To the south are the Otaraia, Waihora, Mangatoetoe, and Ngapotiki faults, while to the immediate south and east are the Dry River and Huangarua faults.

Active faults likely to affect important routes are:

- The Otaraia and Waihora faults, which cross and run parallel to the Pirinoa Road, the Whatarangi Road, and the Cape Palliser Road.

- The Managatoetoe, fault which crosses the Cape Palliser Road.
- The Dry River and Haungarua faults, which cross, and in parts traverse, the Dyerville/ Ruakokopapatuna Road, and Awhea, White Rock No 1, Martinborough-Longbush, and Ponatahi roads.

Landslide

Landslide is potentially the most threatening of all hazards to transportation in the Wairarapa region. It can be triggered by several mechanisms, including earthquake, severe storm, flood and periods of sustained rainfall. Damage can be widespread and in some instances will commit major resources. Because many roads can be affected at once, it may be difficult to find alternative routes.

The Transportation Task Group has trialed a method for assessing risk of road closure by landslides developed by Hicks & Harrison. The mathematical basis is analogous to probability of slope failure per unit slope area *(Omura 1983, Omura and Hicks 1992).* In other words, where landslide scars beside a given stretch of road are twice as extensive as the average for the entire road, then over a long period of time the likelihood of the road being blocked by slope failure (from whatever cause) will be twice the average probability. It is intended to use this method to assess more of Wairarapa's important routes.

Masterton district

Much of the eastern hill country of the district is very susceptible to landslide. The Masterton-Castlepoint Road is the most vulnerable of the important routes (**Figure** 4.7). Along much of its length the road is benched into the hillside above rivers. This makes it particularly vulnerable to dropout failure when the river is in flood or the subgrade is saturated. Because of the confined working space, reinstatement of the road can be complicated. There are several particularly vulnerable sites between Blairlogie and Tinui.

Other sites in the district are identified for their potential to move as a mass landslide. These include Kerosene Ridge on the Blairlogie-Langdale Road, the Blairlogie Hill on the Masterton-Castlepoint Road and Hillend on the Te Ore Ore-Bideford Road. In August 1991, a large landslide on the Te Ore Ore-Bidiford Road blocked a stream. This caused a large lake to form and closed the road. The effects before and after the lake was drained are shown in **Figure 4.8** and **4.9**.

Figure 4.7. Masterton Castlepoint Road at the Whakataki Saddle. This important route was severely affected by slumping in August 1974.

Figure 4.8. Te Ore Ore-Bideford Road, Masterton district. In August 1991, a large landslide, shown above, blocked the stream and the road and bridge were submerged for several months. A temporary route was constructed around the perimeter of the lake.

Other sites include the Langdale Hill on Langdale Road, the Kaiwhata Hill on Kaiwhata Road, at Waimanu on Whangehu Valley Road, and hill sections on Wairere Road, Daggs Road, and the Te Parae Road. The Front Hill and Okau Hill on Mataikona Road are both prone to instability.

Many of the areas previously recognised as potentially unstable have been retired and planted with trees. It is important that these plantings are managed appropriately in the future.

Carterton district

As near Masterton, the eastern hill country of the Carterton District is susceptible to landslides. The

Figure 4.9. Accumulated sediment remaining after draining of the Bideford lake.

most extensive and at-risk areas are near the coast and in particular the area to the south east. To the west, the at-risk areas are small and mainly in the Waiohine Gorge area on the boundary with South Wairarapa District.

Important routes likely to be affected by landslides are the Tupurupuru-Te Wharau Road near Korarau, and the Kaiwhata Road along the Kaiwhata River.

South Wairarapa district

The South Wairarapa district contains the largest and most extensive areas susceptible to landslides in the region. Most are in the eastern hill country towards the coast but there are also large areas along the Palliser Bay coast to the south. The Rimutaka Ranges and coastal terraces in the south west corner of the district are also susceptible.

An important coastal route most affected by landslides (also involving dropouts as a result of coastal erosion) includes the Whatarangi and Cape Palliser Roads (**Figures 4.10 and 4.11**). The inland route to Tuturumuri and Tora, by the White Rock No 2 and Tora Roads, is also affected by landslides (including dropouts), normally rainfall triggered.

Ground settlement

The only vulnerability identified in the vulnerability charts is a potential for minor settlement of bridge approaches. The impact is not likely to be severe and could be addressed promptly.

Flood

Masterton district

Several sections on the important routes have been identified in the Masterton District Plan as vulnerable to flooding. Those most vulnerable to damage are:

- Manawa Road, Annedale Road, Masterton-Castlepoint Road (Tinui to Langdale), Langdale Road and Blairlogie-Langdale Road – due to flooding of the Whareama River. Flooding in this area as recently as 1992 showed a potential to isolate farms beyond the Tinui village and cause moderate damage to roads adjacent to the river's path by undermining them.
- Te Ore Ore-Bideford Road (Black Rock Road to Caves Road), Masterton-Castlepoint Road (Masterton Stronvar Road to Goodlands Bridge), Masterton-Stronvar Road (Masterton-Castlepoint Road to Lees Pakaraka Road) – due to flooding of the Whangaehu River. Flooding in the vicinity of the Goodlands Bridge closes the Masterton-Castlepoint Road reasonably frequently, though for fairly short periods. In such an event the alternative Te Parae Road would generally be available, provided the flooding had not extended to the bottom of Masterton-Stronvar Road.
- Masterton-Martinborough Road (Cavelands Rd to the district boundary) – due to flooding of the lower Taueru River. The main alternative route to Martinborough is closed to through traffic approximately every two years by flooding of this river at Cavelands Road. Recent work in the Ruamahunga River at this point was undertaken as preventative road maintenance when the river threatened to permanently change course and cross the road at two locations.
- Opaki-Kaiparoro Road (North of Jackson Line) and Bluff-Rangitumau Road (Stuarts Road to James Road) – due to flooding of the Kopuaranga River. Apart from the isolation of farms up Kaka Amu Road and James Road, the main impact of flooding in this area would be denial of access to the telecommunications repeater on top of Rangitumau.
- Upper Plain Road (west of Evans Road) and Upper Waingawa Road – due to flooding of the Waingawa River. Significant flooding across Upper Plain Road could deny road access to the Masterton District Council's urban water supply intake and treatment plant.
- Mataikona Road (**Figure 4.12**)

Figure 4.10. Cape Palliser Road at Te Kopi. There is severe instability of the road at this location due to coastal erosion and slumping of the mudstone material. Note the succession of previous road levels below the present road.

Figure 4.11. Cape Palliser Road at Whatarangi Cliffs. A boulder beach is under construction to counter severe beach erosion.

Figure 4.12. Damage to the Packspur Bridge, Mataikona, following scouring and rotating of the abutments in April, 1991.

Carterton district

The sections of important routes vulnerable to flooding are:

- Kaipaitangata Road – due to flooding in the Mangatarere Stream. Access to the Carterton water supply intake and treatment plant would be cut.
- Mount Holdsworth Road – due to flooding in the Atiwhakatu stream.
- Kaiwhata Road – due to flooding in the Kaiwhata River.

In addition to these areas, Belvedere Road was closed in November 1994 when the western approach to the Mangatarere Bridge failed. (**Figure 4.13**)

South Wairarapa district

Sections of important routes vulnerable to flooding are:

- Featherston-Cross Creek Road – due to flooding in Cross Creek. Flooding usually occurs every second year and the road is closed for several hours
- Kahutara Road – due to operation of the Oporua floodway (**Figure 4.14 a and b**)

Windstorm and local wind effects

The main impact of windstorm or local wind effects on the road transport network is the potential for trees and/or power services to fall across the road. Damage is seldom significant and the duration of disruption to traffic is generally reasonably short. Areas with mature trees located close to the roadside have been identified as the most vulnerable in the vulnerability charts.

Masterton district

Generally the impact of tree fall on the road network is not great, but the highest risk areas are those where work space makes it more difficult to clear the obstruction. The Mataikona Hill and Kaiwhata Hill are examples of this category.

Carterton district

The wind hazard is significant on Dalefield Road near the water treatment plant, on western end of Norfolk Road, and on Tupurupuru-Te Wharau Road near Kourarau.

South Wairarapa district

Wind hazards can affect the White Rock No. 1 Road up to the Haunui wind farm, all roads bordering Palliser Bay, and exposed sections of the Kahutara, Martinborough-Pirinoa, Pirinoa, Lake Ferry, Whangaimoana, Whatarangi and Greytown-Bidwills Cutting roads.

Figure 4.13. Mangatarere Bridge, Belvedere Road, Carterton District. The road was closed in November 1994 when the western bridge approach was eroded. *Photo courtesy of the Wairarapa Times-Age.*

Figure 4.14 a and b. Erosion of the Oporua Floodway and Kahutara Road in the South Wairarapa District occurred in September 1988 and resulted in the need for extensive repair work. *Photo (b) courtesy of the Wairarapa Times Age.*

Tsunami

Low-lying areas on the exposed Pacific coast are the most vulnerable to tsunami. The likelihood of damage and the consequent disruption to transport is a function of the size of the wave and the distance from the shoreline. In general, sites exposed to this hazard have been assigned a reasonably high probability of receiving low to medium level damage.

Masterton district

Roads near the Mataikona, Whakataki and Castlepoint foreshores would be most prone to the tsunami hazard.

Riversdale could also be affected, but the degree of disruption should be marginally lower because the main access road is perpendicular to the shoreline.

Carterton district

No important routes would be affected by tsunami.

South Wairarapa district

A wave height of 10 metres could flood land as far north as the north end of Lake Wairarapa. This would affect the following roads:

- Featherston-Cross Creek
- Western Lake
- Kahutara
- Martinborough Pirinoa
- Whatarangi
- Lake Ferry

The low coastal road to Cape Palliser and the coastal end of Tora Road would also be vulnerable to tsunami.

Volcanic ash

Although the impact of damage caused by volcanic ash has been retained as a parameter in the vulnerability charts, it is not considered a significant hazard to the road network. The active volcanoes of the central plateau are well to the north and it is unlikely that any eruption would make Wairarapa roads unsafe to use. Chapter 2 discusses the ash fall hazard and return periods for events in the Wairarapa.

Severe storm

Severe storm events can cause localised flooding where road drainage facilities are unable to cope. There is general disruption to traffic during and immediately following the event, but actual damage is usually low. Metservice warnings give some opportunity to plan transport movements and minimise impacts.

Masterton district

Road sections in many areas of the district are vulnerable to saturated soil conditions, leading to slips, dropouts and washouts. This is dealt with in the landslide section of the report.

Sections of road with flat longitudinal gradient and few opportunities to drain side flows are at greatest risk. Masterton-Martinborough Road at Cavelands Road, Kaiwhata Road, Langdale Road, Manawa Road, Masterton-Stronvar Road (past Patakawa Hill) and Te Parae Road are all susceptible.

The forest road linking Puketiritiri Road to Homewood Road through Ngaumu Forest is rated as vulnerable to storm damage because the formation, road materials and drainage facilities are generally constructed to a lower standard.

Wildfire

Temporary disruption to traffic is the likely consequence of wildfire on the important routes. Although there is potential for structural damage to timber and steel bridges, most of the important routes have concrete bridges. Assuming heat is unlikely to be concentrated directly on the road, it is not expected roads will be structurally damaged.

Through access would almost certainly be denied by the Rural Fire Authority in the event of a reasonably significant fire adjacent to the road. The period of disruption would depend on the size of the fire and the wind direction, but in any event, it would be less than two days.

Masterton district

One of the highest risk roads is Big Saddle on the Masterton-Castlepoint Road. This is because of the relatively high traffic volume, coupled with mature trees and gorse close to the road. This vegetation becomes very dry at the peak of the fire season. Because of the size of the community and the relative isolation, the Mataikona area is also at higher risk.

Carterton district

The sections of important routes most at risk from wildfire are between Schofields Bridge and Te Wharau on the Tupurupuru-Te Wharau Road and between Te Wharau and the Kaiwhata River on the Kaiwhata Road. Although the daily average traffic volumes in these sections are low, the wildfire hazard is high as a result of the exotic tree planting and scrub bordering the road.

South Wairarapa district

Sections of important routes at highest risk to wildfire are on the Whatarangi and Cape Palliser Roads near the Putangirua stream and Johnson Hill. These roads carry relatively high levels of visitor traffic. There are also very short sections of high risk on White Rock No. 2 and Tora Roads. The Western Lake Road is subject to a medium wildfire hazard, along the lake edge.

MITIGATION MEASURES

A level of risk has been indicated in the vulnerability charts for all road sections and components on the important routes, in accordance with WELA Note 5. While low risk situations can be addressed by routine procedures, mitigation measures need to be identified for facilities which are at high or extreme risk

Liquefaction

Many road sections along the important routes have been identified as potentially vulnerable to liquefaction and tentatively flagged as high risk. The WELA hazards task group has undertaken work on specific sites, but more work is required to confirm the zones of liquefiable soils and to ensure that bridge foundations have been designed with this in mind. Until this has been done, the estimates are likely to be conservatively high.

Fault displacement

The Mokonui Fault is in the immediate vicinity of Double Bridges. It would be prudent to establish its exact location in relation to the bridge and evaluate any likely impacts on the bridge. The Dry River and Huangarua faults cross several roads and bridges in the Carterton and South Wairarapa Districts. The location of these faults should be determined accurately and specific information gathered on their faulting history. This would allow the seismic risks involved to be more reliably determined and if appropriate, mitigation measures put in place.

Landslide/roadside instability.

Several sections of the road network have been identified in the vulnerability charts as having a high risk of roadside instability and consequently the risk of losing the lifeline for some period is considered high on these roads. Historically, roads have generally only been impassable for a day or two.

Roadside instability occurs for a variety of reasons. Roads in the Masterton district susceptible to landsliding due to geological and/or topographical conditions include:

- Front Hill and Okau Hill on Mataikona Road
- Bideford Hill at Hillend on Te Ore Ore-Bideford
- Kerosene Ridge on Blairlogie-Langdale Road

- Langdale Hill on Langdale Road
- Te Parae Road
- Tupurupuru-Te Wharau Road
- White Rock No2 and Tora Roads

The Masterton-Castlepoint Road between Blairlogie and Hangmans Bridge is susceptible to slippage due to a severe storm or earthquake. Dropouts caused by floodwater where rivers run parallel to the road can occur in numerous places along the Masterton-Castlepoint Road.

The eroding sections of the Whatarangi and Cape Palliser Roads are covered by an agreement between the South Wairarapa District Council and Transit and are subject to special studies and continuing mitigation measures.

It is recommended that further geotechnical advice be sought on known areas of instability. Stability plantings have already been made in several of these blocks, under supervision of Regional Council Soil Conservation staff. This has been a very cost effective means of providing reasonable protection. Geotechnical advice on opportunities for retaining structures should be sought where appropriate. Good control of stormwater runoff is also an important routine mitigation measure.

Flooding

There are several known locations in the Masterton district where road links are temporarily severed by flooding during storm events. Roads affected include:

From the lower Whangaehu River:

- Te Ore Ore-Bideford Road
- Masterton-Castlepoint Road
- Masterton-Stronvar Road
- Langdale Road
- Manaia Road

From the Whareama River:

- Masterton-Castlepoint Road.

From the Waipoua River:

- Paierau Road

From the Kopauranga River:

- Opaki-Kaiparoro Road
- Masterton-Martinborough Road

From the Ruamahunga and Lower Taueru rivers:

The Wellington Regional Council has recently upgraded plans showing the extent of the 50 year event. These plans can continue to be refined. It is not considered realistic however, to develop mitigation measures in the high risk areas, given the limited time the routes are impassable.

Tsunami

Although it would be hard to mitigate the risk of damage to pavement and road surfaces, an awareness of the impact on road users as part of a broad public education programme could lessen the consequences of such an event.

Wildfire

Although scrub and grass fires could occur almost anywhere, the most vulnerable sections of the road include:

- The Big Saddle on the Masterton-Castlepoint Road
- The hill sections of the Mataikona Road and Riversdale Road
- All areas having a high volume of visitor traffic.

Grass shoulders are mown once every year to a width of 1.5 metres from the seal edge. More frequent and wider mowing may be required in high hazard areas. It is also important to maintain the current squads of well trained and prepared rural fire forces.

4.4 BRIDGES

In addition to the subjective assessments given in the vulnerability charts, bridges on the more important routes have been seismically screened using the preliminary procedures laid out in the Transit New Zealand No 58 report. This process derives a seismic prioritisation grade (SPG) based around three variables. These are:

- Hazard i.e. seismicity at the bridge site (50%)
- Importance of the bridge (30%)
- Vulnerability of the bridge structure (20%).

The hazard and importance indices account for 80 per cent of the SPG and they have all been valued reasonably consistently throughout the district. Only 20 per cent of the SPG is derived from the vulnerability index. It should be noted that the results of the screening process would not necessarily reflect the same priorities as Transfund's criteria for economic evaluation of major bridge projects.

Bridges with a vulnerability index greater than 0.59 have the greatest need for more detailed assessments, which could lead to possible replacement or retrofitting (see **Table 4.5**).

The Tinui, Whakatahine, Kahutara and Huangarua bridges have the highest overall SPG values. The Tinui

Bridge is particularly significant because there are no alternative routes beyond that point on the road, which is the only road transport link to the Castle Point and Mataikona settlements.

Similarly, the Whakatahine Bridge is essential to forestry traffic to the headquarters block of Ngaumu Forest.

Road	Bridge name	Bridge number	Vulnerability index	SPG
Masterton district				
Masterton-Castlepoint	Taueru	7	0.827	0.255
Opaki-Kaiparoro	Double Bridges	1	0.777	0.252
Masterton-Castlepoint	Tinui	16	0.747	0.318
Masterton-Stronvar	Whakatahine Stream	10	0.747	0.321
Masterton-Castlepoint	Kahumingi	8	0.717	0.241
Manawa	Black swamp	3	0.650	0.268
Masterton-Stronvar	Brancepeth	9	0.647	0.282
Te Parae	Te Parae No.2	2	0.610	0.250
Homewood	Homewood (old No.7)	13	0.600	0.250
Carterton district				
Carterton-Gladstone	Gladstone	9	0.663	0.309
South Wairarapa district				
Kahutara	Lower Valley (Tuhitarata)	35	0.771	0.347
Ponatahi Road	Huangarua	102	0.747	0.260
Martinborough-Pirinoa	Dry River	40	0.699	0.243
Martinborough-Longbush	Taylors	112	0.626	0.236
Whatarangi Road	Pricketts	53	0.614	0.246
Featherston-Cross Creek	Waihora	8	0.614	0.272
Western Lake No.1	Wairongamai	20	0.599	0.269
White Rock No.1	Hautotora	68	0.597	0.250
Martinborough-Longbush	Hikawera	108	0.597	0.228

Table 4.5. Summary of Wairarapa bridges with vulnerability indexes > 0.59.

4.5 RAIL

NETWORK DESCRIPTION

Tranz Rail Ltd operates the railway line through the Wairarapa. It was constructed as the main route north from Wellington and was later superseded by a link to the west of the Tararua Range. It links Wellington with Woodville, joining the Palmerston North-Gisborne Line. These lines are part of a larger network running from Wellington to Auckland through the central North Island.

The rail link from Wellington enters the Wairarapa through the 8.8 kilometre Rimutaka Tunnel from Upper Hutt, and crosses the Wairarapa Fault on its descent into Featherston (**Figure 4.15**). It follows a route parallel to this fault more or less directly to Carterton. About three kiometres of the track lies on liquefiable soft sediments on the flood plain of the Mangaterere Stream.

Figure 4.15. The rail bridge at Abbots Creek, Featherston. In November 1975, rockwork and a weir were installed to counter bed-scour at the piers.

From Carterton to Masterton the line crosses the Carterton Fault north of the Clareville Showgrounds and the Masterton Fault close to the Waingawa River Bridge. Although the topography is gentle, in railway terms there is a reasonably long grade from the tunnel to Speedy's Crossing, with some high embankments. There are also some high embankments approaching major bridges.

From Masterton the railway crosses the Waipoua River and passes over about one kilometre of liquefiable sediment at Opaki. It then crosses the Mokonui Fault and the Ruamahanga River at Double Bridges. The line continues through gentle terrain to Kopuaranga. Then, following the valley to Mauriceville, it runs close to and parallel to the Wairarapa Fault. From Mauriceville, the railway crosses the Kowhai Fault and passes through valley systems with a known earthquake-generated landslide history and liquefiable soft sediments.

It leaves the region through the Wiwaka Tunnel east of Hastwell, into the valley system behind Eketahuna.

The length from the eastern portal of the Rimutaka Tunnel to the portal of the Wiwaka Tunnel is 73 kilometres.

Train control north of Featherston is via radio-based track warrants from Wellington train control. Tranz Rail Ltd operates its own radio network. Train control from Featherston south for signals and points is by remote control from Wellington. In the event of power failures, many installations have backup power or can be manually operated. Tranz Rail Ltd has operating procedures for working around failed equipment, but these depend on communication systems.

MITIGATION MEASURES

Any mitigation measures that might appear to be necessary from the vulnerability assessment are regarded by Tranz Rail as a business decision and are not considered appropriate for inclusion in this report. Tranz Rail does, however, have a national contingency plan for reinstatement of facilities following emergencies.

4.6 HOOD AERODROME

NETWORK DESCRIPTION

Hood Aerodrome is located on Masterton's southern urban fringe. It is 1.5 kilometres from State Highway 2 and five kilometres from Masterton Hospital. Hood Aerodrome is strategically important as it offers the only sealed runway in the Wairarapa of any significant capacity. Its strategic importance as a lifeline is seen primarily in the urgent delivery of freight or personnel from outside the district. It would become extremely important if either of the road links over the Rimutakas or to the north were lost.

The main runway is a sealed strip on vector 06/24 and provides a take off and landing distance of approximately 1,200 metres. A grass strip is available immediately adjacent to the sealed runway and another is provided on vector 10/28 with a landing and take-off strip of approximately 1,000 metres. A short grass strip is also available on vector 06/24. The main runway and taxiway has a pilot-activated lighting system. There are also two lit windsocks. Provision is made in the management plan for an extension of the main runway over Manaia Road but this is not anticipated in the foreseeable future, given current demand.

At present, use of the aerodrome is limited to general aviation aircraft of 5,700 kilograms maximum combined take-off weight.

Navigation is aided by a non-directional beacon located on the radio signal south of the Waingawa River. In recent times a GPS approach has been available and it is anticipated that this will in time replace the beacon.

An automatic weather station will soon be installed to provide weather information on the airfield. It will also be available to pilots by radio. Currently there are anemometers at the aero club and old Wairarapa Airlines terminal building.

The aerodrome is not certified by the Civil Aviation Authority, so it may not meet all standards expected of a certified aerodrome. Aircraft movements are not controlled and there is no permanently manned control tower. A local radio frequency is used, but it is mostly unattended. These constraints limit the aerodrome's use for scheduled flights.

The Masterton Fire Station is four kilometres from the aerodrome and there are no on-site facilities for fighting significant fires. On-site equipment is limited to fire extinguishers and first aid kits.

Local users of the aerodrome include:

- Air Services, which operates a small fleet of four aerial topdressing aircraft.
- Heli-flight Wairarapa, which operates six small helicopters in its training school.
- Various leisure operators (Wairarapa and Ruahine Aero Club, Sport and Vintage Aviation Society, Wairarapa Amateur Aviation Society and private owners)

In addition, aircraft engineering workshops are operated by Advanced Aero Engineering and Skyfix.

Emergency access

Aircraft heavier than the rated 5,700 kilogram maximum combined take-off weight are capable of using the facilities in emergencies or when special circumstances dictate. Long aircraft (e.g. the Lifeflight Air Ambulance Metroliner) are unable to gain access to the refuelling facilities because of the grass taxiways. The same aircraft would be unable to land on the grass strip in the wet, if for some reason, the sealed strip were not available.

The Lifeflight helicopter provides a key link for emergency health services in providing a transfer for patients directly from an emergency site to Masterton Hospital, and, if necessary, on to Wellington Hospital. While the helicopter link remains the preferred option, it is very dependent on the weather. The helicopter is backed up by fixed-wing aircraft that can operate in a wider range of conditions.

Rural airstrips

With the assistance of an experienced agricultural pilot, an attempt has been made to identify the main rural airstrips currently used in the Wairarapa. There are approximately 60 airstrips, spread reasonably evenly over the district, which could be used by experienced fixed wing pilots in small planes.

VULNERABILITY ASSESSMENT

Ground shaking

Overall the risk is considered low. It is not anticipated that ground shaking would have a high probability of occurring while aircraft are arriving at or departing from the runway. In the short term there may be some impact on communications, lighting and navigation facilities.

Liquefaction

The alluvial zone along the Waingawa River indicates a potential for liquefaction. With the exception of the runway, the impact of damage is considered reasonably minor.

Fault displacement

No faults are noted in the immediate vicinity. The nearest faults are the Masterton Fault, 1.8 kilometres to the north and the Carterton Fault, 3.8 kilometres to the south.

Landslide

Landslides are not a risk, as the aerodrome is located on level ground.

Ground settlement

There are no indications that ground settlement would be a problem.

Flood

A flood hazard zone identified along the Waingawa River bank which could impact in a moderate way on the operation of the sealed runway in an extreme event (**Figure 4.16**). In 2000, severe bank erosion of the 'over-run' area at the southern end of the runway occurred. Emergency works were needed to protect the runway and realign the river. There is a need for ongoing river management in this location.

Local wind effects

No local wind effects are known to occur in the vicinity of the aerodrome, or for aircraft flying in the Wairarapa.

Figure 4.16. Southern end of the Hood Aerodrome runway, Masterton. Severe erosion occurred in 2000, reducing the 'over-run' area and threatening the runway. Extensive river realignment and rip rap protection was required.

Volcanic ash

The operation of aircraft through an ash cloud is a remote possibility which could have significant consequences.

Wind and severe storm

Flying operations would generally be suspended through storm events and local surface flooding.

Wildfire

The runways and taxiways are mown at least 30 times per year under contract and therefore the risk of a significant fire is low. In the event of fire however, the impact on the aerodrome operations could be reasonably significant for a short period.

MITIGATION MEASURES

Many of the recommendations below have recently been proposed as enhancements to the facility in the Hood Aerodrome management plans.

- A GPS navigation system will help aircraft approach the aerodrome in poor weather.
- An automatic weather station will be accessible to pilots by radio for improved flight safety.
- Upgraded runway lighting with standby power generation will make the aerodrome more reliable for night use.
- Continued prudent management of the Waingawa bed by the Wellington Regional Council will help protect the threshold of Runway 24.
- Extension of the sealed taxiway would allow the Lifeflight Air Ambulance Metroliner to use the aerodrome.

- Appropriate and adequate fire fighting equipment should be available at short notice.

4.7 PETROLEUM FUEL AVAILABILITY IN THE WAIRARAPA

The following is a summary of what is known about fuel storage volumes, storage and distribution integrity and supply sources that can be used to maintain essential services in the region after a natural hazard event.

A standard letter was sent to all major oil companies, emergency service providers, major contractors, the Masterton Airport Manager and larger Wairarapa based businesses. The letter asked a series of questions as follows:

- The number and size of tankage that you have on company owned service station sites in the Wairarapa, south of Eketahuna
- The location, number and size of tanks that you fill on privately owed service station sites in the same area as above
- The location, number and size of tanks (customer/supplier owned) that you may supply to at commercial and industrial sites
- Tankage information and/or contact information for agencies that may be supplying your branded fuel in the area
- The location of your preferred supply point and potential back-up supply points
- The typical delivery frequency to the area
- Contingency plans for retailing fuel during an extended power outage in the area, for example by providing emergency back-up generators
- Any other comment that you think will be useful to ensure the completeness of the proposed WELA report.

The response to this request for information was not very significant, although it did lead to some interviews and written feed back. Only one oil company, Shell New Zealand Ltd, responded to this information request. Listed below is a brief summary of the responses and interviews:

- Fearon Logging – No on site storage, they use Caltex Truckstop at Solway
- Bruce Buchanan Ltd. – No on site storage as they also use the Caltex Truckstop at Solway. They do have trailer tanks that they tow behind their vehicles to provide on site re-fuelling of mobile plant
- Oldfields – They have significant on site storage for diesel (AGO – Automotive Gas Oil), including industrial dispensers and have some large generators (100 Kva and 350 Kva). Like other contractors they also have an assortment of trailer tanks, many of them fitted with vehicle battery powered pumps for dispensing the fuel. They are typically filled twice per month in summer and once per month in winter to suit usage.
- Juken Nissho Ltd (JNL) – They also have significant on site storage for AGO and an industrial dispenser. They are typically filled weekly.
- South Wairarapa District Council – They have no fuel storage facilities, but do have their own small generator for running limited lighting, cell phones and radios.
- Master Roads, Te Ore Ore – They do have some on site storage of both petrol and AGO. Typically the petrol tank is filled when required, while the petrol tank is only partially filled at any one time owing to lower demand.
- Masterton Airport – Has underground storage for both Jet A1 and Avgas.
- Moana Fisheries, Ngawi – The factory no longer stores and sells fuel owing to the RMA, marine environment and other environmental issues. The majority of fishing boats carry a few hundred litres of fuel on board and also own a trailer tank. Apparently Kiwi Fuel line have a small above ground tank at the site. It is estimated that there is only 3 to 4 days fuel cover on site at any one time.

In all cases the supply point for bulk fuel is Seaview at Wellington, with the exception being Gull Petroleum whose only supply point is Mount Maunganui. The main Oil Companies have alternative supply points at Napier and New Plymouth. They also have terminals at Whangarei, Auckland (Wynyard Wharf and Wiri), Mount Maunganui, Nelson, Christchurch, Timaru, Dunedin and Bluff in addition to those listed above.

None of the respondents have any form of contingency plan in place for alternative supply or methodology for retrieving fuel from storage when the power is down. Many operators have trailer mounted tanks typically in the 1000 to 1300 litre range. Many of these are fitted with 12 volt electric pumps operated from the vehicle battery. These pumps are used to dispense the fuel (AGO). Petrol cannot be dispensed without all wiring complying with the hazardous area regulations and electrical safety.

The dispensers at a typical retail site (service station) are fitted with computer controlled metering equipment that requires "clean" electrical supply. This type of supply is not generally available from conventional generators. These would require some form of filtering and power correction to ensure satisfactory operation. Normally some alteration of the site wiring is required before a generator can be connected to the site meter board as a back up source of electrical energy.

As the majority of sites are fitted with remote fill points (which are typically 100 mm diameter), the only reasonably easy point that fuel can be pumped from is the underground tank dip point, and this is only 50 mm in diameter. Only hazardous area approved electrical apparatus can be used to pump petrol from these points or an air operated pump attached to a compressor that is sited outside the hazardous zone.

Based on the writer's industry experience and periodic newspaper articles, the petroleum industry is continually rationalising the number of outlets that they operate or supply to. The reasons are many and varied, but one of the primary ones is based on environmental concerns and the RMA. When the RMA was first developed and implemented, the Oil Industry, Regional Councils, The Ministry for the Environment and other related organisations jointly developed a Code of Practice for the installation of bulk fuel storage tanks. This code was developed to ensure a consistent standard was applied by all authorities across the country. Different tank installation configurations were developed for sites having different levels of sensitivity. Sensitivity was typically based on the potential to contaminate underground water supplies. Models were then developed for assessing each site and determining what level of containment would be provided to the underground tanks. As many of the existing installations are quite old, a decision is made whether or not to continue with the site. Often the answer is to abandon the site e.g. Mobil at Pirinoa, Smiths Motor Engineers at Carterton, Shell at Eketahuna. This trend will continue as cars are more fuel efficient and can travel for many hundreds of kilometres before requiring a re-fill. This same philosophy applies to industrial sites where the customer is frequently provided with a fuel card and asked to re-fill at the nearest service station or truck stop rather than have their own installation and the consequent potential environmental issues associated with uncontrolled usage.

Balancing this trend is the shift to bigger and more efficient road tankers to deliver fuel as and when required to larger tanks on fewer sites via a roading network that is continually being improved.

Conclusions and Recommendations

- The number of retail sites is continually being rationalised down for a number of reasons, but principally to ensure compliance with current environmental standards and codes of practice
- Larger tanks are being fitted to fewer sites to help increase product delivery efficiencies
- The number of industrial sites is being reduced to minimise environmental issues
- Industrial and commercial customers are being provided with fuel cards that allow them to re-fuel at service stations or truckstops, thus reducing the pressure for on site storage. These cards also provide other beneficial management controls and audit trails
- Road tank truck and trailer configurations are being designed and detailed to carry larger volumes as road weight limits are increased. This allows for greater delivery efficiencies
- Road design and construction allows larger vehicles to travel to more places more easily and quickly
- Fuel efficient cars can travel greater distances between re-fills
- No respondent has considered any fuel contingency plans
- AGO cannot be stored indefinitely to be used for a possible future catastrophic event, such as a large earthquake
- No part of New Zealand has recently suffered widespread medium term (duration) damage to such an extent that normal services have been severely hindered. Even the 1987 Edgecombe earthquake was quite localised
- Many contractors have trailer mounted tanks of 1000-1300 litres capacity (filled with AGO), many of which are fitted with 12 volt battery operated pumps. These are very portable and easily towed by 4WD vehicles
- Many farms have on site tanks storing both AGO and petrol in limited quantities. These are typically dispensed using gravity or a hand pumps
- Unless back up equipment to temporarily maintain operations is checked regularly, then its reliability is generally questionable if called upon to work in extreme conditions at short notice.

Based on the sparse and widely distributed population of the Wairarapa, any contingency plan should take into account the following points:

1. 4WD utes, tractors and motor bikes will be available at any location in the region
2. Trailer tanks with a fuel carrying capacity of 1000-1300 litres will be quite readily available within the region to transport fuel to areas where it may be required. Many of these are fitted with 12 volt battery powered electric pumps
3. Limited quantities of fuel will be available from most farms until alternative supplies are confirmed
4. Numerous small airstrips are available to be used for light planes and/or helicopters to ferry equipment close to where it may be required
5. Good communication processes via the commercial radio network should inform/request targeted help at designated locations
6. Contact information for selected contractors, service stations, truckstops and large commercial/industrial installations should be updated annually
7. Some form of formal partnering relationship should be considered with an organisation such as Oldfields. They have a reasonably diverse range of fuel products on site, industrial dispensers, large portable generators and a diverse range of heavy earth moving equipment
8. If any equipment is purchased, consideration should be given to locating it at a fire station or similar serviced operation to ensure it is operated periodically, maintained and available
9. If an investment in some form of infrastructure is considered potentially worthwhile, it may be beneficial to direct this toward electrical work on 2 or 3 strategically chosen sites to enable immediate connection of a portable generator to the switchboard to drive part of the sites dispensing equipment
10. Researching the immediate (1 to 3 days) fuel needs that may be required by emergency services and comparing this with the known available volumes will be beneficial.