Rotorua District Council
Taupo District Council

Broadlands Road Corridor Management Plan

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Broadlands Road
Corridor Management Plan

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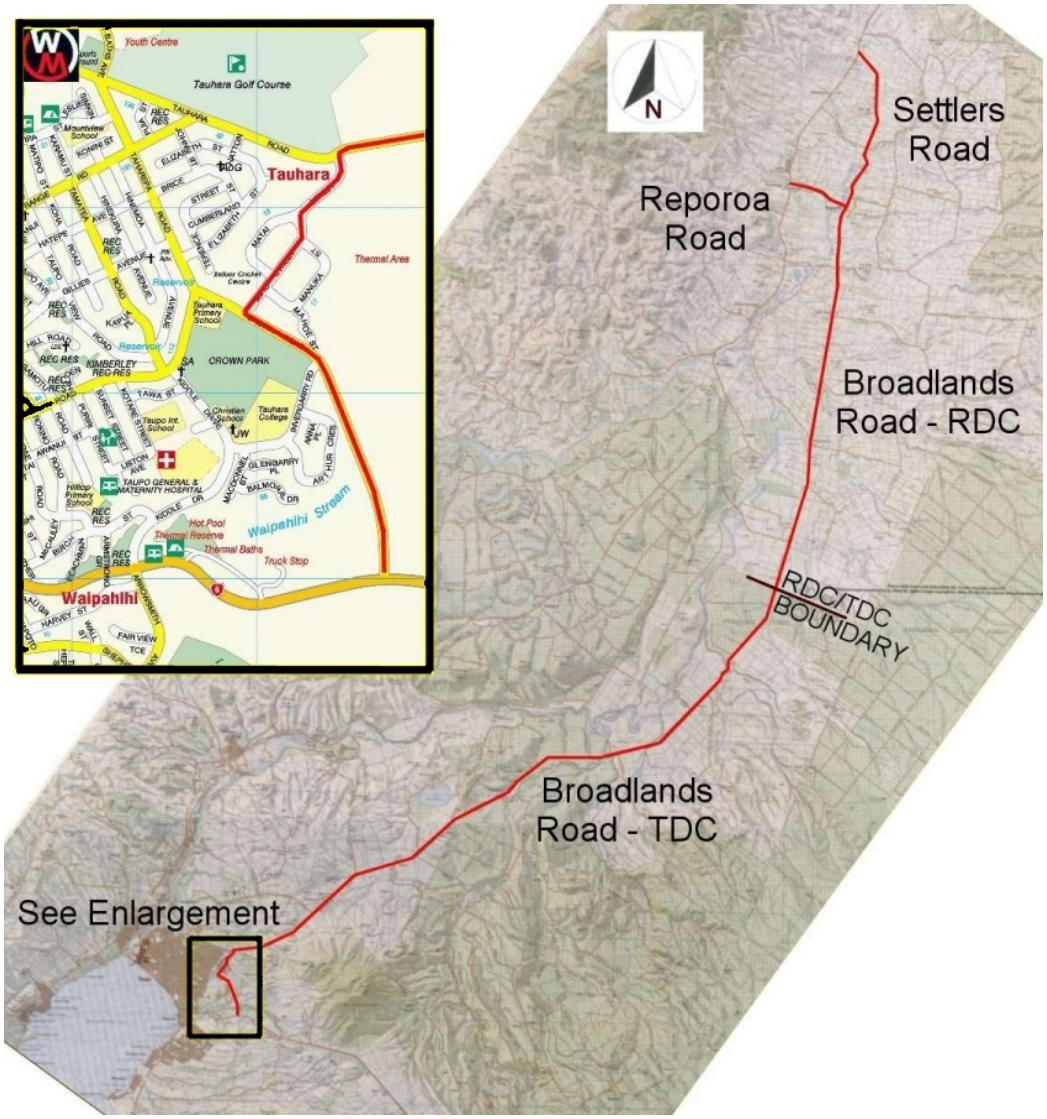
Executive Summary

Location

The route under consideration encompasses a total length of 49.49km, including Settlers Road, Reporoa Road and Broadlands Road in the Rotorua District, and Broadlands Road, Miro Street and Crown Road in the Taupo District.



General

The study route forms an alternative arterial route to SH5 between Taupo and Rotorua. This route currently carries up to 20% heavy vehicles, including logging trucks and milk tankers.

Some of the key conclusions of this study are:

- Traffic volumes are expected to increase over the next 20 years or so at a rate above that seen historically, reflecting expected rapid population growth in the Taupo District. The staged construction of the proposed Eastern Taupo Arterial will have different effects on traffic volumes on each subsection of the route.
- The proportion of heavy vehicles in the traffic stream is expected to remain fairly constant at 15-20%.
- The level of service (LOS) on the study route is expected to be at LOS C or better until at least 2024.
- The road is narrow in places, which can cause problems for overtaking vehicles.
- The relatively straight and flat alignment of the study route means passing opportunities are available.
- Broadlands Road has a high proportion of overtaking type crashes, but overall mid-block injury crash rates are comparable with typical national rates.
- A large number of recreational and competitive cyclists use Broadlands Road, and the numbers are expected to increase.

Strategy

The main strategies for the study route are to:

- Rehabilitate pavements in accordance with RDC and TDC's respective Roading Asset Management Plans, and the prioritised programme given in Appendix 2 of this report.
- Increase the seal width along Broadlands Road, Settlers Road and Reporoa Road in conjunction with rehabilitation and renewal works, and as subsidised stand-alone cycling projects.
- Realign or ease low radius horizontal curves and/or improve warning signage at these curves where appropriate.
- Provide consistency along the route in terms of seal width, intersection layout, and signage.

Land Transport Management Act Requirements

Any projects arising out of the this Report will be subject to the requirements of the LTMA if the RDC or TDC will be applying for Transfund funding. In approving a project Transfund must take into account how the activity:

- Assists economic development;
- Assists safety and personal security;
- Improves access and mobility;
- Protects and promote public health; and
- Ensures environmental sustainability.

These factors are based on objectives outlined in the New Zealand Land Transport Strategy.

Projects

The tables below describe the major projects considered for the study length, their estimated cost and indicative BCR, and positive contributions to NZTS objectives.

Project Name	Cost ($K)	BCR	Contribution to NZTS Objectives
Settlers Road Realignment – RP 2,410-3,155	$545	**0.9**	• Safety and Personal Security • Economic Development
Settlers Road Realignment – RP 5,065-5,590	$411	**0.8**	• Safety and Personal Security • Economic Development

Table 1. Rotorua District Projects

Project Name	Cost ($K)	BCR	Contribution to NZTS Objectives
Broadlands Road Curve Easing – RP 5,185-5,420	$121	**2.9**	• Safety and Personal Security
Broadlands Road Curve Easing – RP 11,485-11,700	$138	**1.5**	• Safety and Personal Security
Broadlands Road Curve Easing – RP 23,235-23,470	$152	**1.9**	• Safety and Personal Security
Broadlands Road Southbound Climbing Lane – RP 6,940-9,240	$1,472	**1.4**	• Safety and Personal Security • Economic Development
Broadlands Road Cycle Lane/Shoulder Widening – RP 0-3,300	$327	**1.6**	• Safety and Personal Security • Public Health • Environmental Sustainability
Broadlands Road Cycle Lane/Shoulder Widening – RP 3,300-5,300	$459	**2.0**	• Safety and Personal Security • Public Health • Environmental Sustainability
Broadlands Road Cycle Lane/Shoulder Widening – RP 5,300-9,700	$952	**1.7**	• Safety and Personal Security • Public Health • Environmental Sustainability
Broadlands Road Cycle Lane/Shoulder Widening – RP 9,700-16,100	$1,337	**1.8**	• Safety and Personal Security • Public Health • Environmental Sustainability
Broadlands Road Cycle Lane/Shoulder Widening – RP 16,100-19,900	$889	**1.5**	• Safety and Personal Security • Public Health • Environmental Sustainability
Broadlands Road Cycle Lane/Shoulder Widening – RP 19,900-24,500	$979	**2.1**	• Safety and Personal Security • Public Health • Environmental Sustainability

Table 2. Taupo District Projects

1 Introduction

The purpose of this strategy is to formulate strategic plans for the 20-year period to 2024 for upgrading the study route, shown in Figure 1, in order to provide a reasonable level of service that will address safety issues that may be present.

The study:

- Considers the current and future road needs,
- Identifies where desirable standards and guidelines are not being met,
- Identifies constraints to development along the route,
- Defines a strategy for the development and upgrading of the study route,
- Identifies a maintenance regime for rehabilitation of the study route.

It is important to recognise that to enable any projects that arise out of this strategy, to be able to receive Transfund funding, the Rotorua District, and Taupo District, Councils will need to demonstrate how those projects comply with the provisions of the Land Transport Management Act 2003. The requirements of this Act are set out in Section 7.2 of this Report.

2 Description of Route

2.1 Route Location

Figure 1 below shows the study route under consideration for this report.

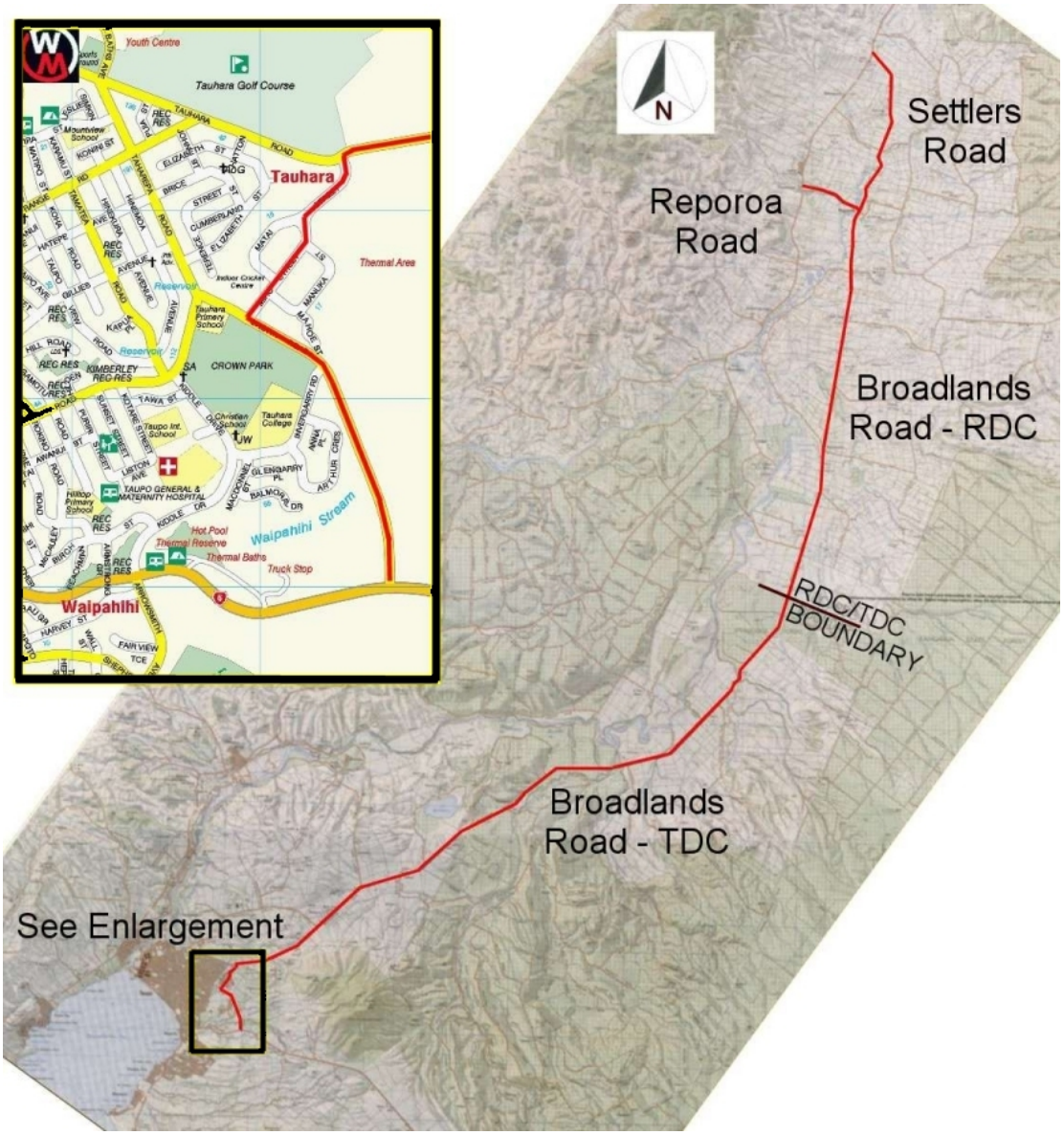


Figure 1. Location Map

Subsections

For the purposes of this study the route has been divided into subsections as shown in Table 3.

Local Authority	Subsection Road		From	To	Length (m)
	No.	Name			
RDC	1	Settlers Road	SH 5 (RP 0)	Broadlands Rd (RP 6,130)	6,130
	2	Reporoa Road	SH 5 (RP 0)	Broadlands Rd (RP 2,252)	2,252
	3	Broadlands Road	Settlers/Reporoa (RP 0)	District Boundary (RP 13,800)	13,800
TDC	4	Broadlands Road	Miro/Tauhara (RP 0)	District Boundary (RP 24,522)	24,522
	5	Miro Street	Crown Rd (RP 0)	Broadlands Rd (RP 1,053)	1,053
	6	Crown Road	Miro St (RP 307)	SH 5 (RP 2,040)	1,733

Table 3. Subsections

All subsections are classed as rural, except for Miro Street (Subsection 5), which is urban. Crown Road (Subsection 6) from RP 307 to 943 has a 50km/h speed limit and therefore is partially urban.

It should be noted that the route position for Broadlands Road in the Rotorua District increases north-south, while in the Taupo District route position increases south-north.

2.2 Road Functions

Subsection 1 – Settlers Road

Settlers Road is not identified as a district arterial in the Rotorua District Plan but by nature and use should be classed as a rural arterial. It is predominantly rural, with a short urban section in Reporoa at the southern end. This section of the route has a number of functions:

- For inter-regional freight and travellers, to/from Bay of Plenty and Taupo or Hawkes Bay.
- Access road for local residents to/from nearby main centres of Rotorua, Taupo and Reporoa
- Access road for milk tankers to farms and the Reporoa dairy factory
- Through road for logging trucks, linking with Broadlands Road

Subsection 2 – Reporoa Road

Reporoa Road is not currently classified in the RDC District Plan. This road could possibly be classified as a rural arterial. It has three main functions:

- Access road to/from dairy factory for employees residing in Reporoa
- Access road for heavy vehicles to the dairy factory
- Access for local traffic between SH5 and Reporoa

Subsection 3 – Broadlands Road RDC

Broadlands Road is classified as a rural arterial in the RDC District Plan, and has a similar function to Settlers Road, as follows:

- An inter-regional arterial for freight and travellers, to/from Bay of Plenty and Taupo or Hawkes Bay.
- Access and collector road for local residents to/from nearby main centres of Rotorua, Taupo and Reporoa
- Access road for milk tankers to farms and the Reporoa dairy factory
- Through road for logging trucks
- Access and through road for heavy vehicles to/from Tauhara Quarry
- This section also forms part of the cycle leg of the NZ Ironman triathlon, and is used for training purposes in the lead up to this event in early March.

Subsection 4 – Broadlands Road TDC

Broadlands Road in the Taupo District is classified in the TDC Roading Asset Management Plan and District Plan as a Regional Arterial, and has the following main functions:

- An inter-regional arterial for freight and travellers, to/from Bay of Plenty and Taupo or Hawkes Bay.
- Access and collector road for locals to/from nearby main centres of Rotorua, Taupo and Reporoa
- An access road from Taupo to the Landfill
- Access for heavy vehicles to/from the Tauhara Quarry
- Through road for logging trucks
- As part of the cycle leg of the NZ Ironman triathlon, used for training purposes in the lead up to this event in early March.

Subsection 5 – Miro Street

Miro Street is classified in the TDC Roading Asset Management Plan and District Plan as a Regional Arterial; however, it is different from other sections of the study route in that it is urban in nature. It passes through an industrial area on the eastern outskirts of Taupo and serves as an access and collector road for traffic to this industrial area, and also as an inter-regional arterial in the same manner as the rest of the study route.

Subsection 6 – Crown Road

Crown Road is classified in the TDC Roading Asset Management Plan and District Plan as a Regional Arterial and forms the southern link of the study route to the State Highway network.

The initial section of Crown Road, to RP 943, has a 50km/h speed limit making it urban by definition.

3 Traffic and Crash Characteristics

3.1 Traffic Volumes

3.1.1 Existing

Traffic volume count data has been taken from RDC and TDC RAMM databases and is described in Table 4.

Subsection	Route Position (m)	Year	Traffic Volume (vpd)	% HCV
Settlers Road	185	2003	1,309	15%
Reporoa Road	200	2003	1,028	21%
Broadlands Road RDC	500	2003	1,863	17%
	13,800	2003	1,820	18%
Broadlands Road TDC	3,182	2004	2,418	16%
	3,382	2004	2,549	16%
	5,556	2004	2,333	15%
	16,666	2004	2,216	16%
	23,536	2004	2,664	18%
Miro Street	50	2003	4,606	20%
	647	2003	4,038	20%
Crown Road	504	2003	3,647	10%
	1,873	2003	1,798	15%

Table 4. Study route traffic volumes

Side Roads

Table 5 describes the traffic volumes of the side roads connecting with the study route.

Subsection	Side Road	Year	Volume	Comment
Settlers Road	Loop Road	2000	70	500m from Settlers - ESTIMATE
	Wharepapa Road	2001	47	1.5km from Settlers
	Birch Road	2003	494	680m from Settlers
Broadlands Road RDC	Homestead Road	2003	292	200m from Broadlands Rd
	Strathmore Road	2003	436	195m from Broadlands
	East Road	2003	267	180m from Broadlands
	Vaile Road	2001	80	1km from Broadlands
	Earle Road	1995	134	
	Allen Road	1990	120	At Broadlands - ESTIMATE
	Ohaaki Road	1999	350	At Broadlands - ESTIMATE

Subsection	Side Road	Year	Volume	Comment
Broadlands Road TDC	Tiverton Downs Road	2003	160	150m from Broadlands
	River Road	2003	396	Near Broadlands
	White Road	2000	248	At Broadlands
	View Road	2001	253	Near Broadlands
	Centennial Drive	2002	746	140m from Broadlands Rd
Broadlands Road TDC/Miro Street	Tauhara Road	2002	4225	200m from Broadlands Rd
Miro Street	Matai Street	2002	1112	
	Manuka Street	2000	910	Near northern int with Miro
Crown Road	Invergarry Road	2000	1885	By Crown Rd

Table 5. Side road traffic volumes

3.1.2 Future Trends

Future traffic flows are difficult to predict accurately. Based on historical count data available, traffic growth on the study route is currently in the vicinity of 1-2% per year for each subsection.

The future estimation of traffic needs to take the following factors into account, each of which is expected to have a significant impact on the use of the study route over the next 20 years.

Population Growth

Taupo and the Bay of Plenty are two of the fastest-growing areas in New Zealand in terms of population. Projections from the Taupo District Growth Model (2004) indicate that the total population of the Taupo District will increase by up to 80%, to 62,250, by 2024. Much of this growth will be in the Taupo urban area and Taupo West rural area. This growth is at a level above that historically seen in the Taupo area. Statistics New Zealand (2002) projected population growth of up to 16% in the Taupo District over the period 2001-2021.

Statistics New Zealand (2002) indicates projected mid-range population growth of 8% in the Rotorua District, to 72,300, over the period 2001-2021. Over the same period the total population of the Bay of Plenty region is expected to increase by approximately 25%.

This population growth is expected to lead to significant increases in traffic on road networks within each district. Correspondingly, it is assumed there will be an increase in interregional traffic wishing to travel between Hawkes Bay, Taupo and the Bay of Plenty, a proportion of which will use the study route. We estimate the magnitude of this increase will be above historical arithmetic growth rates of 1-2% per year.

East Taupo Arterial (ETA)

Gabites Porter (2001) developed a 1999 Taupo traffic model for the TDC as part of the ETA project. This model estimates traffic in 1999 and 2016 with and without construction of the ETA, but does not assess the effects on traffic flows of staged construction of the ETA. This model was developed before the most recent Taupo Growth Model, and is being updated to include the land use information found by the Growth Model.

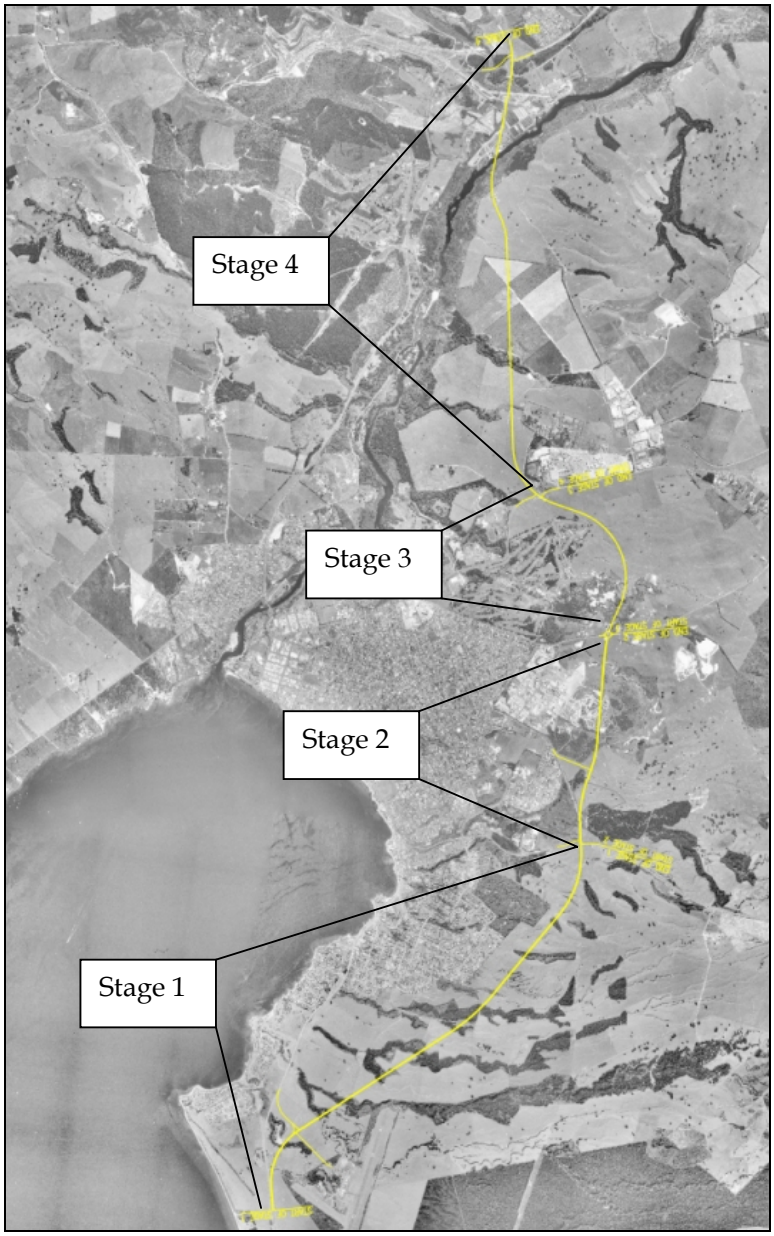


Figure 2. Proposed stages of ETA

The effect of staged construction on subsections of the study route will differ for each subsection. Figure 2 outlines the proposed stages of the ETA. Expected effects on the study route are shown qualitatively in Table 6 below.

Subsection	Effect on Traffic Volume	
	Stages 1 and 2 Completed	**Stages 3 and 4 Completed**
Settlers Road	Increase	Decrease
Reporoa Road	No Change	No Change
Broadlands Road RDC	Increase	Decrease
Broadlands Road TDC	Increase	Decrease
Miro Street	Decrease	No Change
Crown Road	Increase	No Change

Table 6. Effect of ETA on traffic volumes

Construction of stages 1 and 2 will create a bypass of the Taupo urban area for interregional travellers between areas to the south and east of Taupo and Rotorua/BoP. This bypass will be quicker and encourage more of these travellers to use the ETA and Broadlands Road to/from Rotorua, as an alternative to SH1 and SH5.

The southern section of Crown Road is likely to be utilised as part of the ETA, with a new connection to the ETA planned from Crown Road approximately 400m south of the Invergarry Road intersection, as shown in the plan in Appendix 5 of this report. The nature of Crown Road is expected to change with the proposed land development in the area. Crown Road will no longer be part of an inter-regional alternative route to SH5, and will instead become more of a collector road providing access to proposed commercial/industrial developments in the area. Miro Street will no longer be part of an inter-regional route and will experience a decrease in traffic overall.

Completion of the ETA through construction of stages 3 and 4 will complete the Taupo urban bypass. A proportion of interregional travellers to/from Rotorua are expected to continue along the ETA and SH5 instead of turning at Broadlands Road, resulting in a decrease of traffic on Broadlands Road. Traffic volumes on Crown Road and Miro Street will tend to be unaffected by this.

It is likely that Broadlands Road will remain a relatively popular alternative to SH5 between Taupo and Rotorua, particularly for local traffic.

The traffic model gives an indication of the likely magnitude of traffic volume changes on the study route as a result of completion of the ETA. This is shown in Table 7 below.

Road Name	Location	2016 Without ETA	2016 With ETA	% Change
Broadlands Road	North of Tauhara/Miro intersection	3,273	3,247	-0.8%
Miro Street	North end near Broadlands Rd	3,179	2,979	-6.3%
	South end near Crown Rd	7,972	7,576	-5.0%
Crown Road	Miro St to Invergarry Rd	3,473	3,871	+11.5%
	Invergarry Rd to SH5/ETA	1,623	2,525	+55.6%

Table 7. Taupo traffic model effects of ETA (from Gabites Porter (2001))

For the purposes of this study we have assumed stages 1 and 2 of the ETA will be constructed by 2008, with stages 3 and 4 completed by 2010.

Heavy Vehicles

With the high percentage of heavy vehicles currently using the study route it is important to consider the future trends of these road users. For this report the forestry and dairy industry were approached, to discuss their expected use of the route over the next twenty years.

Key responses and issues raised by forestry include:

- Unless the forestry customer base expands significantly, for example new sawmills are built or existing plants increase capacity/output, not much of an increase in logging trucks is expected on the study route. Forecasts of supply and demand, and subsequent transport requirements, are still in progress. A nominal increase in logging trucks on the route of say 10% over the twenty-year period has been quoted
- The proposed ETA could provide alternative access to customers on Centennial Drive, negating the need to use Broadlands Road for logging trucks from the southeast.
- Forestry would be interested in exploring the possibility of upgrading the crossing of Broadlands Road TDC from Broadlands Forest into Tiriti Road (approximate RP 23,800) to a standard capable of accepting the large off-highway double unit they employ in their off-road operations.

Key responses and issues raised by the dairy industry include:

- The number of dairy tankers using the study route is unlikely to change significantly over the next twenty years or so.
- A major factor that could have a bearing on dairy movements in the area is profitability in the dairy industry, which may encourage some farmers to change from dry stock farming to dairy farming if profitability improves. However, in the Taupo catchment this will be discouraged as part of efforts to protect Lake Taupo.

These responses suggest the numbers of heavy vehicles using the study route can be expected to remain relatively constant. A conservative assumption would be to assume the current proportion of heavy vehicles in the traffic stream, approximately 15-20%, will remain constant.

There is a possibility that the proportion of heavy vehicles on the initial section of Broadlands Road TDC may decrease slightly when the ETA is complete.

Racetrack Development

The proposed redevelopment of Centennial Park racetrack will generate short-term traffic increases on the study route, particularly during large national or international events. Appendix 5 of this report includes excerpts from Opus (2003) that assesses traffic effects, and proposed traffic management strategies. Traffic during these events will be managed according to Traffic Management Plans (TMP's) developed by organisers. Due to the relatively short and infrequent nature of large events, the effect on the study route overall is considered to be minor, if event traffic is managed properly.

Traffic Projections

In projecting the future traffic on the study route, we have used the Taupo traffic model and population growth predictions to make the assumptions regarding quantitative traffic volume changes listed in Table 8 below:

Subsection	Annual Growth Rate 2004-2008	Change 2008	Annual Growth Rate 2008-2010	Change 2010	Annual Growth Rate 2010-2024
Settlers Road	3%	8%	3%	-5%	3%
Reporoa Road	3%	-	3%	-	3%
Broadlands Road RDC	3%	8%	3%	-5%	3%
Broadlands Road TDC	3%	8%	3%	-5%	3%
Miro Street	3%	-5%	3%	-	3%
Crown Road	3%	5%	3%	-	3%

Table 8. Traffic volume change assumptions

Table 9 and Figure 3 show the estimated future traffic volumes on the study route.

Subsection	Projected Traffic Volume	
	2014	**2024**
Settlers Road	1,724	2,114
Reporoa Road	1,428	1,743
Broadlands Road RDC	2,453	3,008
Broadlands Road TDC	3,315	4,065
Miro Street (Northern end)	5,096	6,296
Miro Street (Southern end)	5,860	7,240
Crown Road (Miro-Invergarry)	4,990	6,070
Crown Road (Invergarry-SH5)	2,772	3,372

Table 9. Estimated future traffic volumes

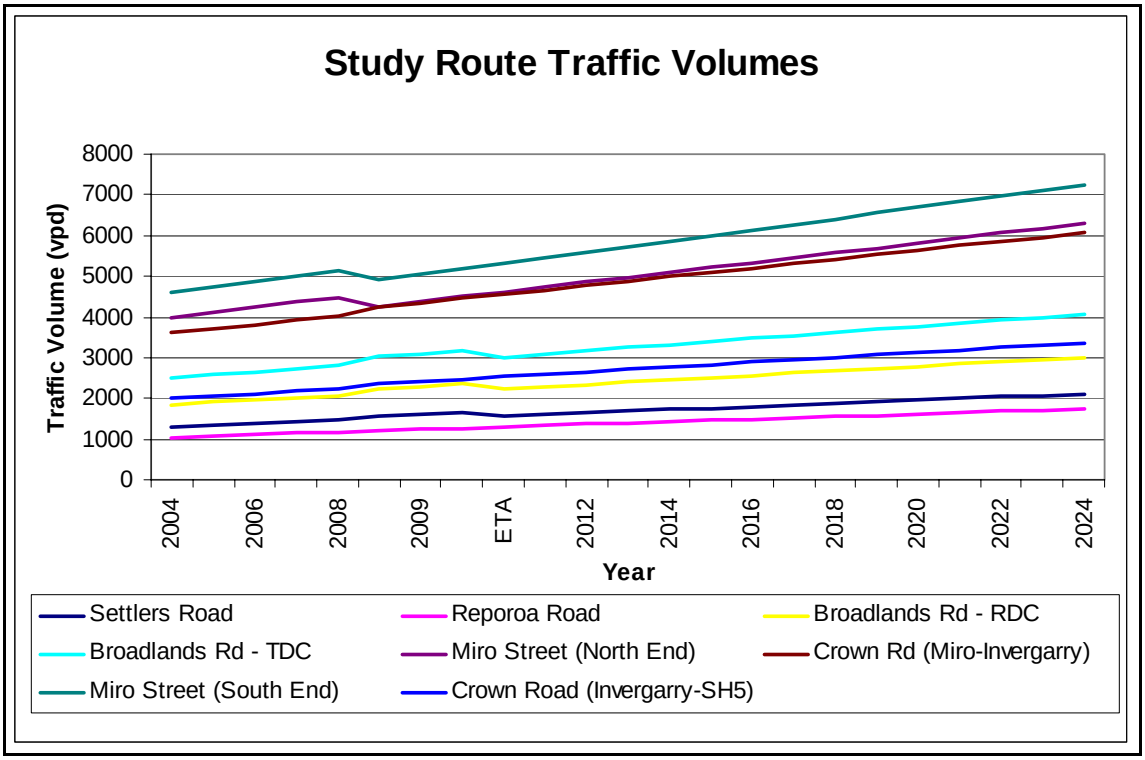


Figure 3. Estimated traffic volumes

Side Roads

Traffic volumes on many of the side roads on the study route will not experience significant increases over the next 20 years. Increases will generally be dependent on the extent of development along each side road.

Table 10 estimates side road traffic volume growth over the next 20 years to 2024. Many of the side roads are expected to have minimal development along them in this period; a nominal arithmetic traffic growth rate of 1% has been applied to these roads.

Side Road	Growth Rate (%/year)	2014 Traffic Volume (vpd)	2024 Traffic Volume (vpd)
Invergarry Road	2%	2413	2790
Manuka Street	2%	1165	1347
Matai Street	2%	1379	1601
Tauhara Road	3%	5746	7014
Centennial Drive	2%	925	1074
View Road	1%	286	311
White Road	1%	283	308
River Road	2%	483	562
Tiverton Downs Road	1%	178	194
Ohaaki Road	1%	403	438
Allen Road	1%	149	161
Earle Road	1%	159	173
Vaile Road	1%	90	98
East Road	1%	296	323
Strathmore Road	1%	484	528
Homestead Road	1%	324	353
Birch Road	2%	603	701
Wharepapa Road	1%	53	58
Loop Road	1%	80	87

Table 10. Side road traffic growth

Cyclists

Broadlands Road is used heavily as a training route by cyclists, in particular from January-March in the lead-up to the NZ Ironman race in early March, and to some extent in October-November as a lead-up to the "Round the Lake" cycle race in late November.

With TDC pledging financial support to the NZ Ironman race until at least 2007[1] the race is expected to stay in the area until at least then. However, after this there is no guarantee the race will stay in Taupo, and will depend on the commitment the TDC and community make to host the event. Since moving from Auckland to Taupo six years ago, competitor numbers have more than doubled for the event, and organisers of the 2004 event had to cap the entry numbers. In the future competitor numbers may be further increased if the facilities can cope[2]. Therefore we expect the number of cyclists using Broadlands Road to increase as competitor numbers increase.

The main issue for cyclists is safety. The number of heavy vehicles using the road, combined with the relatively narrow seal width, creates a potential hazard for cyclists. However, there is currently no reported crash problem involving cyclists on the study route. In the last five years there was one cycle versus vehicle crash, where a van failed to

[1] Source: TDC website, http://www.taupo.govt.nz

[2] Source: New Zealand Ironman website, http://www.ironman.co.nz

give way to a cyclist at the Broadlands Road/Centennial Drive intersection in February 2000, resulting in serious injuries to the cyclist.

Surface texture was also identified as an issue for cyclists, where the preference is for a smoother surface. However, in high-speed rural areas larger chip sizes are, and will continue to be, used as these provide a safe travelling surface for vehicles, particularly in wet conditions. Surface treatments are available to improve texture on cycle lanes, but these are generally more expensive and therefore limited by budgetary constraints.

One way of reducing the hazard for cyclists is to separate them as much as possible from the traffic stream. Good-quality sealed shoulders, such as that already existing on the western side of Broadlands Road between Miro Street and Centennial Drive, could be extended to provide this separation and reduce the potential for serious crashes.

3.2 Road Crashes

3.2.1 Crash History

Road crash data for the study route has been obtained from the Land Transport Safety Authority (LTSA) Crash Analysis System (CAS) database, and analysed for the five-year period 1 July 1998 – 30 June 2003.

Crash locations and severity for this five-year period are shown on the Route Data Sheets in Appendix 1, and the complete crash list is given in Appendix 6. During this period, a total of 70 crashes were recorded on the study route, including 2 fatal, 5 serious injury, 16 minor injury and 47 non-injury crashes.

Peer Group Data

Crash statistics for the study route have been compared where possible against Peer Group data for similar road types. All Territorial Local Authorities (TLA's) in New Zealand have been grouped into Peer Groups by the LTSA, based on several characteristics including size and urban/rural ratio of road network. Table 11 lists the Peer Group members relevant to this study.

Peer Group C	**Peer Group D**	
Rotorua	**Taupo**	South Waikato
Gisborne	Ashburton	Southland
Hastings	Far North	Tasman
Kapiti Coast	Franklin	Thames-Coromandel
New Plymouth	Horowhenua	Waikato
Porirua	Masterton	Waimakariri
Timaru	Matamata-Piako	Waipa
Upper Hutt	Rodney	Waitaki
Wanganui	Selwyn	Western BOP
Whangarei	South Taranaki	Whakatane

Table 11. LTSA - Peer group members

LTSA publish Road Safety Reports annually for each TLA that compares local road crash statistics with Peer Group and national figures. The most recent Road Safety Reports for RDC and TDC, for the five-year period 1998-2002, have been obtained for comparison with study route crashes.

Crash Rates

Transfund (2002) outlines a method for calculating typical mid-block injury crash rates for any particular length of road, which takes into account:

- Traffic volumes
- Road length
- Road width
- Terrain type

This typical crash rate is the number of mid-block injury crashes that can be expected on a road, given in reported injury crashes/year. Comparing this number with actual reported mid-block injury crashes gives an indication of the relative safety of a road.

Table 12 compares reported midblock injury crash rates on the study route with typical rates as calculated using the Transfund method. Details of the calculation are given in Appendix 6 of this report.

Subsection	Length (km)	Average ADT (vpd)	Midblock Injury Crash Rate (injury crashes/year)	Typical Crash Rate (injury crashes/year)
Settlers Road	6.130	1,300	0.80	0.51
Reporoa Road	2.252	1,050	0	0.15
Broadlands Road RDC	13.800	1,850	0.40	1.64
Broadlands Road TDC	24.522	2,500	2.20	4.06
Miro Street	1.053	4,300	0.20	0.21
Crown Road	1.733	3,600	0.20	0.29

Table 12. Midblock injury crash rate comparison

The midblock injury crash rates for all subsections except Settlers Road are comparable or lower than the typical injury crash rate for roads with similar width and traffic volume characteristics. Settlers Road has a midblock injury crash rate 60% higher than typical.

Severity

The graphs and Table 13, Table 14 and Table 15 below show the severity of injury crashes on each subsection in terms of the road type (Rotorua Rural, Taupo Rural and Taupo Urban), and gives a comparison with local and LTSA peer group crash statistics. Reporoa Road is not included as no injury crashes were reported during the five-year analysis period.

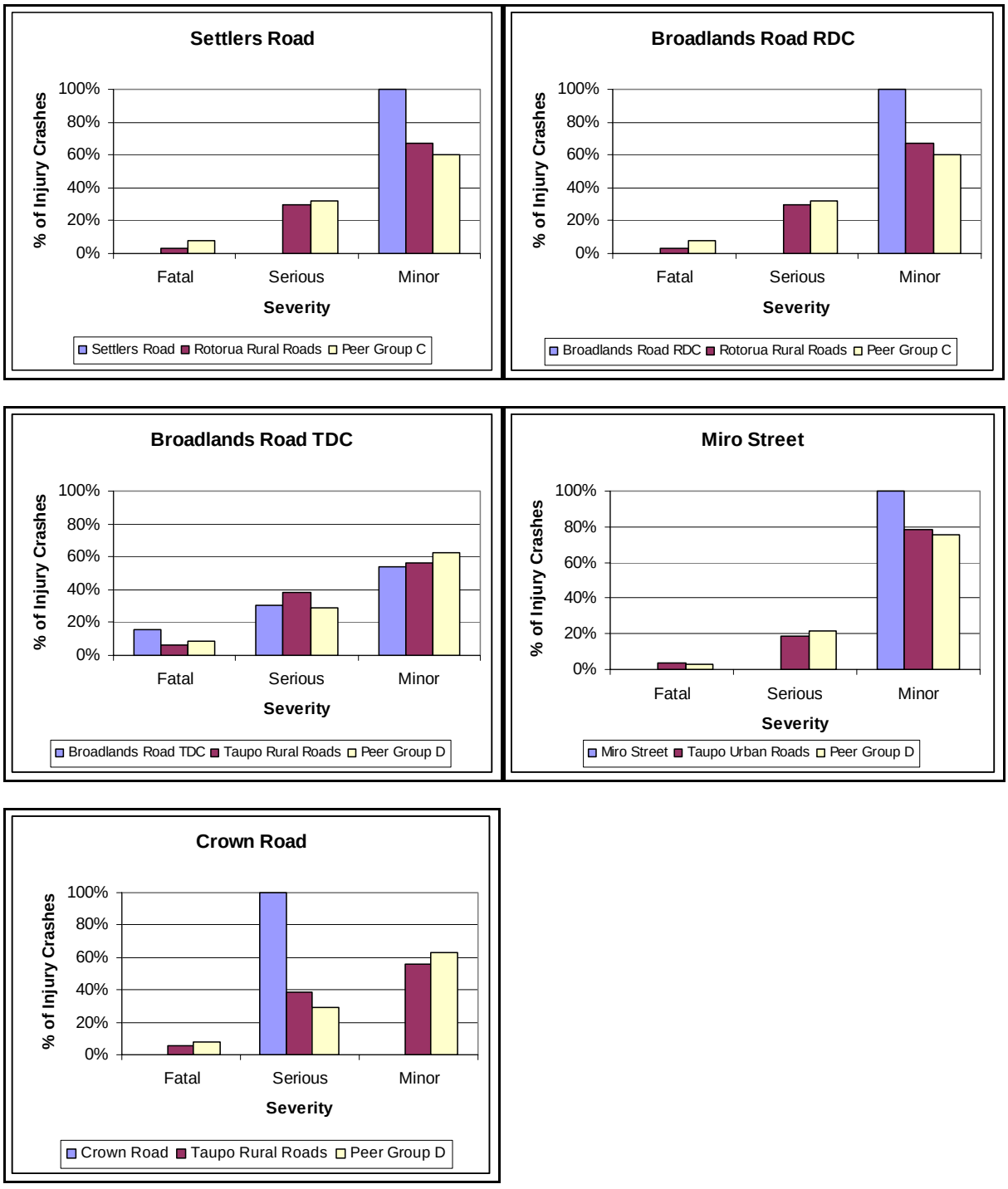


Figure 4. Severity of injury crashes on study route

Rotorua Rural	Subsection				Rotorua Rural Local Roads 1998-2002	Peer Group C 1998-2002
	Settlers Road		Broadlands Road			
	No.	%	No.	%		
Fatal	0	0%	0	0%	3%	8%
Serious	0	0%	0	0%	30%	32%
Minor	5	100%	3	100%	67%	60%

Table 13. Injury crashes in Rotorua Rural study route area

Taupo Rural	Subsection				Taupo Rural Local Roads 1998-2002	Peer Group D 1998-2002
	Broadlands Road		Crown Road			
	No.	%	No.	%		
Fatal	2	15%	0	0%	6%	8%
Serious	4	31%	1	100%	38%	29%
Minor	7	54%	0	0%	56%	63%

Table 14. Injury crashes in Taupo Rural study route area

Taupo Urban	Subsection		Local Roads 1998-2002	Peer Group D 1998-2002
	Miro Street			
	No.	%		
Fatal	0	0%	3%	3%
Serious	0	0%	19%	22%
Minor	1	100%	78%	75%

Table 15. Injury crashes in Taupo Urban study route area

Broadlands Road – TDC (Subsection 4) has a relatively high severity of crashes compared with local and peer group statistics.

Movement Types

Crashes on the study route have been compared with peer group and national statistics for the crash movement type to identify any crash trends. The following graphs detail this comparison.

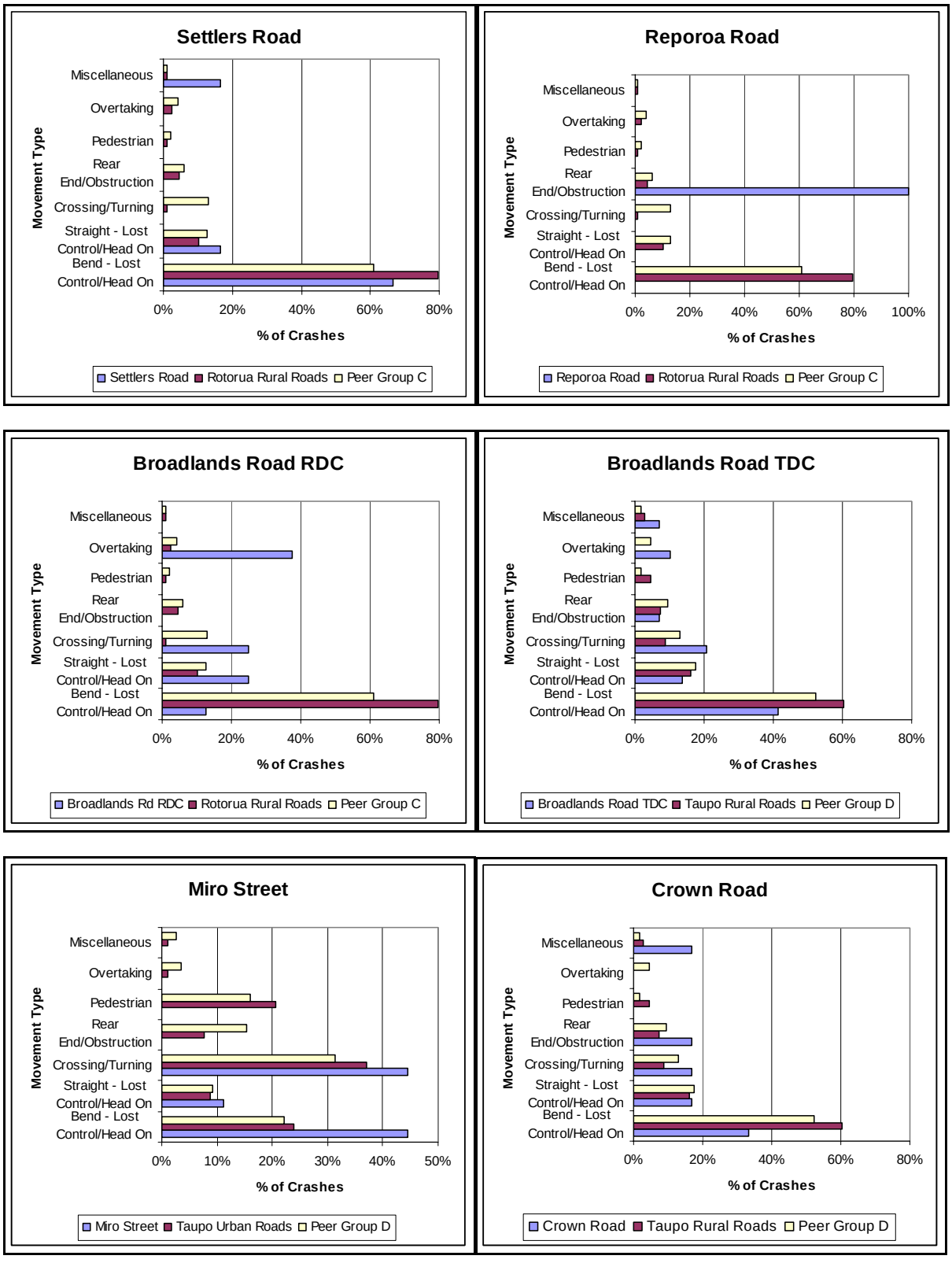


Figure 5. Crash movement types on study route subsections

The tables below consider movement types for the subsections combined into their road types for each district.

Movement Type	Number	%	Rotorua Rural Local Roads	Peer Group C
Bend - Lost Control/Head On	13	48%	80%	61%
Straight - Lost Control/Head On	5	19%	10%	13%
Crossing/Turning	2	7%	1%	13%
Rear End/Obstruction	1	4%	5%	6%
Pedestrian	0	0%	1%	2%
Overtaking	3	11%	2%	4%
Miscellaneous	3	11%	1%	1%
Total	27	100%	100%	100%

Table 16. Rotorua Rural (Settlers Road, Reporoa Road and Broadlands Road RDC) crash movements

Movement Type	Number	%	Taupo Rural Local Roads	Peer Group D
Bend - Lost Control/Head On	14	40%	60%	52%
Straight - Lost Control/Head On	5	14%	16%	18%
Crossing/Turning	7	20%	9%	13%
Rear End/Obstruction	3	9%	7%	9%
Pedestrian	0	0%	4%	2%
Overtaking	3	9%	0%	5%
Miscellaneous	3	9%	3%	2%
Total	35	100%	100%	100%

Table 17. Taupo Rural (Broadlands Road TDC, Crown Road) crash movements

Movement Type	Number	%	Taupo Rural Local Roads	Peer Group D
Bend - Lost Control/Head On	4	44%	24%	22%
Straight - Lost Control/Head On	1	11%	9%	9%
Crossing/Turning	4	44%	37%	31%
Rear End/Obstruction	0	0%	8%	15%
Pedestrian	0	0%	21%	16%
Overtaking	0	0%	1%	4%
Miscellaneous	0	0%	1%	3%
Total	9	100%	100%	100%

Table 18. Taupo Urban (Miro Street) crash movements

Broadlands Road RDC has a relatively low proportion of bend – loss of control/head on type crashes, which will in part be due to the straight, flat nature of the road with relatively few curves.

Broadlands Road RDC and TDC are both over-represented in overtaking type crashes compared with peer group and national statistics.

Weather

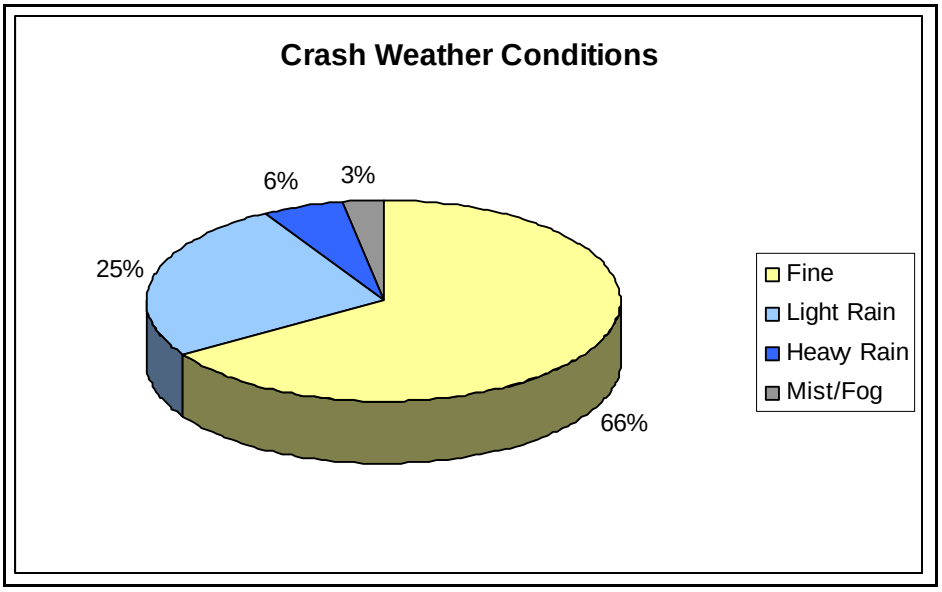
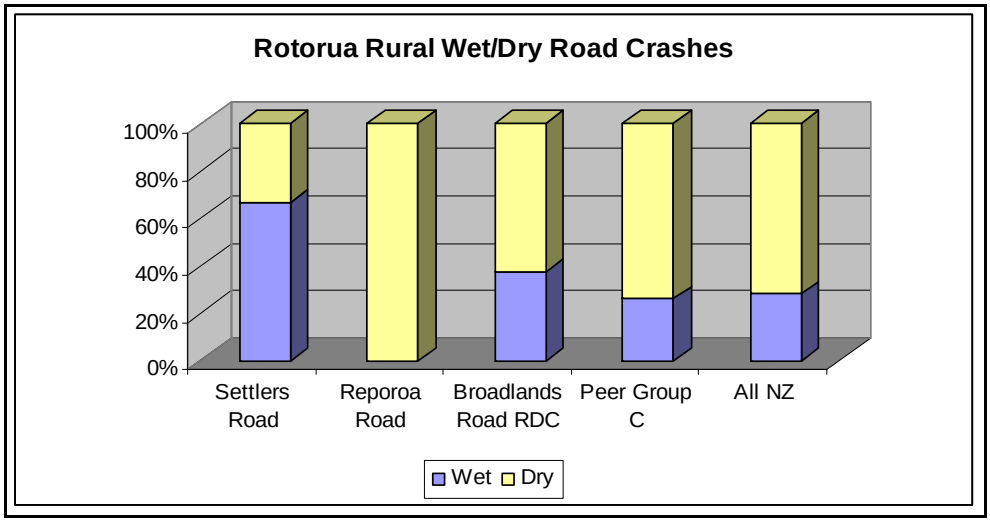


Figure 6. Crash weather conditions

Figure 6 shows that most crashes on the study route occurred in fine weather conditions.

Wet Road Crashes

The wetness of the road in reported crashes has been compared with peer group and national statistics, separated into categories – Rotorua Rural, Taupo Rural and Taupo Urban. This comparison is shown in the graphs below.



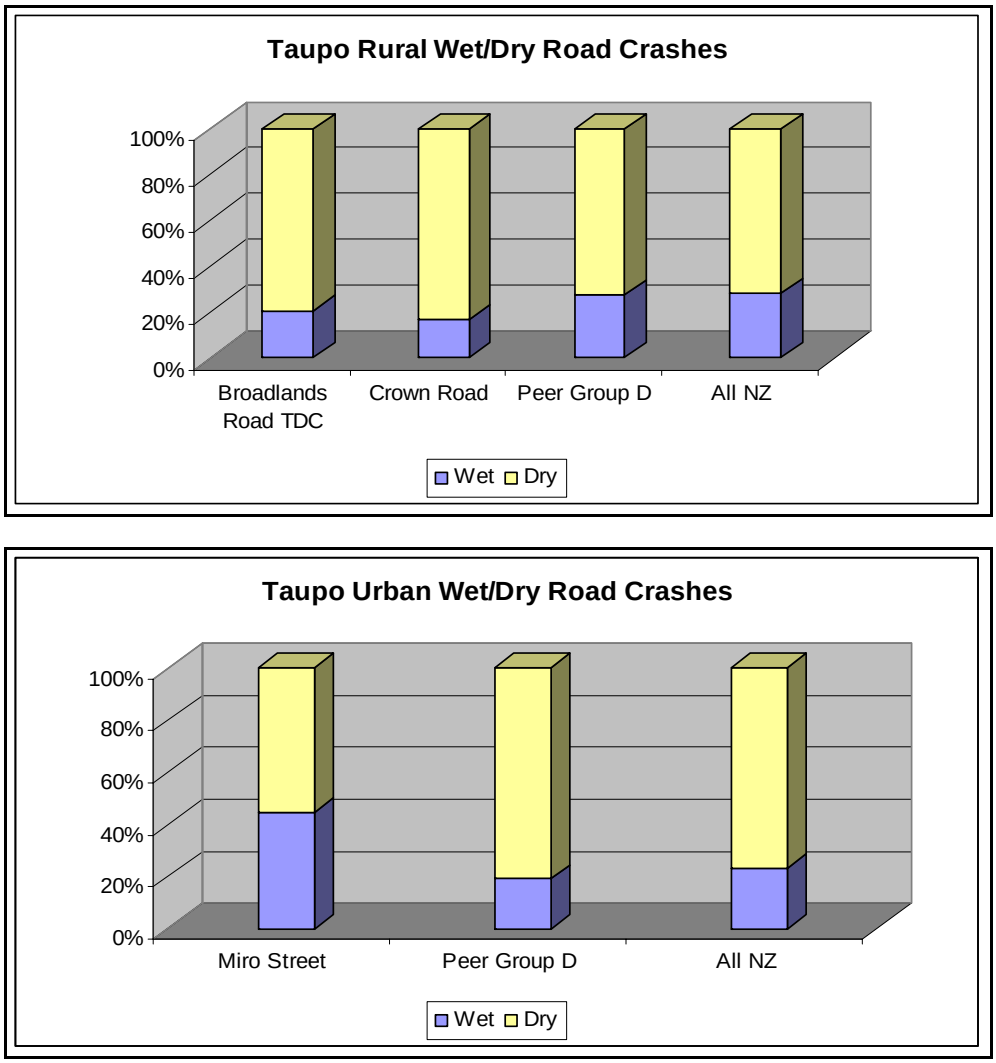


Figure 7. Wet road crashes on each subsection

Analysis of the road wetness for crashes on each subsection shows the following:

- 67% of the 18 reported crashes on Settlers Road occurred on a wet road surface, far greater than comparable peer group roads and national statistics
- Broadlands Road RDC has a higher proportion of crashes occurring on wet roads compared with peer group and national statistics
- Broadlands Road TDC and Crown Road wet road crashes are below peer group and national figures
- Miro Street has a higher proportion of wet road crashes than comparable peer group and national statistics
- Rutting of the pavement, and insufficient skid resistance and surface texture, on sections of the study route could be contributing to the relatively high rate of wet road crashes on some sections.

Crashes in Darkness

Figure 8 below compares the proportion of crashes on the study route occurring in darkness with the respective peer group averages.

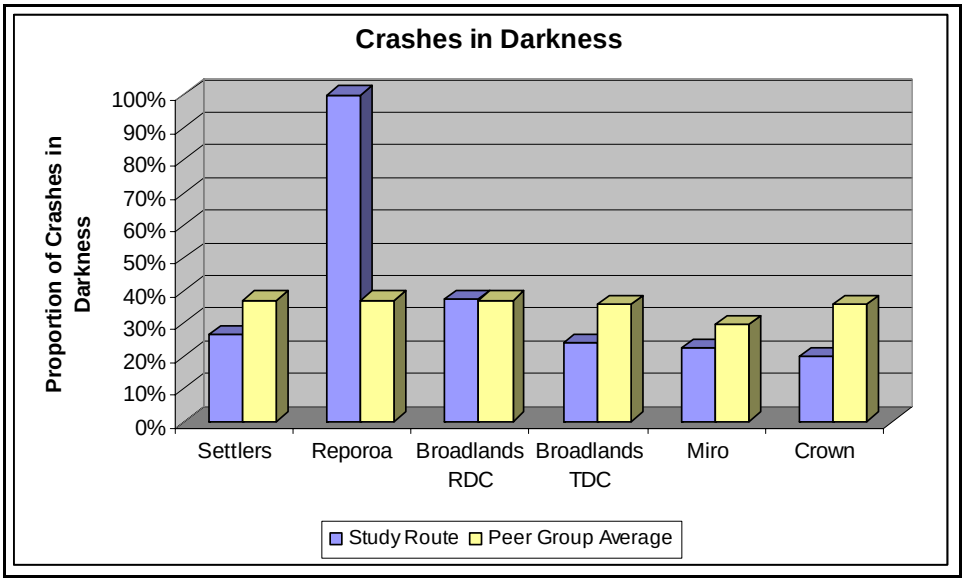


Figure 8. Crashes in darkness

The proportion of crashes on the study route occurring in darkness is generally below the respective peer group averages. This suggests there is currently adequate reflective delineation on the route.

It should be noted that there was only one crash recorded on Reporoa Road during the five-year analysis period. While this crash occurred in darkness, the sample size is too small to draw any relevant conclusions for this road.

3.2.2 Black Spots

The LTSA definition of a crash black spot is "A site where 5 or more crashes OR 3 or more SERIOUS or FATAL crashes have been recorded in a 5-year period, within a 510m DIAMETER for RURAL areas, or a 70m DIAMETER for URBAN areas".

We have identified two black spots on the study route as shown in Figure 9, and detailed in Table 19 below:

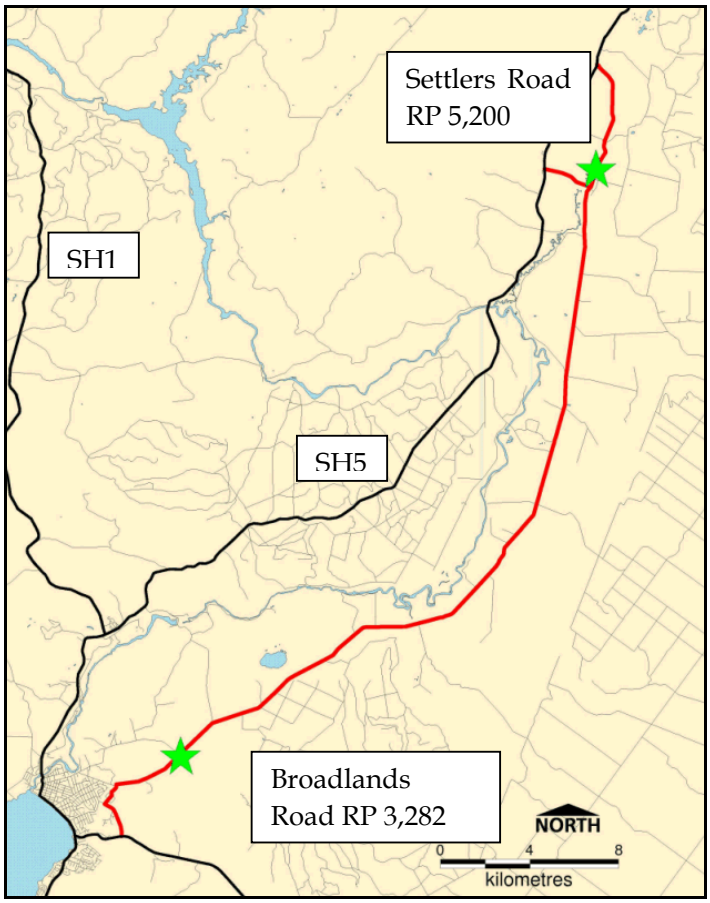


Figure 9. Crash black spot locations

Road Name	Location	Reported Crashes July 1998-June 2003
Settlers Road	Reverse Curve at RP 5,200m	5 Non-injury
Broadlands Road TDC	RP 3,282m Centennial Dr Intersection	2 Serious 3 Non-injury

Table 19. Study route blackspots

The Settlers Road black spot mainly involved loss of control type crashes, while the Broadlands Road black spot involved crossing/turning movements in the serious injury crashes.

As outlined in Section 9.4 of this report, the Settlers Road blackspot has been identified for a possible realignment to remove the tight reverse curve.

3.2.3 Crash Summary

- In the five-year period 1 July 1998 – 30 June 2003 there were 71 crashes on the study route – 2 fatal, 5 serious injury, 16 minor injury and the balance non-injury.

- One serious injury crash involved a cyclist.
- Broadlands Road TDC has a relatively high severity of crashes compared with local and peer group statistics.
- Settlers Road has a mid-block injury crash rate 60% higher than the typical rate for similar roads. This is based on a total of 4 injury crashes in the five-year period.
- Overtaking crashes are over-represented on both sections of Broadlands Road compared with local and peer group statistics
- Settlers Road has a very high proportion of wet road crashes (67%) compared with peer group (26%) and national (28%) statistics for rural roads.

3.2.4 Future Upgrading Effects

Based on possible upgrades identified in Section 9 of this report, we expect that upgrading will have the following effects on crashes on the study route:

- Localized seal widening at intersections will reduce potential conflict between turning and through traffic and improve safety at these locations, especially with increasing traffic volumes.
- Seal widening will help to reduce the occurrence of head-on, loss-of-control, and overtaking type crashes.
- Curve easing and improvements will improve the ability of vehicles to safely traverse corners.
- Concentrating rehabilitation works on pavements in relatively poor condition, that is, in areas with significant rutting and low skid resistance, will reduce overtaking and loss-of-control type crashes, and help to reduce wet road crashes particularly on Settlers Road.

3.3 Level of Service

3.3.1 Definition

Level of Service (LOS) describes the quality of service provided by the length of road. In general terms, as the amount of traffic increases, if the road remains unchanged the level of service decreases. Six grades of LOS have been identified, as given in Austroads, Part 2 (1988):

Level of Service	Description
A	Free Flow – Individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre is excellent.
B	Stable Flow – reasonable freedom to manoeuvre, although the general level of comfort and convenience is a little less than Level of Service A.
C	Stable Flow – restricted freedom to manoeuvre and the general level of comfort and convenience declines noticeably at this level.
D	Close to Limit of Stable Flow, approaching unstable flow, little control over speed and manoeuvres.
E	Volumes are at or close to capacity. No freedom to select desired speed or manoeuvre. Unstable flow and minor disturbances within the traffic stream will cause breakdown.
F	Forced Flow.

Table 20. Level of Service

For rural roads, the Level of Service is calculated for the **peak hour daily flow** on the road and is dependant on the following factors:

- Sight Distance
- Geometric Alignment
- Seal Width
- Grade of Road
- Directional Split of Traffic Flow (assumed to be 70/30 on rural subsections and 60/40 on urban subsections to reflect the high proportion of commuting one-way traffic in the peak flow).

Austroads (1988) suggests peak hour flows can be assumed to be from 10-15% of the AADT (Average Daily Traffic volume in vehicles per day). We have assumed the peak hour volume is 10% of the AADT.

3.3.2 Standards and Guidelines

Transportation Research Board (1997) states that LOS E corresponds to the maximum flow rate, or capacity, on a road. However for most design or planning purposes LOS D or C are usually used as the maximum capacity because they ensure a more acceptable quality of service to road users.

For this report we have assumed a LOS of C or greater is desirable for the peak hour.

3.3.3 Current and Future Level of Service

Table 21 lists the current and future peak hour LOS on each subsection of the study route based on the current road layout and geometry, and estimated future traffic volumes as given in Section 3.1 of this report. Detailed calculations are included in Appendix 4 of this report.

Road Name	2004 LOS	2014 LOS	2024 LOS
Settlers Road	LOS B	LOS B	LOS B
Reporoa Road	LOS A	LOS A	LOS B
Broadlands Road - RDC	LOS B	LOS B	LOS B
Broadlands Road - TDC	LOS B	LOS C	LOS C
Miro Street	LOS C	LOS C	LOS C
Crown Road	LOS B	LOS C	LOS C

Table 21. Peak hour Level of Service

4 Road Characteristics and Condition

4.1 Introduction

This section outlines the current condition of the study route in terms of pavement, horizontal and vertical geometry, intersections, drainage, structures and passing opportunities. Relevant standards and guidelines have been stated, and where the current condition falls below acceptable standards these areas are identified and improvement proposals are outlined.

The timeframes given for improvement proposals, and corresponding priority levels, are defined below:

Timeframe	Approximate Duration from Present (years)	Priority Level
Short	0-5	High
Medium	5-15	Medium
Long	>15	Low

Table 22. Timeframe definition

These timeframe 'bands' recognize the difficulty in specifying when funding will become available for particular projects. Projects are therefore given a priority level, to be carried out when funding is available.

4.2 Pavement

4.2.1 Seal Width

Standards and Guidelines

Standards have been taken from RDC adopted standards and TDC's Code of Practice for Development of Land.

TLA	Road Type	AADT	Guideline Seal Width (m)
RDC		0 – 250	6.0
		250 – 1,000	7.5
		1,000 – 2,000	8.5
		> 2,000	10.0
TDC	Regional Arterial (Urban)	All	11.0
	Rural Arterial	< 5,000	9.4
	Rural Arterial	> 5,000	10.0

Table 23. Guideline seal width standards

Austroads (1999) provides guidelines for exclusive cycle lane and sealed shoulder width, reproduced in Table 24 below. Exclusive cycle lanes may be appropriate where:

- Bicycle traffic is concentrated;
- An existing or potential significant demand for bicycle travel can be demonstrated;
- It is needed to provide continuity within a bicycle route network;
- A road is carrying or is likely to carry more than 3,000 vehicles per day and/or a significant percentage of heavy vehicles.

As identified in Section 3.1 of this report, a large number of cyclists use Broadlands Road prior to and during events such as the New Zealand Ironman race, and provision of sealed shoulders is appropriate to cater for these road users.

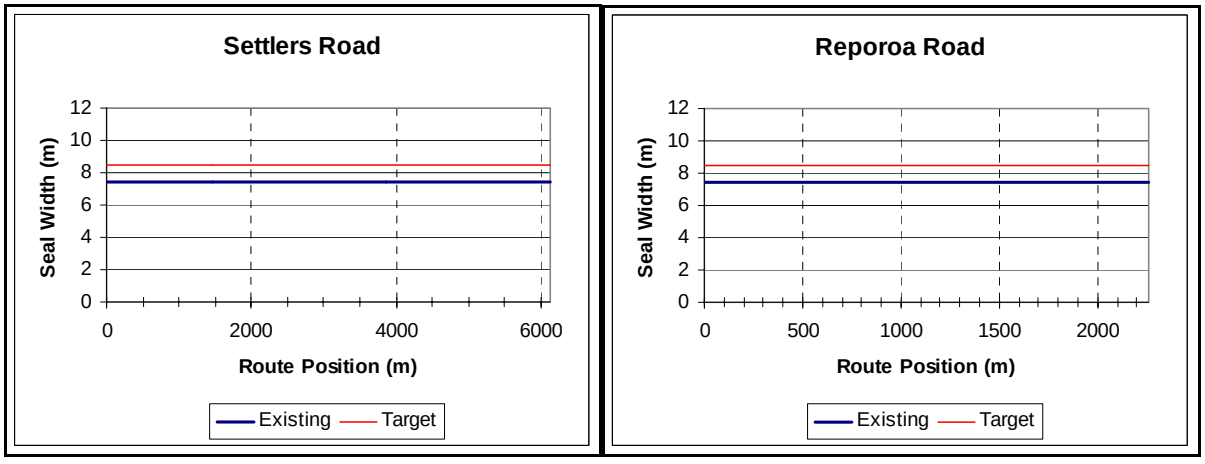
	Lane Width (m)		
Road Speed (km/h)	60	80	100
Desirable	**1.5**	**2.0**	**2.5**
Acceptable Range	1.2-2.5	1.8-2.7	2.0-3.0

Table 24. Austroads bicycle lane and sealed shoulder dimensions

At least 2.0m of sealed shoulder is desirable where the adjacent motor traffic is moving at high speed (100km/h).

Existing Situation

The following data is sourced from RDC and TDC RAMM databases. The consistency of width described is assumed to be indicative of seal widths present rather than completely accurate.



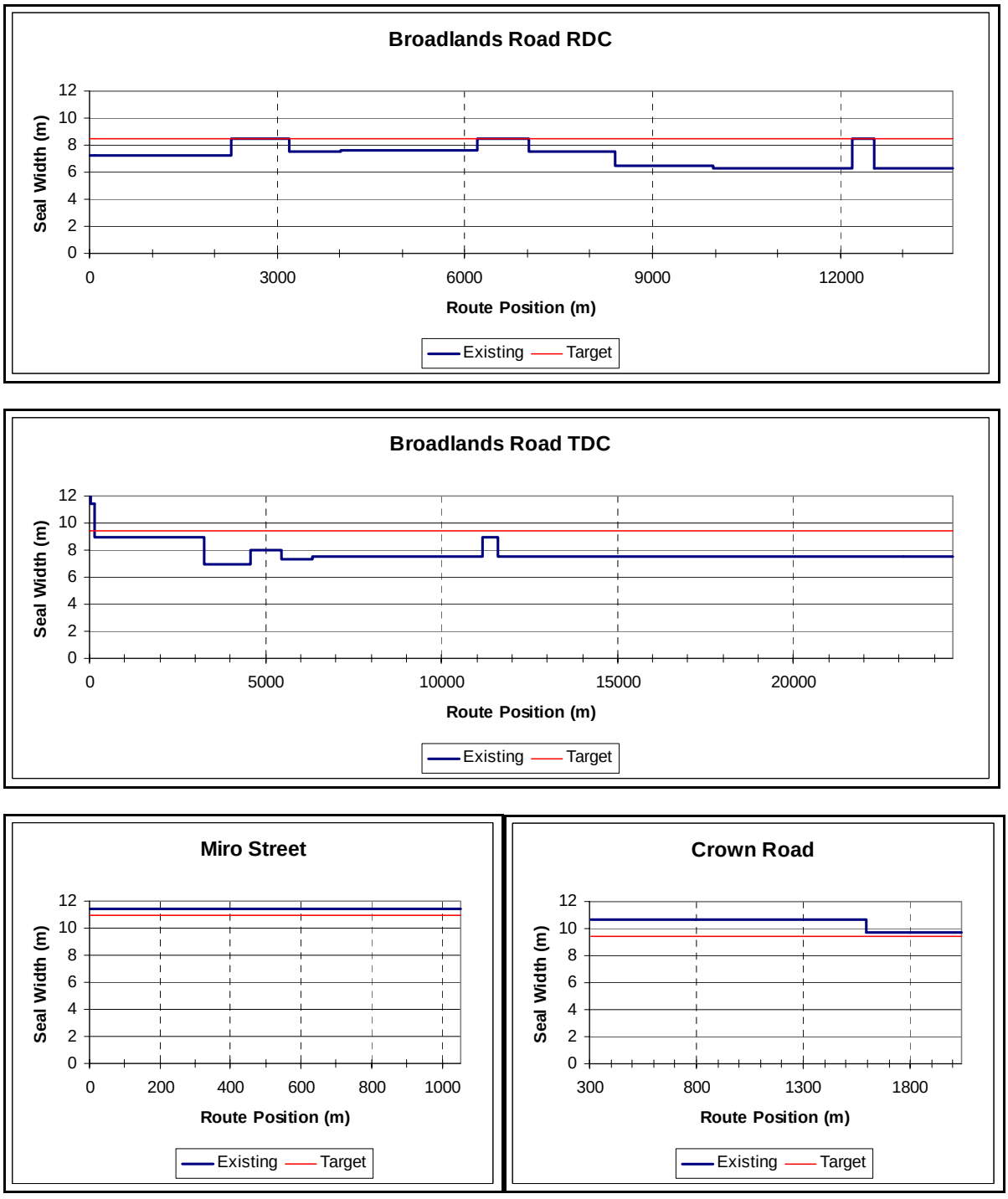


Figure 10. Seal widths on each subsection

Improvement Proposals

Significant lengths of the study route have seal widths below the respective guidelines adopted by RDC and TDC.

A measure of whether having the actual seal width less than the target width is causing problems is to look at the occurrence of loss of control/head on and overtaking-type crashes. Narrow seal widths are generally linked to loss of control/head on type crashes, where out of control vehicles have little or no sealed recovery area in which to regain control, or oncoming vehicles have no space in which to safely avoid out of control vehicles. It is also a factor in overtaking type crashes, where either the overtaking or overtaken vehicle cross the edge of seal and lose control. Austroads, Part 4 (1988) indicates that the occurrence of these types of crashes decreases as pavement widths increase.

As shown in Section 3.2 of this report, the rural sections of the study route do not have especially high proportions of loss of control/head on type crashes. However, increasing the seal width would improve safety and personal security and promote alternative forms of transport, such as cycling.

TDC indicate that funding has been applied for through their long-term plan with Transfund for seal widening works on Broadlands Road, totalling $100K per year for the years 2006/07 to 2010/11. The location of this work has not been specified.

Transfund subsidise cycle lanes, cycleways or increased road shoulder widths, including bridge-widening projects, from a funding category allocated specifically for such projects. Generally to be successful in attracting funding these projects need to be identified in a "current strategy". TDC have a current cycling strategy in place that identifies Broadlands Road as an important cycling route.

Cycle lanes could be constructed in stages, extending the current cycle shoulder on Broadlands Road TDC northwards and replicating this on the opposite shoulder.

"Do-Nothing" Implications

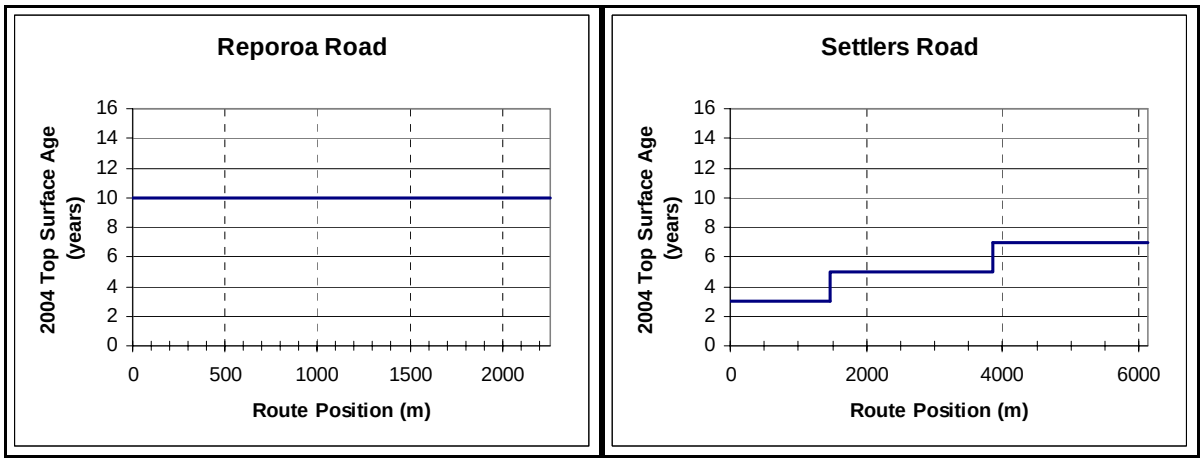
Maintaining the status quo seal width as traffic volumes increase will increase the potential for serious crashes, particularly involving cyclists and/or heavy vehicles. Overtaking and loss of control type crashes will probably continue to be over-represented.

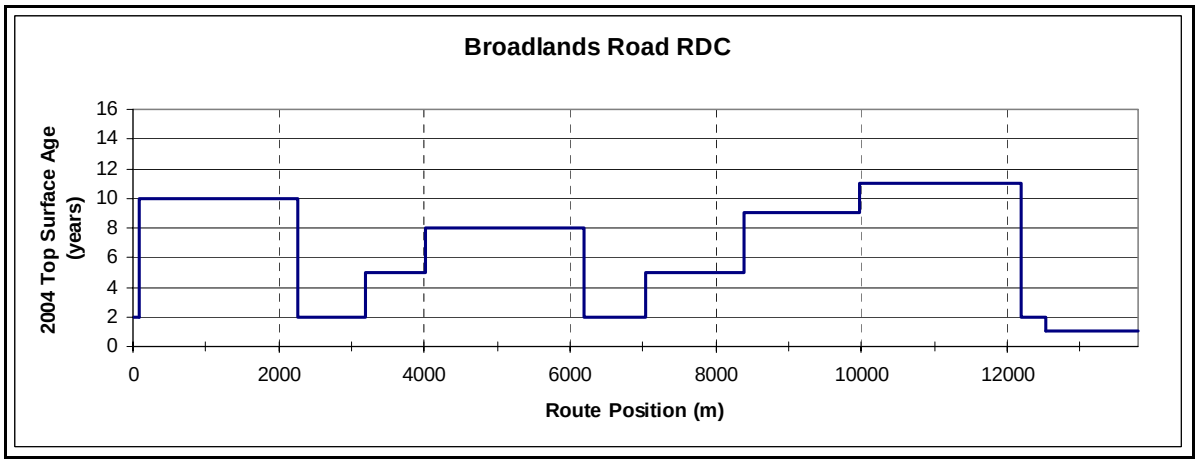
The recommended strategy is to increase seal width on the route, using a two-pronged approach:

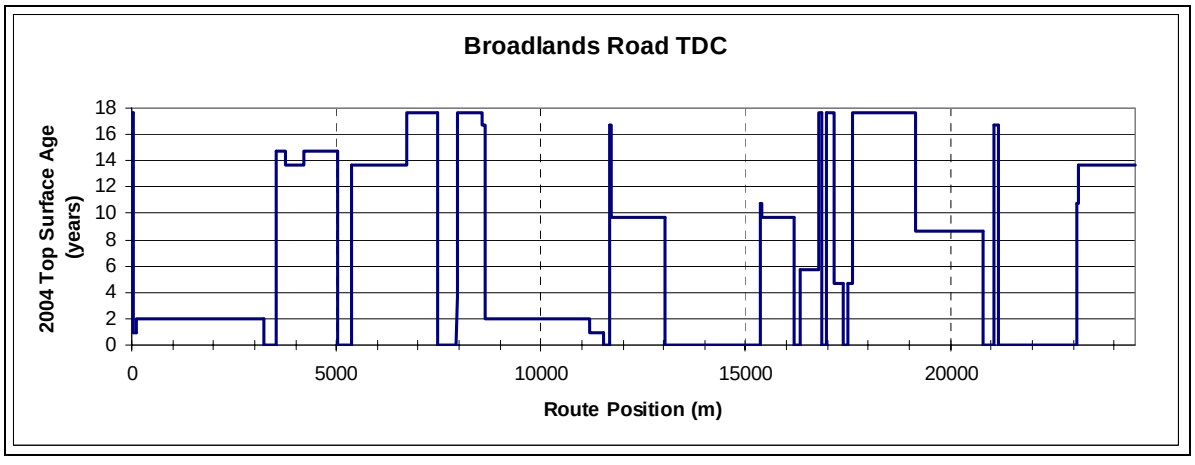
- Widen the seal to guideline standards where possible, in conjunction with reconstruction and rehabilitation works, or large maintenance patching.
- Identify specific projects involving creation of cycleways and/or increased shoulder widths on the route and apply for funding from Transfund's cycling projects budget.

4.2.2 Top Surface Age

Asset Valuation data provided by RDC and TDC gives the approximate age of the top surface on the study route as summarised in the following graphs.


Reporoa Road
2004 Top Surface Age (years)
0
2
4
6
8
10
12
14
16
0
500
1000
1500
2000
Route Position (m)
Settlers Road
2004 Top Surface Age (years)
0
2
4
6
8
10
12
14
16
0
2000
4000
6000
Route Position (m)


Broadlands Road RDC
2004 Top Surface Age (years)
0
2
4
6
8
10
12
14
16
0
2000
4000
6000
8000
10000
12000
Route Position (m)


Broadlands Road TDC
2004 Top Surface Age (years)
0
2
4
6
8
10
12
14
16
18
0
5000
10000
15000
20000
Route Position (m)

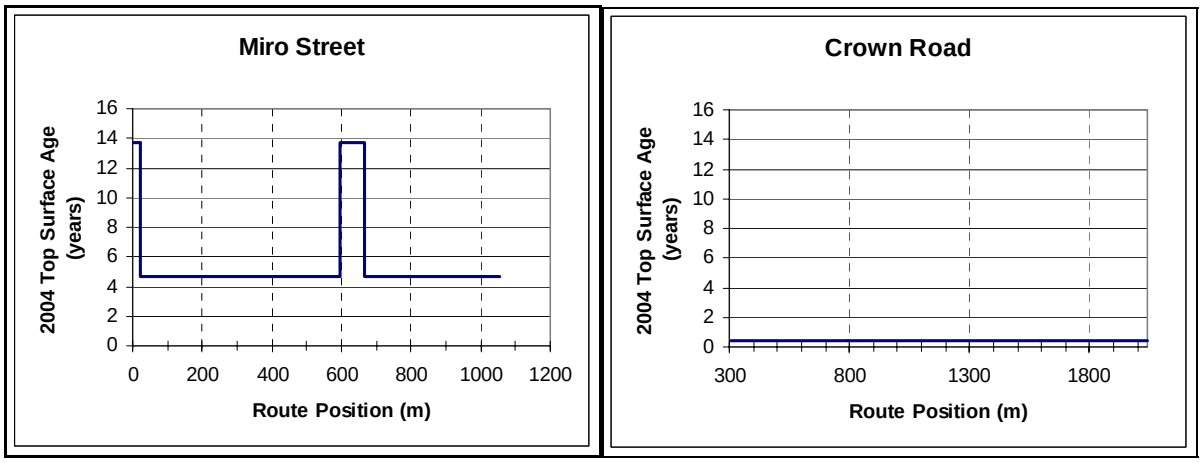


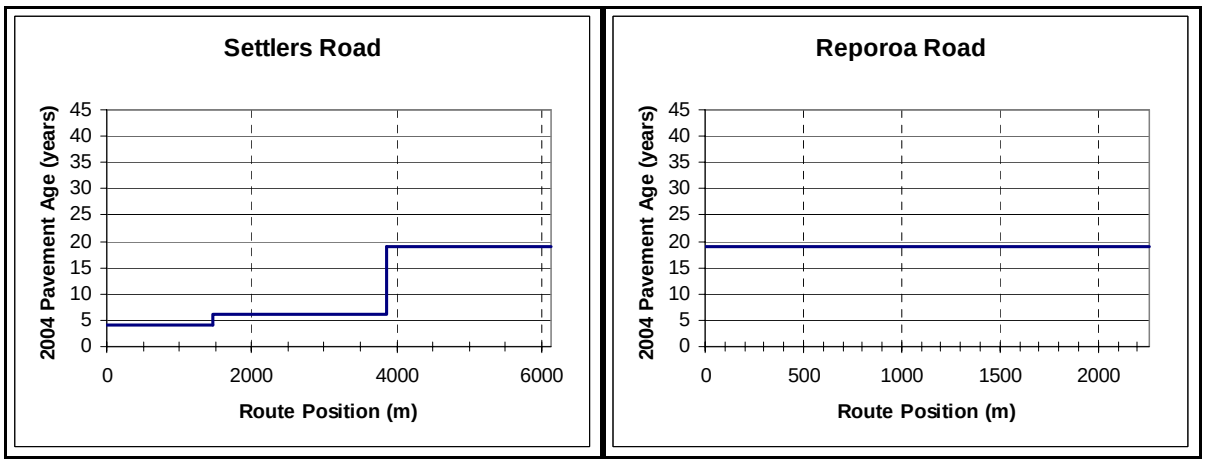
Figure 11. Top surface age

Improvement Proposals

Each Council runs a maintenance programme that involves periodic reseals based on the age and condition of the surface material. In general older sections of seal will require attention first. Maintenance costs are also an indication of areas of seal or pavement that may require attention. Appendix 2 lists timeframes for rehabilitation/renewal works on each section based on these factors.

4.2.3 Pavement Age

Asset Valuation data provided by RDC and TDC gives the approximate pavement age of subsections on the study route.



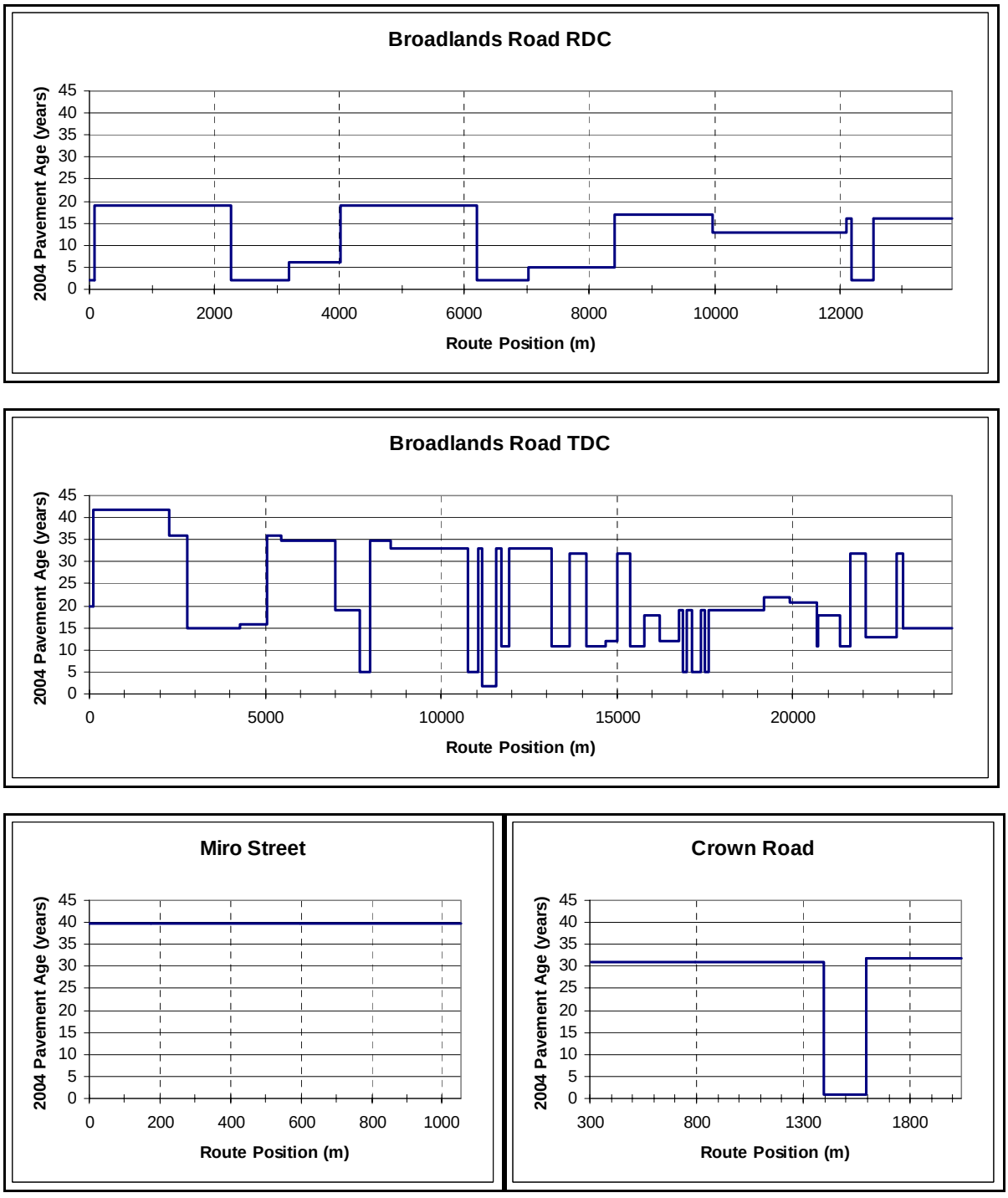


Figure 12. Pavement age

Improvement Proposals

Each Council runs a maintenance programme involving pavement reconstruction and rehabilitation works where the need is identified. Pavement age is one of the main factors

taken into account when prioritising reconstruction works; the other is the pavement condition or performance, which is also related to the maintenance costs for the pavement. Appendix 2 lists timeframes for rehabilitation/renewal works on each section based on these factors.

4.2.4 Roughness

Standards & Guidelines

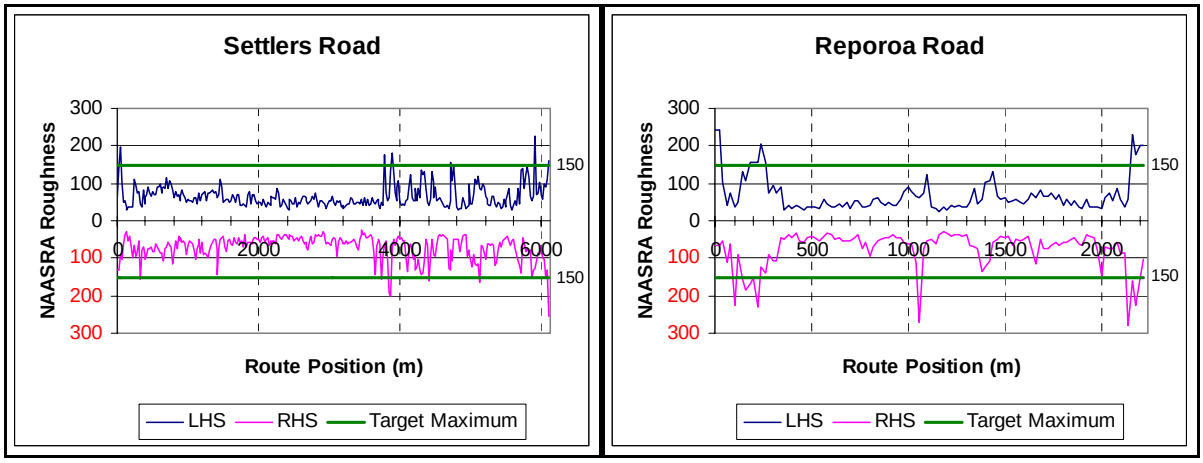
RDC state in their Roading Asset Management Plan that the target level of service is "more than 90% of all roads with 150 NAASRA counts or less".

According to the TDC Roading Asset Management Plan, "TDC's 2003/04 Proposed Level of Service in their Annual Plan states that no more than 20% of the sealed road network will have a NAASRA roughness not greater than 130, and the average of all the sealed network shall be less than 90 NAASRA".

The target maximum roughness levels are shown on the roughness plots below.

Existing Situation

Roughness data was collected in the high-speed data run completed in March and April 2004.



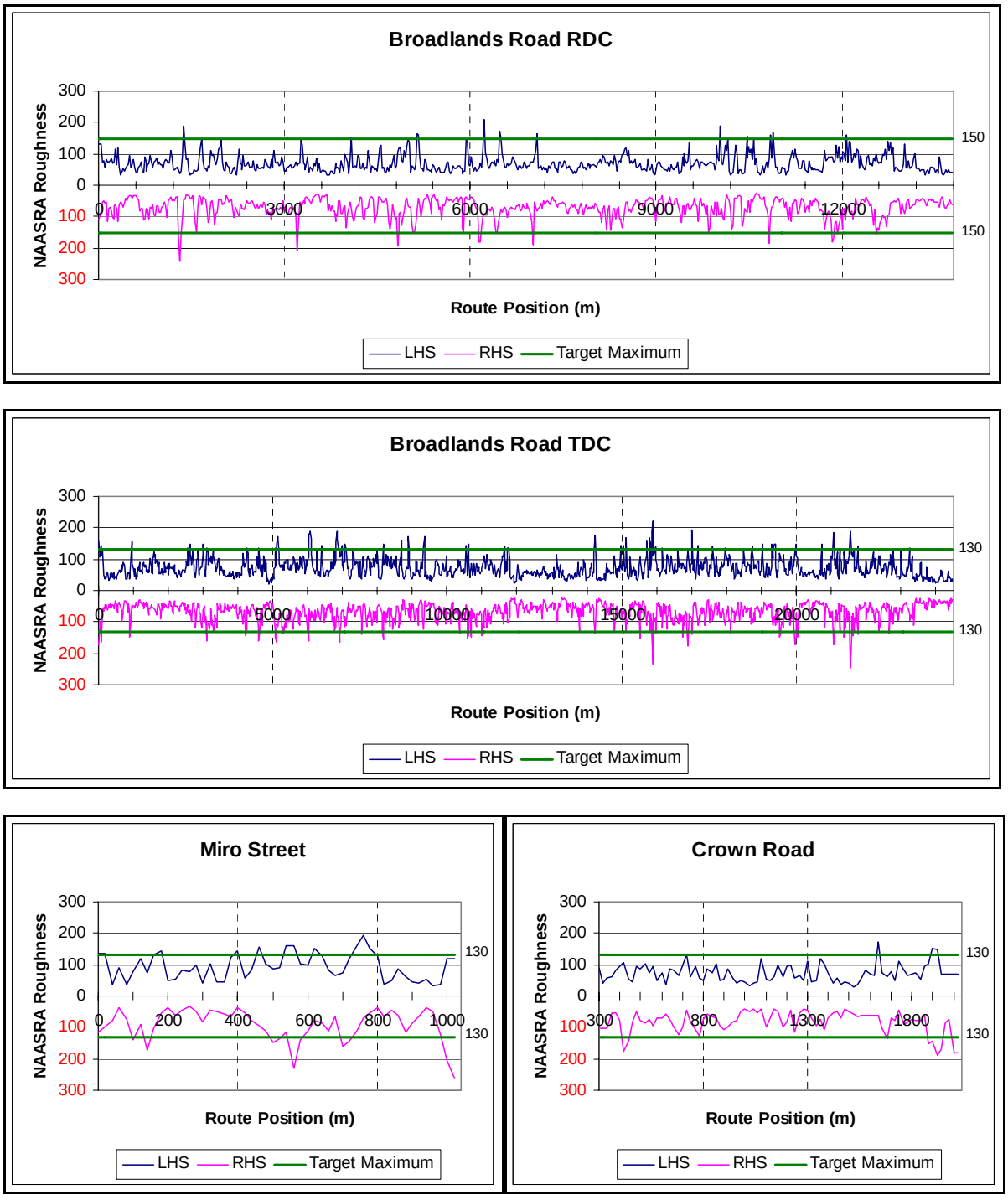


Figure 13. Roughness along each subsection

Table 25 below shows the average roughness for each subsection.

Subsection	Average Roughness (NAASRA)	Roughness Range (NAASRA)	
		Minimum	Maximum
Settlers Road	68	26	253
Reporoa Road	73	26	281
Broadlands Road RDC	71	23	242
Broadlands Road TDC	70	20	248
Miro Street	93	31	262
Crown Road	78	27	188

Table 25. Study route roughness

Improvement Proposals

High roughness levels occur over several isolated sections of the study route, but the roughness of subsections is generally within the target levels specified, indicating current maintenance practices are generally achieving the desired outcome in terms of roughness levels.

Table 26 lists portions of pavement where roughness levels are above target levels for a length of at least 100m. The proposed timeframe of pavement rehabilitation, based on the prioritised programme identified in Appendix 2 of this report, is also given.

Subsection	Route Position (m)	Lane	Average Roughness	Rehab Timeframe
Reporoa Road	180-280	Both	156	Medium
Broadlands Road TDC	19,960-20,080	Right	140	Medium
	15,800-15,980	Left	141	Short
	19,320-19,420	Left	135	Short

Table 26. Lengths of pavement with high roughness

4.2.5 Rutting

Standards and Guidelines

Transit (2002) defines rutting bin limits, reproduced in Table 27 below.

Bin	Rut Depth (mm)
1	10-19
2	20-29
3	30-39
4	40-49
5	50-59
6	60-100
7	> 100

Table 27. Rutting bin limits

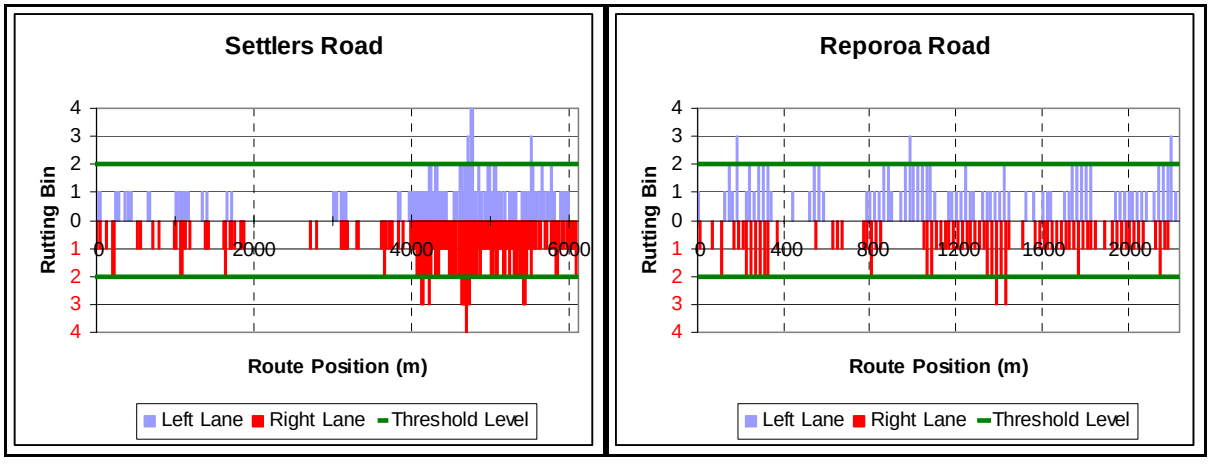
TDC's Roading Asset Management Plan states the target level of service in terms of wheel path rutting is to have less than or equal to 2% of the network with rutting greater than 30mm (bin 3 or higher). RDC does not give a target level of service in their Roading Asset Management Plan.

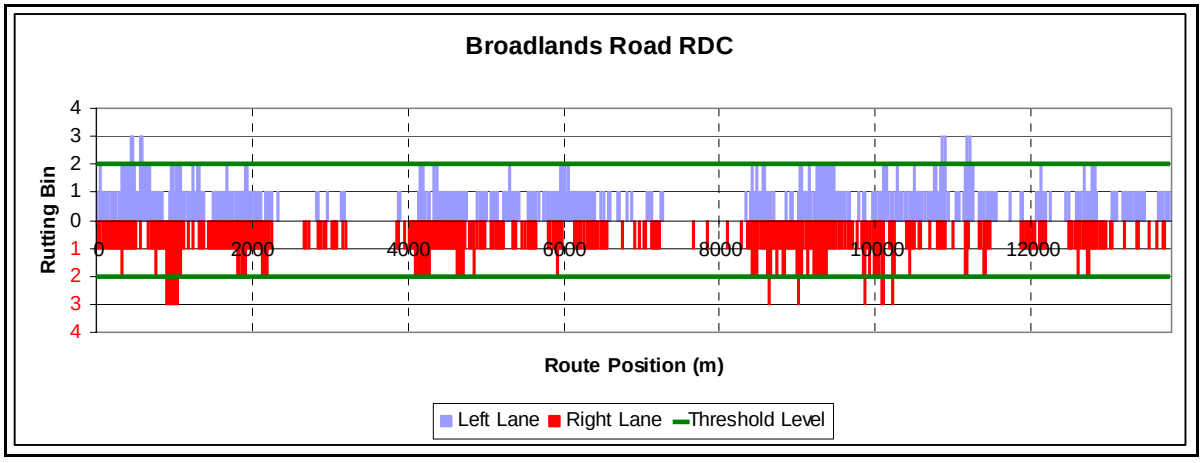
Rutting > 30mm has been used as the threshold level in this report.

Existing Situation

Rutting affects drainage of the pavement when water is unable to runoff the road surface, and pools in the ruts. This creates a potential safety hazard with aquaplaning in wet conditions, and reduces the passing sight distance for vehicles following heavy vehicles, which can result in driver frustration, as drivers are unable to safely perform passing manoeuvres and may attempt more reckless manoeuvres.

Rutting on each subsection of the study route was measured during the high-speed data collection in early 2004. The data collected has been grouped into rutting 'bins', as outlined in Transit (2002) and detailed below. The graphs below show the rutting in terms of 'bins' on the study route.





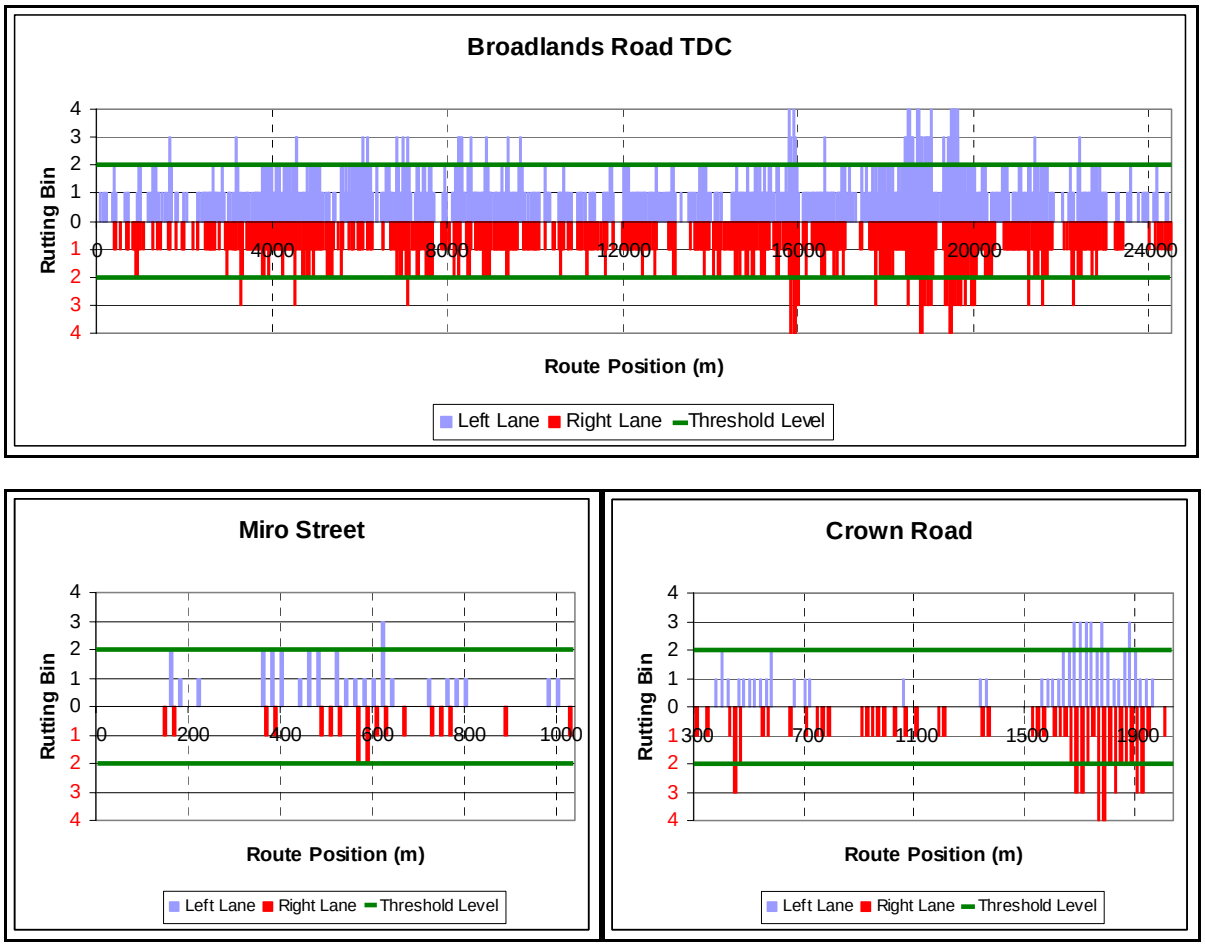


Figure 14. Rutting on each subsection

Settlers Road from RP 0-4,000 demonstrates the effectiveness of pavement rehabilitation on managing rutting. This section was last reconstructed between 1998-2000, while the final section of Settlers Road, from RP 4,000-6,130, was last reconstructed in 1985. This final section shows significantly more rutting than the first section.

Subsequent resurfacing on Crown Road included two-coat sealing in wheel ruts, which has resulted in a minor improvement. The final section of Crown Road, where rutting is most prevalent, will essentially be bypassed by the East Taupo Arterial when this is constructed.

Improvement Proposals

Rutting can be improved by rut filling repairs or rehabilitation/renewal of the pavement. Sections of pavement greater than 50m in length with rutting in bin 3 or higher are detailed in Table 28 below. These sections should be considered for repairs or rehabilitation work. The prioritised rehabilitation programme in Appendix 2 of this report has taken rutting into account in prioritising rehabilitation works.

Subsection	Route Position (m)	Length (m)	Lane
Settlers Road	4,620-4,780	160	Both
Broadlands Road RDC	900-1,060	160	Right
Broadlands Road TDC	8,240-8,320	80	Left
	15,780-16,000	220	Both
	18,440-18,620	180	Left
	18,720-19,060	340	Both
	19,320-19,720	400	Both
	19,940-20,020	80	Right
Crown Road	1,680-1,940	260	Both

Table 28. Significant lengths of rutting > 30mm

4.2.6 Skid Resistance/Texture

Standards & Guidelines

The Investigatory Levels (IL's) for skid resistance vary depending on the Site Category as defined in TNZ T/10: 2002, and are given in Table 29 below:

Site Category	Site Definition	Investigatory Level (IL)	Threshold Level (TL)
1	Approaches to: • Railway level crossings • Traffic Lights • Pedestrian Crossings • Roundabouts • Stop and Give Way Controlled Intersections • One Lane Bridges	0.55	0.45
2	• Curve <250m radius • Down Gradients >10%	0.50	0.40
3	• Approaches to road junctions • Down Gradients 5-10% • Motorway junction area including on/off ramps	0.45	0.35
4	• Undivided Carriageways	0.40	0.30
5	• Divided Carriageways	0.35	0.25

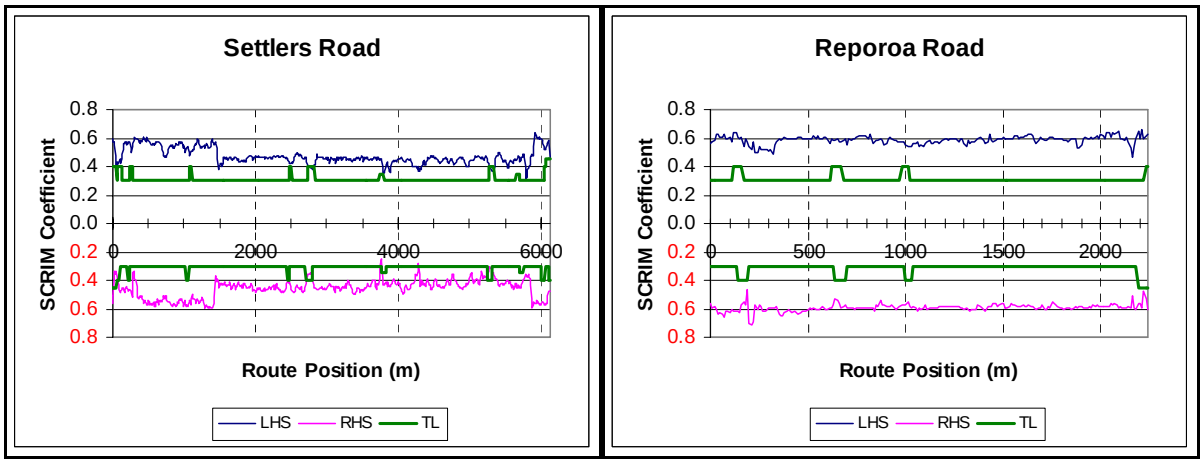
Table 29. Investigatory Skid Resistance Levels (abbreviated from TNZ T/10: 2002 Table 1)

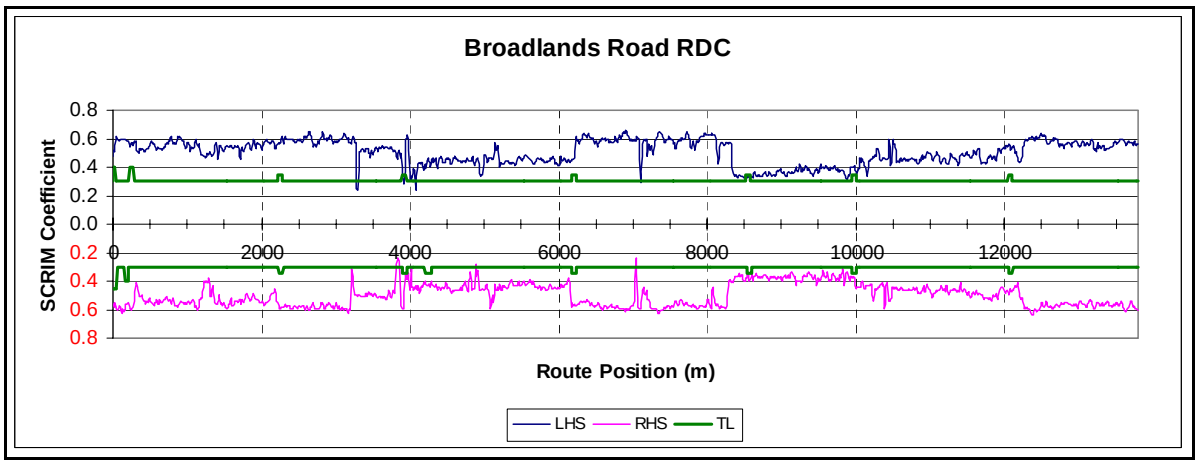
The Threshold Level (TL) is 0.10 below the IL. If the skid resistance falls below the TL, an investigation of the section of road is required to establish if treatment should be undertaken.

As part of the high-speed data collection process an exceptions report is produced that lists sites with skid resistance below TL, and also sites with macro texture less than 0.5mm MPD. Macro texture refers to water drainage paths between individual chips, which impacts on the wet skidding resistance performance of the chipseal.

Existing Situation

Skid resistance measurements were taken in 2004 over the full length of the study route. The graphs below plot the recorded Mean Summer Scrim Coefficient (MSSC) for the study length, for the LHS and RHS respectively.





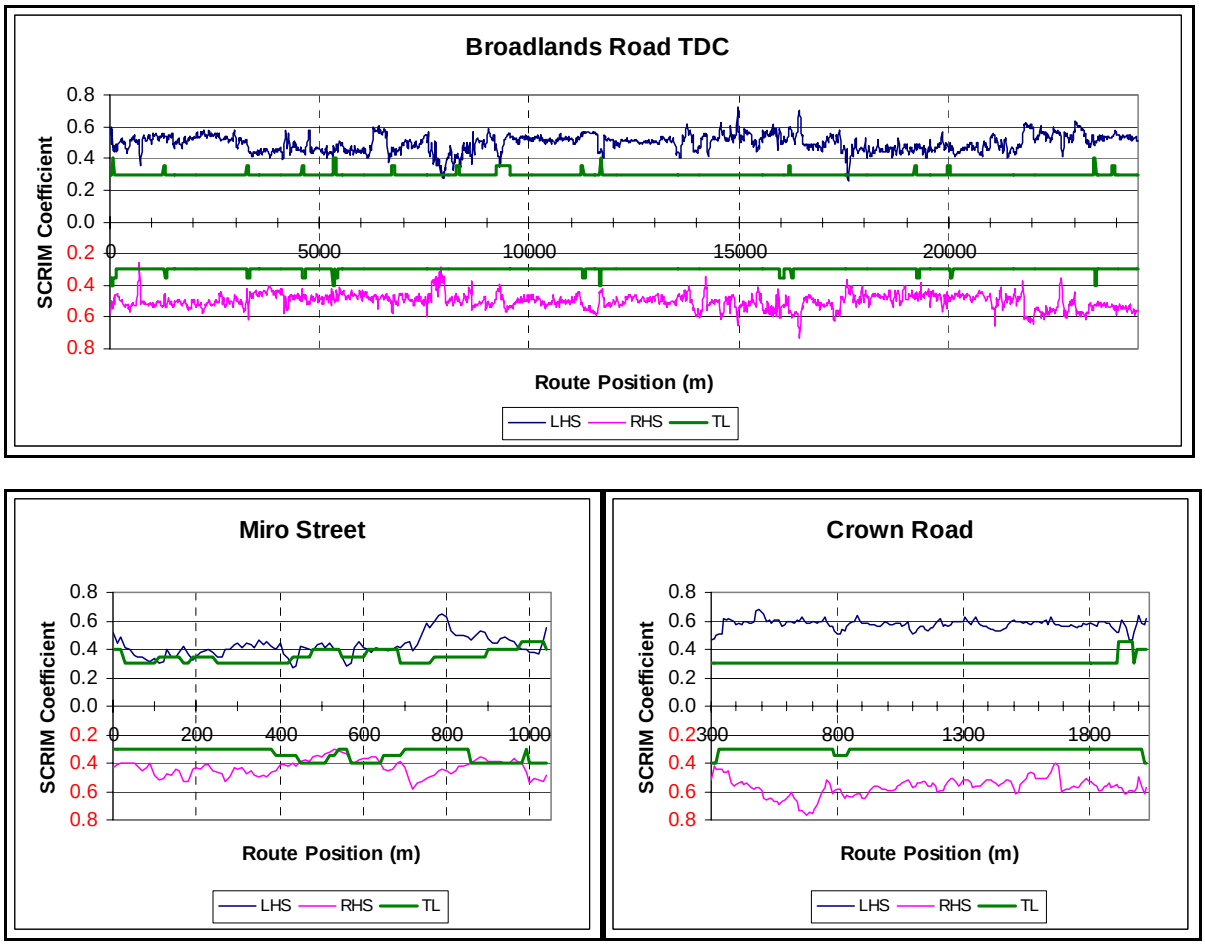


Figure 15. Skid resistance on each subsection

Improvement Proposals

The exception reports taken from high-speed data collected in 2004 have been summarised in the table below for sections at least 50m in length where the skid resistance or macro texture is below the TL. These sites should be investigated and treated as soon as practicable.

Subsection	Lane	Route Position (m)	Length (m)
Settlers Road	Right (northbound)	20-70	50
	Right (northbound)	2710-2800	90
	Left (southbound)	2760-2820	60
	Right (northbound)	5250-5320	70
	Left (southbound)	5280-5350	70
Broadlands Road - RDC	Left (southbound)	0-50	50
	Right (northbound)	1230-1300	70
	Right (northbound)	3820-3930	110
	Left (southbound)	3890-3990	100
	Left (southbound)	8520-8580	60
Broadlands Road - TDC	Left (northbound)	6,280-6,540	260
Miro Street	Right (southbound)	440-530	90
	Left (northbound)	520-570	50
	Right (southbound)	560-640	80
	Left (northbound)	970-1030	60
	Right (southbound)	850-980	130

Table 30. Sections with skid resistance below TL

4.3 Horizontal Geometry

4.3.1 Existing Situation

The horizontal geometry of the study route is shown on the Route Data Sheets in Appendix 1. The following paragraphs briefly describe the horizontal geometry.

Subsection 1

Settlers Road is the most curvilinear section of the study route. Within its 6,130m length there is a series of single and reverse curves joined by straight sections of up to 1,000m length.

Subsection 2

Reporoa Road is generally straight with some large-radius curves.

Subsection 3

Broadlands Road in the Rotorua District is predominantly straight with very few curves.

Subsection 4

Broadlands Road in the Taupo District can be considered as a series of straight sections of road 2,000-3,000m in length with low radius curves joining them; in some isolated areas there are multiple curves.

Subsection 5

Miro Street is a relatively short urban (low speed) road, straight at the southern end and curvilinear at the northern end.

Subsection 6

Crown Road is generally a large-radius sweeping curve, with a straighter section in the middle.

4.3.2 Standards and Guidelines – Operating Speeds

Austroads (2003) defines "Operating Speed" as the 85th percentile speed of cars at a time when traffic volumes are low, that is when drivers are free to choose the speed at which they travel. On straight flat rural roads with low traffic volumes, the 85th percentile Operating Speed of cars is generally close to 110km/h.

Vehicle speeds on a series of curves and short straights tend to stabilise at a value related to the range of curve radii. This speed is called the "Section Operating Speed".

Estimating Operating Speeds on rural roads involves looking at three basic elements: the driver, the road and the vehicle. Austroads (2003) has developed an Operating Speed estimation model, based on a large number of observations of traffic behaviour, which has been used to assess Section Operating Speeds for the study route.

By using Figure 15 below (taken from Austroads (2003)) the Section Operating Speed can be determined and used to assess the adequacy of existing road geometry, in particular the radius of individual curves along the route.

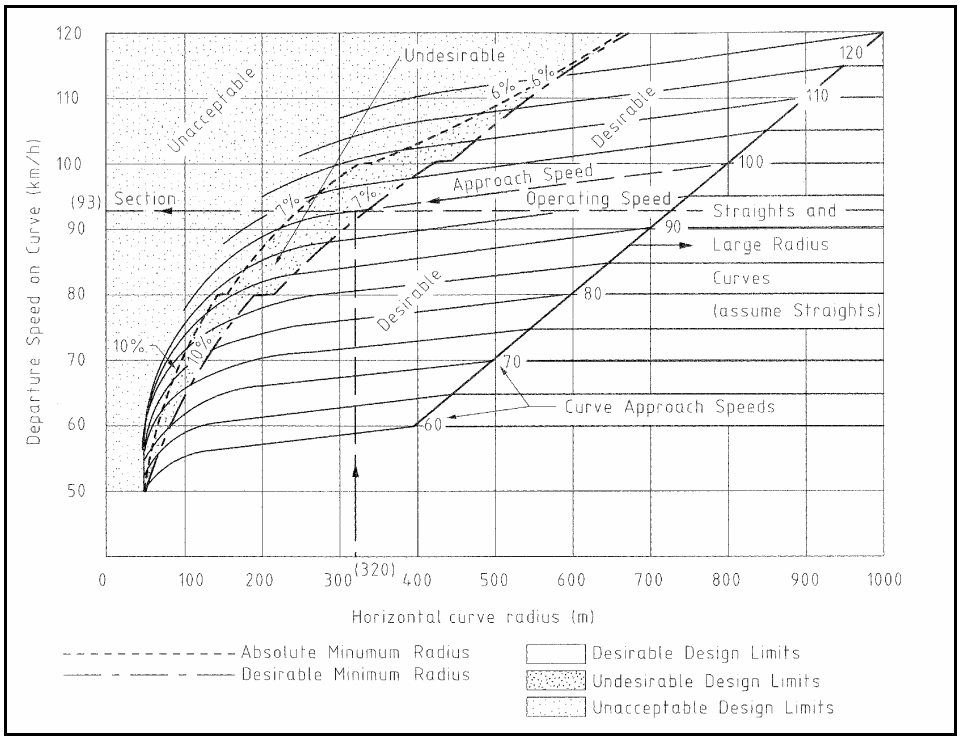


Figure 16. Deceleration plot for rural curves (reproduced from Austroads (2003))

The Route Data Sheets in Appendix 1 show the assessed Operating Speed along the study route. Based on this Operating Speed model Figure 15 defines a given curve as having desirable, undesirable or unacceptable radius, which is a function of the approach (operating) speed and curve radius. A high approach speed to a low radius curve is an unsafe situation. If a curve falls into the "unacceptable" zone, the radius should be increased or, if this is not possible, curve warning signs should be provided to inform drivers of the restricted alignment.

4.3.3 Improvement Proposals

Curves whose radius falls within the "unacceptable" zone in Figure 15 are listed in Table 31 below, with improvement proposals for each curve.

Subsection	Route Position (m)	Approach Speed (km/h)[1]	Radius (m)	Desirable Minimum Radius (m)	Comments/ Potential Improvements
Settlers Road	1,100	102	206	270	Corner recently eased. Improve warning signage.
	2,500	105	212	330	Warning signs present, 1 loss of control crash. Possible realignment.
	2,750	100	153	280	Warning signs present, 2 loss of control crashes. Possible realignment.
	5,300	97	202	250	Warning signs present, crash black spot. Realignment recommended.
Broadlands Road RDC	2,780	110	346	430	No crash history. Possibly improve signage.
	9,900	110	227	430	No crash history. Possible curve easing or improve warning signage.
Broadlands Road TDC	5,330	110	181	430	3 loss of control crashes (2 minor injury). Realignment recommended.
	11,700	110	220	430	1 loss of control crash. Improve warning signage. Possible realignment.
	13,550	110	240	430	No crash history. Possible curve easing or improve signage.
	15,460	110	329	430	No crash history. Possible curve easing or improve signage.
	17,150	110	299	430	Warning signs present. Possibly ease curve or improve signage.
	17,660	110	279	430	1 loss of control crash. Possible curve easing or improve signage.
	23,500	110	215	430	2 loss of control crashes (1 fatal, 1 minor injury). Possible realignment.

Note 1. Where approach speed is different from each direction, highest approach speed is quoted

Table 31. Curves with radius below desired standard

4.4 Vertical Geometry

4.4.1 Standards & Guidelines

Austroads (2003) gives general maximum grades for rural roads based on operating speed and terrain type, reproduced below.

Operating Speed (km/h)	Terrain		
	Flat	Rolling	Mountainous
60	6-8%	7-9%	9-10%
80	4-6%	5-7%	7-9%
100	3-5%	4-6%	6-8%
120	3-5%	4-6%	-

Table 32. General maximum grades for rural roads

Austroads (2003) indicates the adoption of grades steeper than the general maximum may be justified in situations where:

- Difficult terrain means general maximum grades are not practical;
- Absolute numbers of heavy vehicles are low; and
- Less important local roads where the cost or impact of achieving higher standards are difficult to justify.

The study route runs through generally flat to rolling terrain, with Operating Speeds of 90-110 km/h. Based on this the general maximum grade has been assessed as 5%.

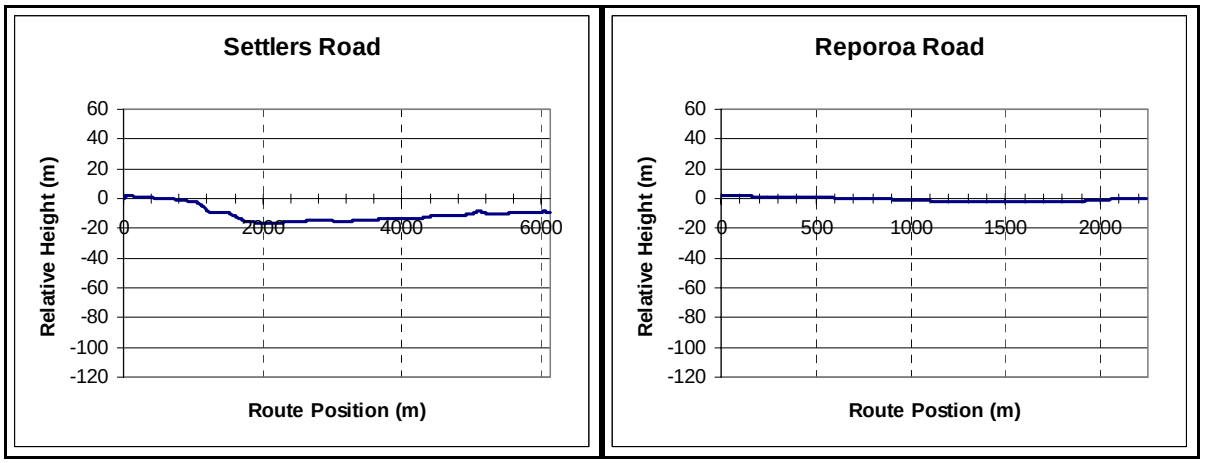
4.4.2 Existing Situation

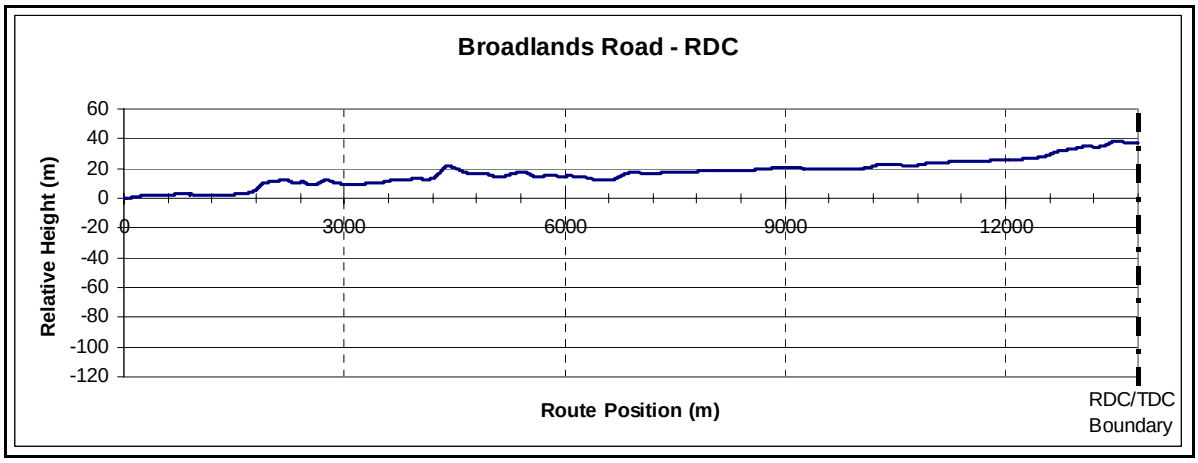
The study route runs mainly through flat to rolling terrain crossed by several small stream gullies. The route data sheets in Appendix 1 show vertical gradient along the study route, while the photos and graphs below show the vertical profiles of each subsection.

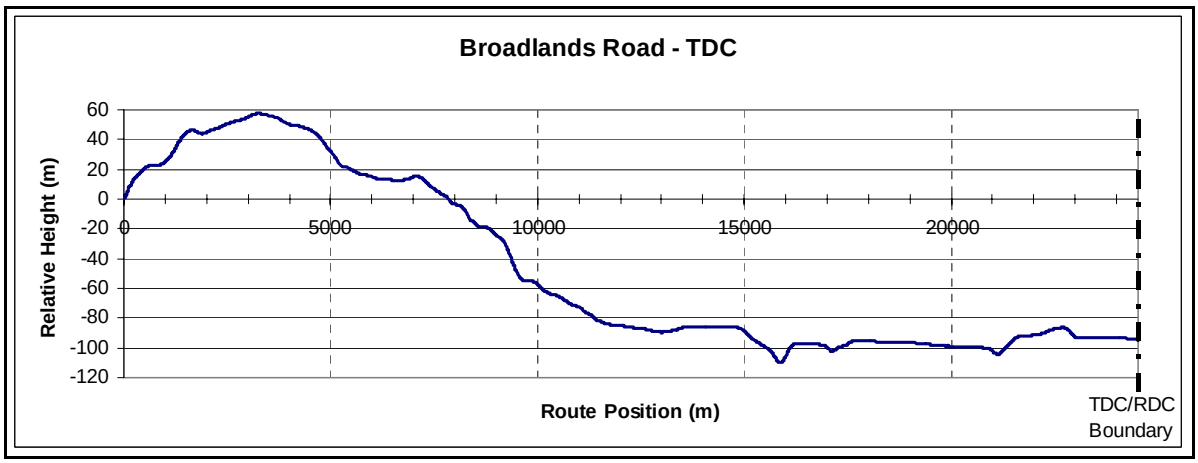
Figure 17. Varying vertical profile on Broadlands Road TDC

The nature of the terrain results in a mainly flat route, with short sections of steeper gradient particularly around the stream gullies. In these areas the crest curves reduce sight

distance. Figure 16 above shows examples of the vertical geometry found on the study route.







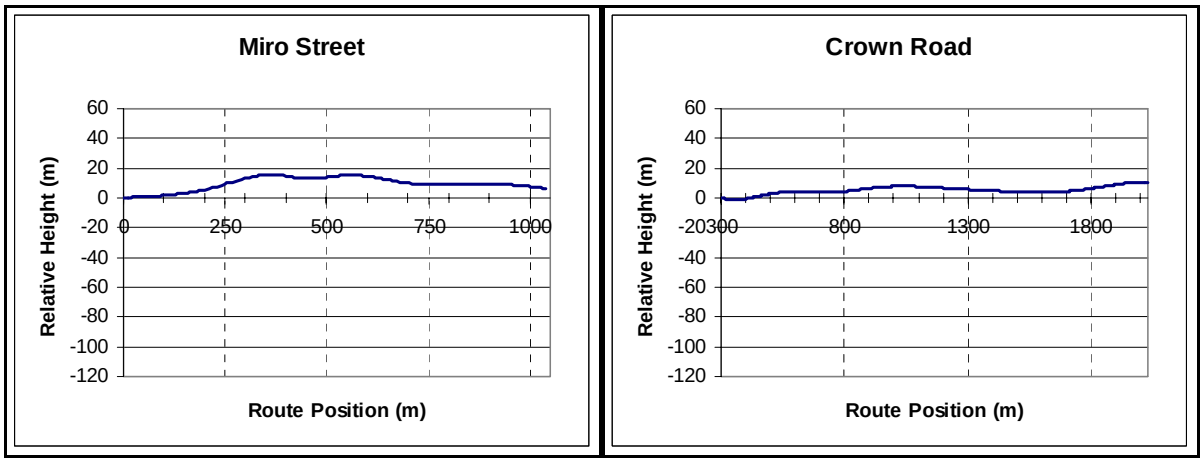


Figure 18. Vertical profile of each subsection

The vertical profile of Broadlands Road TDC shows the greatest range in height along the road. A climb of almost 80m for southbound (decreasing RP) vehicles from RP 9,500 to RP 7,100 represents the most prolonged steep positive gradient, averaging approximately 3% with a maximum of 7%.

4.4.3 Improvement Proposals

Table 33 below lists the identified vertical curves with maximum gradients above the general maximum grades.

In general, steep sections on the study route are relatively short, and are the result of difficult terrain approaching stream gullies. The sites do not have skid resistance or crash problems; as such, no improvements are recommended to improve the grades on these sections.

Subsection	Route Position (m)	Operating Speed (km/h)	Gradient (%)		Length (m)	Comments/ Recommendation
			Desirable Max	Actual		
Broadlands Road RDC	4,300	110	5%	7%	50	Short section of steep gradient. No improvement necessary.
Broadlands Road TDC	9,300-9,500	110	5%	7%	250	Extended gradient with steeper section slows southbound heavy vehicles. Initial analysis suggests climber lane may be warranted.

Subsection	Route Position (m)	Operating Speed (km/h)	Gradient (%)		Length (m)	Comments/ Recommendation
			Desirable Max	Actual		
	16,000	110	5%	6.7%	100	Short section of steep gradient. No improvement necessary.

Table 33. Sections of study route with gradients above general maximum grades

4.5 Side Roads/Intersections

4.5.1 Standards and Guidelines

Rural

Austroads, Part 5 (1988) provides guideline warrants for rural turn lanes on undivided rural roads based on turning volumes, as shown in Figure 18 below.

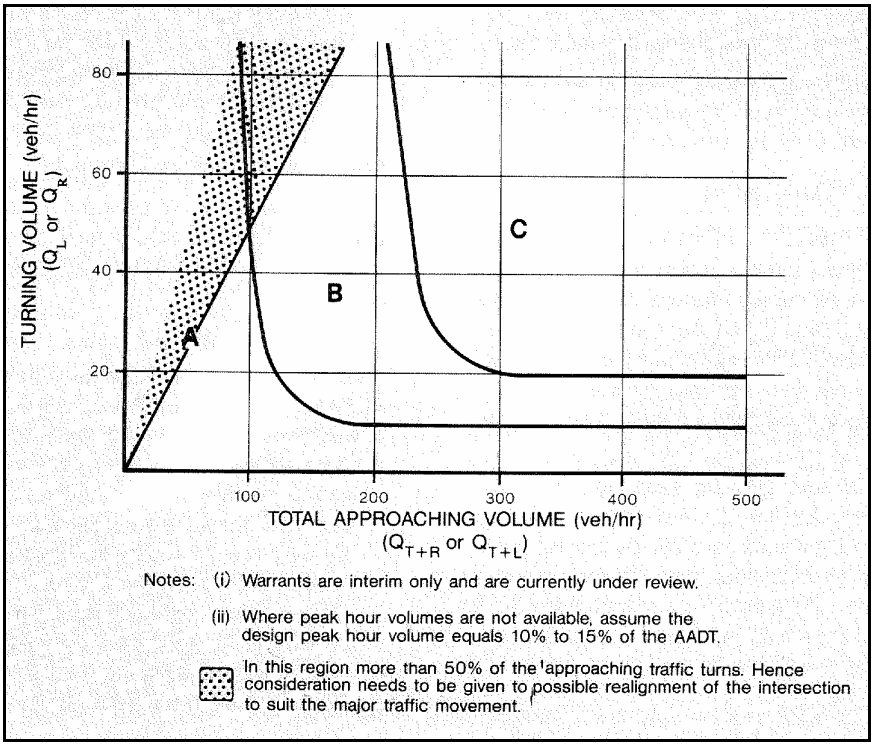


Figure 19. Turning lane volume warrants

The type of treatment recommended by Austroads (1988) for an intersection that falls into zones A, B or C on Figure 18 is shown in Figure 19 below.

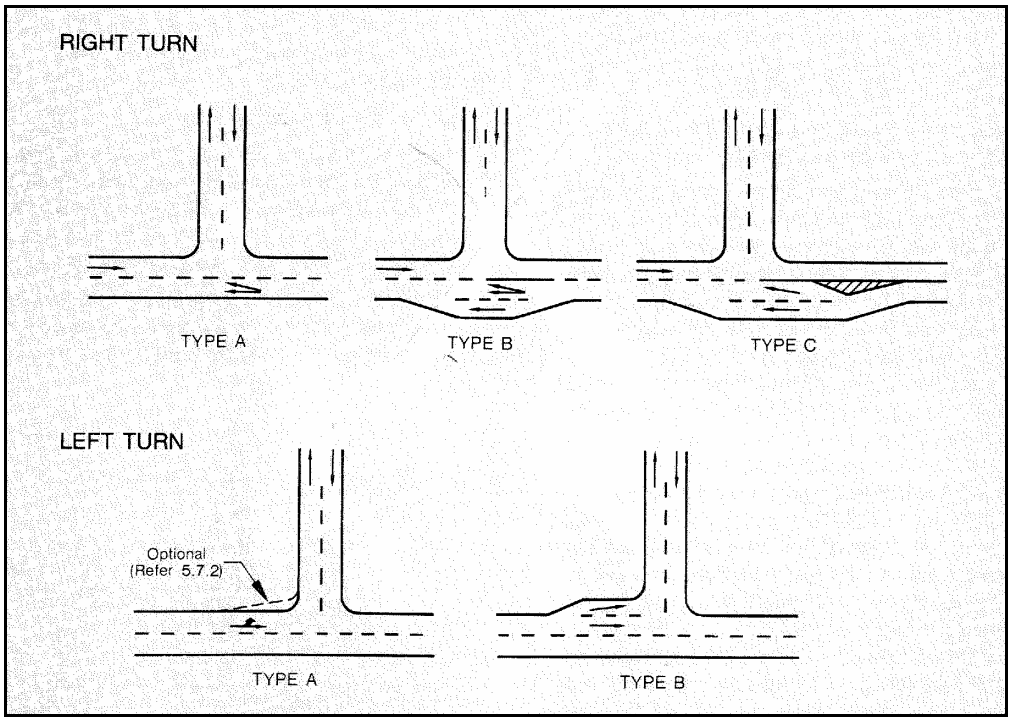


Figure 20. Turning lane treatments from Austroads (1988)

Safety concerns have been raised regarding the use of the Type B treatment for right turn lanes on New Zealand Roads, and their use is generally discouraged. In place of the Type B treatment a Type A right turn treatment is recommended. Type A and Type C right turn lane treatments are shown in more detail in Figure 20. Note the provision in Type A of sufficient seal width to permit passing of a right turning vehicle.

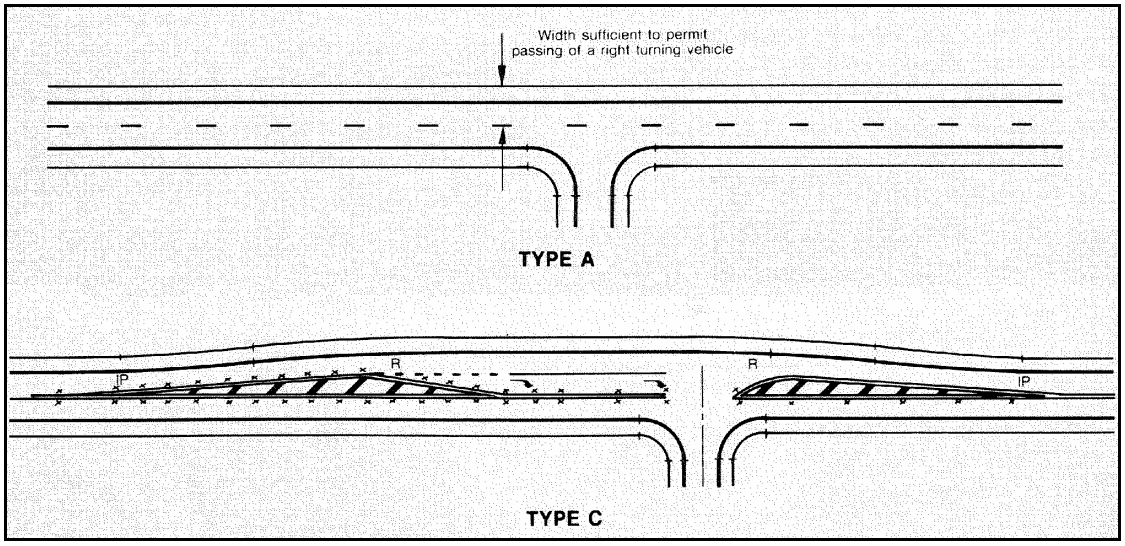


Figure 21. Right turn treatments

4.5.2 Existing Situation

The table below lists the side road intersections with the study route.

Sub-section	Side Road	Route Position (m)	Side	Traffic Volume vpd (year)	Control	Lighting	Layout/Comments
Settlers Road	Wharepapa Road	3,770	Right	47 (2001)	Give Way	Flaglit	Constrained by existing drainage channels
	Loop Road	3,880	Left	70 (2000)	None	None	
	Birch Road	5,650	Left	494 (2003)	Give Way	Flaglit	
Settlers/Broadlands/Reporoa/Guthrie Rd					Roundabout	Flaglit	Single-lane roundabout
Broadlands Road RDC	Homestead Road	2,200	Right	292 (2003)	Stop	Flaglit	
	Strathmore Road	3,960	Left	436 (2003)	Give Way	Flaglit	
	East Road	6,200	Left	267 (2003)	Give Way	Flaglit	Localized widening
	Vaile Road	8,540	Right	80 (2001)	Give Way	Flaglit	
	Earle Road	8,550	Left	134 (1995)	Stop	Flaglit	
	Allen Road	9,970	Left	120 (1990)	Give Way	Flaglit	
	Ohaaki Road	12,020	Right	350 (1999)	Give Way	Flaglit	Right Turn Bay
Broadlands Road TDC/ Miro Street	Tauhara Road	0	N/A	4225 (2002)	Give Way on Miro	Flaglit	Priority with Broadlands/through on Tauhara traffic
Broadlands Road TDC	Centennial Drive	3,282	Left	746 (2002)	Stop	Flaglit	Right Turn Bay may be shorter than Transit (1998) guidelines. Crash black spot.
	Off Highway Road	4,593	Cross		Stop	Flaglit	Right Turn Bay for southbound traffic
	View Road	5,356	Left	253 (2001)	None	None	Uncontrolled intersection, localized seal widening

Sub-section	Side Road	Route Position (m)	Side	Traffic Volume vpd (year)	Control	Lighting	Layout/Comments
	White Road	16,166	Right	248 (2000)	Stop	Flaglit	
	River Road	19,114	Left	396 (2003)	Stop	Flaglit	Austroads 'Type B' Right Turn lane
	Tiverton Downs Road	19,910	Right	160 (2003)	Give Way	Flaglit	Austroads 'Type B' Right Turn lane
Miro Street	Manuka Street (South)	176	Right	910 (2000)	Give Way	Flaglit	Urban intersection
	Matai Street (South)	260	Left	1,112 (2002)	Give Way	Flaglit	Urban intersection
	Manuka Street (North)	500	Right	910 (2000)	Give Way	Flaglit	Urban intersection
	Matai Street (North)	597	Left	1,112 (2002)	Give Way	Flaglit	Urban intersection Right Turn Bay
Crown Road	Invergarry Road	794	Left	1,885 (2000)	Give Way	Flaglit	Right Turn Bay

Based on current and future traffic volumes, as estimated in Section 3.1 of this report, Table 34 specifies the warranted turn lane treatments at each rural intersection along the study route. A number of assumptions were made regarding turning traffic volumes and directional splits, which are detailed in Appendix 3 of this report. Due to the relatively low traffic volumes on many of the side roads, the turning lane warrants are not sensitive to the assumptions used.

Subsection	**Side Road**	**Turning Lane Warrants – Treatment Type**					
		2004		**2014**		**2024**	
		Right Turn	Left Turn	Right Turn	Left Turn	Right Turn	Left Turn
Settlers Road	Loop Rd	A	A	A	A	A	A
	Wharepapa Rd	A	A	A	A	A	A
Broadlands Road RDC	Homestead Rd	A	A	A	A	A	A
	Strathmore Rd	A	A	A	A	B	B
	East Rd	A	A	A	A	A	A
	Vaile Rd	A	A	A	A	A	A
	Earle Rd	A	A	A	A	A	A
	Allen Rd	A	A	A	A	A	A
	Ohaaki Rd	A	A	A	A	B	A
Broadlands Road TDC	Tiverton Downs Rd	A	A	A	A	A	A
	River Rd	A	A	A	B	A	B
	White Rd	A	A	A	A	A	A
	View Rd	A	A	A	A	A	A
	Centennial Dr	B	B	B	B	B	B

Table 34. Intersection turning lane warrants

Urban

Austroads (1988) states; "In urban areas the provision of auxiliary turn lanes should be considered at all…intersections where turning volumes are high or where turning traffic would cause significant interruption to through traffic".

Turning volumes on Miro Street and its side roads are currently not high enough to justify right turn bays. Also, the seal width on Miro Street is sufficient to allow through traffic to safely pass stopped turning vehicles.

4.5.3 Improvement Proposals

Rural intersections on the study route should be improved where necessary to warranted standards identified in Table 34, in a prioritised order and as funding allows. Those intersections with higher turning volumes and/or existing crash problems should gain highest priority. Table 35 and Table 36 provide a prioritised order for recommended intersection upgrades.

Priority	Intersection	Treatment Type
1	Broadlands Road/Strathmore Road	Type A
2	Broadlands Road/Homestead Road	Type A
3	Broadlands Road/East Road	Type A
4	Broadlands Road/Earle Road	Type A
5	Broadlands Road/Allen Road	Type A
6	Broadlands Road/Vaile Road	Type A
7	Broadlands Road/Earle Road	Type A
8	Settlers Road/Wharepapa Road	Type A
9	Settlers Road/Loop Road	Type A – Consider closing

Table 35. RDC prioritised intersection upgrades

Priority	Intersection	Treatment Type
1	Broadlands Road/Centennial Drive	Left turn slip lane
2	Broadlands Road/River Road	Type A
3	Broadlands Road/View Road	Type A; Flaglighting
4	Broadlands Road/White Road	Type A
5	Broadlands Road/Tiverton Downs Road	Type A

Table 36. TDC prioritised intersection upgrades

All rural intersections on the study route should be improved to Austroads (1988) standards as appropriate. In the majority of cases this will involve localised seal widening at intersections to allow through traffic to safely pass stopped traffic waiting to turn. The following paragraphs detail proposals for specific intersections.

Settlers Road/Loop Road Intersection

Loop Road is a short, low use, metalled road that does not service any properties, and acts mainly as a short cut for traffic between Settlers Road and Longview Road. The loose metal can migrate onto Settlers Road creating a maintenance issue and potential safety hazard. RDC should consider sealing or closing this road.

Broadlands Road/Miro Street/Tauhara Road Intersection

Priority at this intersection is currently with through traffic on Broadlands Road/Tauhara Road. There has been some suggestion, based on current traffic volumes, of changing the priority of this intersection to the Broadlands/Miro route or providing a roundabout at the intersection. There is currently no crash problem at this intersection.

When the proposed ETA is constructed, the Broadlands/Tauhara through route will form the principal access to the ETA from central Taupo, in which case the current intersection configuration would be the preferred layout. We recommend this intersection be monitored and if safety or efficiency issues develop in the period before construction of the ETA, consideration should be given to constructing short-term improvements.

Broadlands Road/Centennial Drive Intersection

Recent seal widening on the true LHS, north of this intersection, assists the left turn movement out of Centennial Drive. Widening on the northbound left hand approach to this intersection will assist left turn movements into Centennial Drive, improving safety by separating turning vehicles from through traffic, particularly during events at the adjacent Centennial Park Raceway when high traffic flows can be expected at this intersection.

Broadlands Road/Off Highway Road Intersection

Off Highway Road is technically a private road constructed on TDC land and maintained by the forestry company. This intersection is currently used by oversized forestry vehicles to cross Broadlands Road to/from a sawmill, and by some heavy vehicles as an alternative access to/from the Tauhara quarry. There is currently a right turn bay for vehicles approaching from the north.

This intersection presents the following safety issues:

- In foggy/poor visibility conditions, vehicles approaching on Broadlands Road find it difficult to see oversized trucks crossing at the intersection, and vice versa. This creates a significant potential hazard to traffic approaching at speed, as it can take oversized vehicles up to 30 seconds to clear the intersection. Currently, flashing orange lights have been installed on the advanced warning sign, to warn traffic that a truck is using the crossing, as shown in Figure 22.

Figure 22. Approach to Off Highway Road intersection from the north

- Whilst a right turn bay is provided for traffic approaching from the north, there is no such provision for vehicles approaching from the south. If trucks travelling to the quarry continue to use Off Highway Road, we recommend a right turn bay be constructed or, at a minimum, localized widening of the true LHS shoulder take

place such that through traffic can safely pass stopped trucks waiting to turn right. If Off Highway Road is closed to quarry traffic, a right turn bay would be desirable at the Old Quarry Road entrance to improve safety at this location.

Broadlands Road/View Road Intersection

This is currently an uncontrolled intersection. We recommend Give Way control be applied at this intersection, including appropriate road marking and signage. This will make it clear to drivers on View Road that they are approaching an intersection, and provide better control to their movements. Flaglighting should also be provided.

Broadlands Road/River Road Intersection

This intersection has an Austroads 'Type B' right-turn lane. This layout type has raised some safety concerns regarding their use on New Zealand roads, and their use is generally discouraged. There are two main options for improving the layout of this intersection to a standard that New Zealand road users are familiar with:

(a) Provide a 'Type A' treatment, involving continuing the edge line as per the approach to the intersection, with through traffic able to use the shoulder to pass vehicles turning right. This is a low cost option, but with comparatively lower safety standards than a right turn bay.

(b) Constructing a 'Type C' right turn bay. This will include a longitudinal extension to the existing localized seal widening at the intersection, possible increase in seal width, and road marking. While being more expensive than the first option, this would provide a higher level of safety for this intersection.

Based on guidelines in Austroads (1988), a right turn bay at this intersection is not warranted. Therefore, we consider option (a) is the most appropriate for this intersection.

Broadlands Road/Tiverton Downs Road Intersection

This intersection is similar to the River Road intersection, with an Austroads 'Type B' right-turn lane. Options for improving this layout are the same as outlined above, and we consider option (a) to be an appropriate treatment at this intersection.

Crown Road/Miro Street Intersection

TDC has received requests from the community for a roundabout to be installed at this intersection. There is no significant recorded crash problem at this intersection, with the crash history revealing one, non-injury, crossing/turning type crash in the last five years. Installing a roundabout here would mainly have the effect of a threshold treatment into the residential area further west of the intersection on Crown Road, and the industrial area on Miro Street, particularly if consideration were given to the suggestion to increase the speed limit on Crown Road between RP 307 and RP 1,000 from 50km/h to 80km/h or 100km/h.

4.6 Drainage

4.6.1 Existing Situation

Drainage on each subsection consists of the following:

Subsection 1 – Settlers Road

Ground conditions on this subsection are generally poor-draining peat. Subsequently, deep drainage channels are present on one or both sides from approximately RP 1,500 to RP 4,000. The top surface level is generally well above the surrounding farmland.

The deep channels in places are relatively close to the edge of seal, which both limits the possibility of seal widening and creates a hazard for vehicles.

Rutting is a problem whereby water pools in the wheel tracks after rain, creating a hazard for vehicles.

Subsection 2 – Reporoa Road

Drainage is from grassed water tables. There are no apparent problems with drainage aside from rutting, with water pooling in the wheel tracks.

Subsection 3 – Broadlands Road RDC

The underlying ground conditions are peat for approximately the first half of Broadlands Road, becoming freer draining pumice around the second half of the section. Again, rutting is the only major issue with existing drainage.

Subsection 4 – Broadlands Road TDC

Grassed water tables with underlying pumice provide adequate drainage, with rutting again the only major issue.

Subsection 5 – Miro Street

Miro Street is predominantly urban, with kerb and channel.

Subsection 6 – Crown Road

Crown Road has kerb and channel drainage at the northeast end in the urban area, and water tables in the rural area.

4.6.2 Improvement Proposals

The major issues, and potential improvements, involving drainage are:

- The deep channels on Subsection 1 are a hazard for vehicles due to their proximity to the edge of the road. Culverting these as a stand-alone project would be expensive. A possibility would be removing the drains in conjunction with seal widening/rehab work, preferably with Transfund subsidy if it met the criteria. However, the current crash history makes this unlikely.
- Rutting along significant portions of the study route causing water to pond in the wheel tracks. This can be remedied through rehabilitation work targeting areas with significant rutting.

4.7 Bridges/Structures

Bridges/structures on the study route are listed in Table 37 below.

Subsection	Name	Route Position (m)	Width (m)	Length (m)
Settlers Road	Waiotapu Stream	3,860	7.3	14.9
	Tokiaminga Stream	4,420	7.3	10.1
Reporoa Road	Waiotapu Stream	2,050	7.32	27.4
Broadlands Road RDC	Wharekaunga Stream	250	7.44	9.1
	Kopuhurihuri Stream	1,350	7.48	7.5
	Rotongata Stream	3,240	7.47	6.0
	Mangatete Stream	4,100	7.2	19.7
	Torepatutahi Stream	6,450	8.76	24.3
Broadlands Road TDC	Broadlands Rd Stock Underpass	8,000	13.6	3.5
	Pueto Stream	15,750	8.5	12.4
	Kereua Stream Culvert	16,996	-	5.0
	Waiehu Stream Culvert	20,990	9.0	8.0

Table 37. Bridges and structures

The widths of bridges on the study route are generally similar to the current seal width. This currently provides a fairly consistent width of route for drivers. The lack of sealed shoulders on most of the bridges creates a potential hazard for cyclists due to the constriction associated with the bridge itself. However, due to the relatively short lengths of the bridges this hazard is less significant than that presented by the lack of sealed shoulders on the majority of the route. There have been no reported cyclist or pedestrian-related crashes in the last five years at any of the bridges on the route.

If progressive widening of the seal along the route was to occur in the future, many of the bridges in subsections 1, 2 and 3 will tend to be perceived as 'pinch points'.

Transfund have funding available for bridge widening projects for the benefit of cyclists.

4.8 Passing Opportunities

4.8.1 Existing Situation

Currently there are no dedicated passing lanes on the study route. However, the horizontal and vertical geometry provides relatively good passing opportunities. In the five-year period July 1998-June 2003 there have been 6 overtaking-related crashes on the study route (2 minor, 4 non-injury). The main limitations to passing opportunities are:

- Small vertical curves limit sight distance as the road follows the rolling topography.
- Narrow seal width on the rural subsections. This lack of seal width makes it difficult for vehicles to pass in particular the high proportion of heavy vehicles in the traffic stream, and creates a potential safety hazard during passing manoeuvres.
- The pavement condition, with rutting in the wheel tracks, also creates difficulties for passing in wet road conditions. Heavy vehicles create a thick cloud of moisture around them that severely reduces visibility for following traffic. The presence of ponded water also creates a potential safety hazard for vehicles travelling, and performing passing manoeuvres, at high speed.
- Foggy conditions, which occur relatively often during the winter months on the rural subsections.

4.8.2 Improvement Proposals

Seal widening, as identified in Section 4.2.1, will improve the safety of passing manoeuvres by allowing heavy vehicles to pull further to the left hand side, and giving passing vehicles more clearance to both the vehicle being passed and the opposing edge of seal. Rehabilitating areas of pavement in poor condition will also improve visibility, friction and safety in wet conditions.

Climbing Lane

There is a section of Broadlands Road TDC with an extended positive grade in the southbound (decreasing RP) direction, which tends to slow heavy vehicles. Based on truck performance curves given in Austroads (2003) as shown in Figure 23 below, the speed of trucks over this section of road has been assessed. Figure 24 shows this assessment.

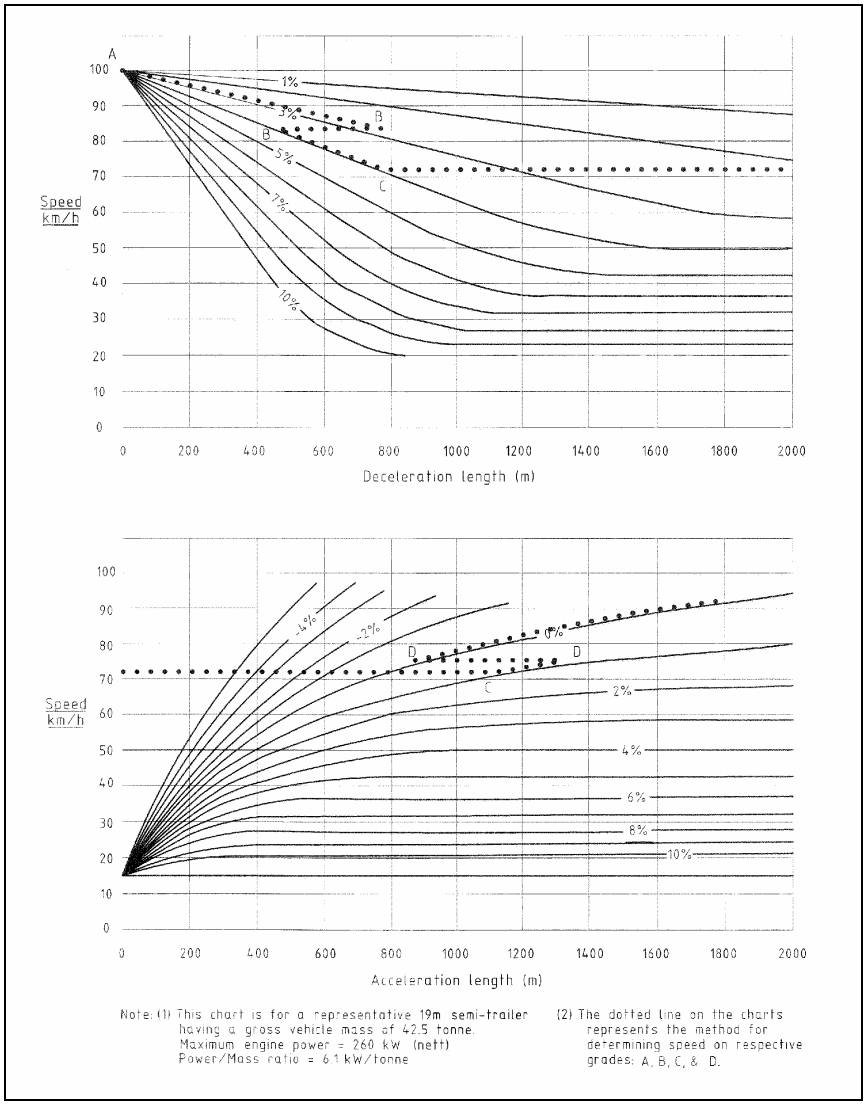


Figure 23. Austroads truck performance curves

Transit (2001) provides criteria for climbing lane warrants, based on truck performance curves and deviation in heavy vehicle speed from the average speed of the section of road. Studies have shown the accident involvement rate for slow vehicles increases more rapidly when the vehicle speed reduction is greater than 15 km/h. Therefore, a climbing lane should normally be introduced at the point where the design vehicle is expected to experience a 15 km/h speed reduction below the design speed of the road. For the purposes of this initial analysis, we have used a truck speed of 75 km/h as the start point for a climbing lane, as it is 15 km/h below the 90 km/h legal speed limit for trucks on New Zealand roads. Based on these criteria, a climbing lane is warranted in the southbound (decreasing RP) direction on Broadlands Road TDC from RP 6,940-9,240, as shown in Figure 24.

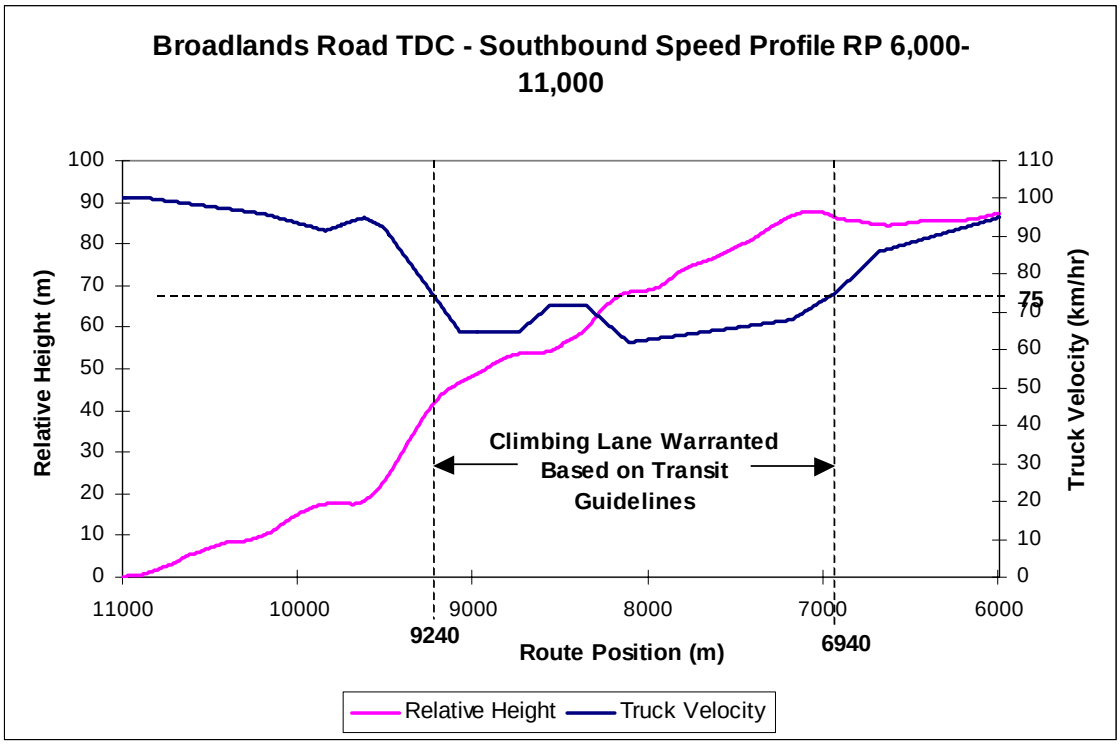


Figure 24. Climbing lane warrant (using Transit criteria)

Austroads (2003) provide different criteria, stating, "The theoretical start point (of the climbing lane) is taken as the point at which the speed of the truck falls to 40 km/h and decelerating. The point at which the truck has reached a speed equal to the operating speed minus 15 km/h and is accelerating determines the end of the lane." Based on these guidelines, a climbing lane is not warranted at this location as trucks reach a theoretical low speed of 62 km/h.

We recommend that the existing limitations on passing opportunities be recognised and where possible, seal widening carried out in conjunction with rehabilitation work. Construction of the identified climbing lane should be investigated further and possibly put forward for funding. Monitoring and maintenance of rutting will also improve the safety of passing manoeuvres in wet conditions.

5 Geology

The geology of the area generally comprises volcanic rocks and sedimentary soils of the Pliestocene era (1.8 million years to recent). The distribution of these materials is shown in Figure 25 (taken from the DSIR Geological Map of New Zealand 1:250,000 series, Sheet 5 - Rotorua and Sheet 8 – Taupo (Healy et. al 1964)) and described below in order of increasing age.

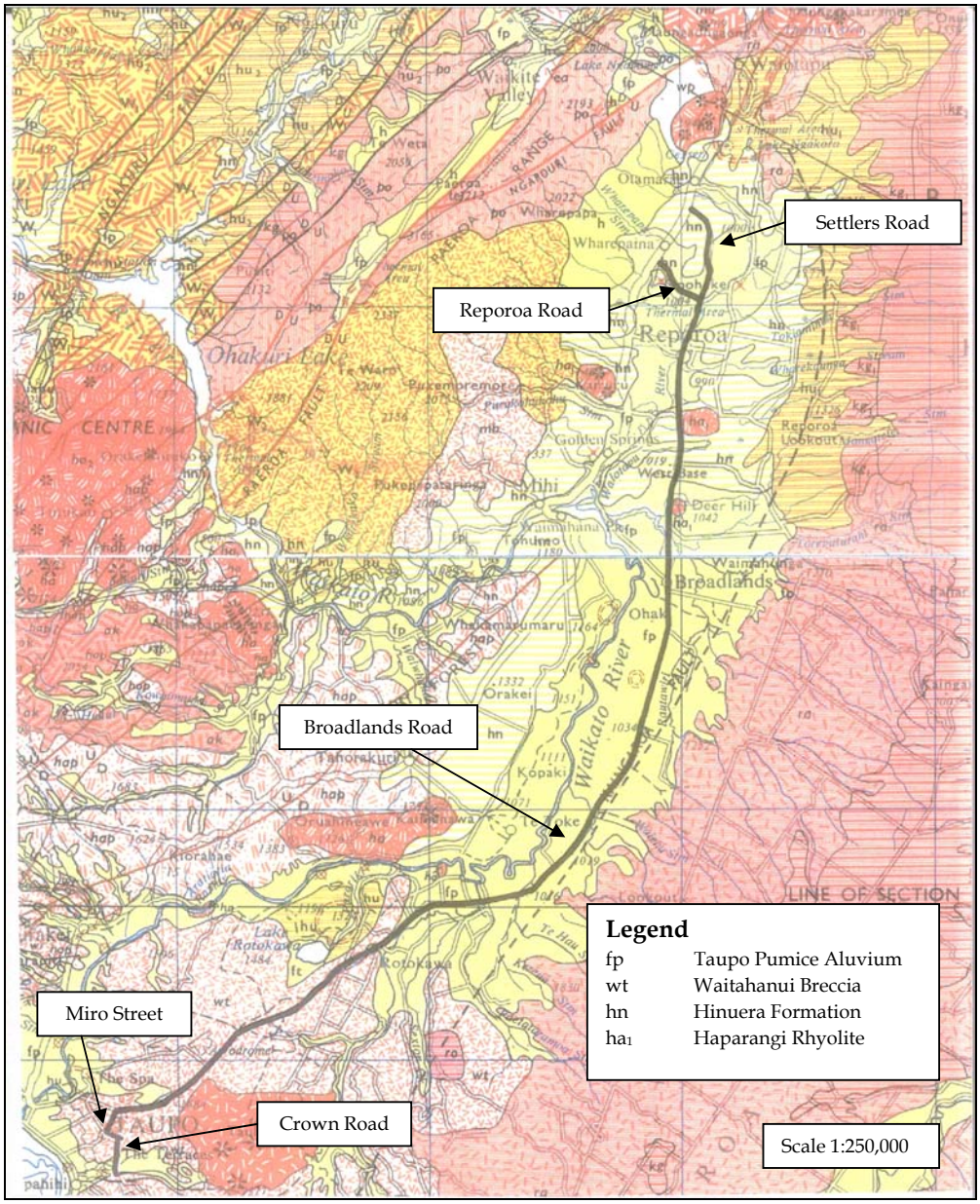


Figure 25. Geology of the study route

The descriptions of the materials the route traverses (largely taken from the Geological Maps (Healy et. al 1964)) are as follows.

(a) Taupo Pumice Alluvium: Pumice alluvium lahar and glowing avalanche deposits. Typically forming flat terrain, infilling the valleys (valley confined) in the Hinuera Formation at this locality

(b) Waitahanui Breccia: Pumice breccia, lapilli tuff and glowing avalanche deposits. Low hummocky and gently sloping terrain

(c) Hinuera Formation: Fluvatile pumice – rhyolite and ignimbrite sands and gravels. Typically low rolling terrain with shallow slope angles

(d) Haparangi Rhyolite: Lithoidal rhyolite, dissected domes and flow. Proximally bounded by younger Hinuera Formation deposits.

Subsection	Route Position (m)	Dominant Geology
Settlers Road	0-1,700	Hinuera Formation
	1,700-5,300	Taupo Pumice Alluvium
	5,300-5,800	Hinuera Formation
	5,800-6,130	Taupo Pumice Alluvium
Reporoa Road	0-2,252	Taupo Pumice Alluvium
Broadlands Road RDC	0-1,800	Taupo Pumice Alluvium
	1,800-2000	Hinuera Formation
	2,000-2200	Haparangi Rhyolite
	2,200-13,800	Taupo Pumice Aluvium with Hinuera Formation forming high points
Broadlands Road TDC	0-11,000	Waitahanui Breccia
	11,000-24,522	Taupo Pumice Alluvium
Miro Street	0-1,053	Waitahanui Breccia
Crown Road	307-2,040	Waitahanui Breccia

Table 38. Geology along the study route

5.1 Faulting, Seismicity and Geothermal activity

The Geological Maps (Healy et. al 1964) show a concealed northeast to southwest trending normal fault, downdropped to the northwest, running adjacent to the alignment at a distance of 1 to 5km. It is thought that this fault is inactive. There are several other active faults within 20km proximity of the alignment.

EW TR96/17 places the study area in Unit A for a Preliminary Ground Shaking Hazard in the Environment Waikato Region. Unit A is the most hazardous with typical amplification of approximately two MMI (Modified Mercalli Index) units. Settlement and liquefaction resulting from seismic activity is common. Areas underlain by Hinuera formation have widespread amplification potential and localised liquefaction and landsliding potential.

The Geological Maps (Healy et. al 1964) show thermally active areas north and west of Reporoa and south of Broadlands. Geothermal activity is evident near Taupo adjacent to Broadlands Road and documented in the TDC Summary of Subsidence Report – February 2003.

Extraction of geothermal groundwater from the Wairakei-Tauhara field has been identified as causing differential settlement in several areas in Taupo. Crown Road and Miro Street are included in the area identified by the Taupo District Council (TDC Summary of Subsidence Report – February 2003). Parts of Crown Road can expect differential settlements of up to 100mm over a 25m horizontal run.

5.2 Landscape and Topography

Generally the route follows the near level plains formed by the Taupo pumice alluvium. There are numerous stream and drain crossings, some in deep gullies. It is expected that soft silty alluvium will be encountered in these watercourses. The route passes over and around several Hinuera formation hills with shallow sideling cuts and fills. Nearer Taupo the route traverses the Waitahanui Breccia with several cuttings as the road moves onto the next terrace level. Geothermal activity is evident near the alignment, which runs through the diverse Taupo Fault Belt.

5.3 Geotechnical Characteristics

For each of the geological formations that we expect to encounter, we have identified the following general geotechnical characteristics that may constrain roading works. Detailed investigations and design will be required.

1. Taupo Pumice Alluvium:
   - Variable silts, sands and pumiceous gravels
   - Silt deposits can be wet and sensitive and difficult to work with. Generally not suitable for fill.
   - Shallow cut slopes in silty soils typically stand at angles of 2H:1V. Erosion Control is required on cut slopes.
   - Cuts through the sands and pumiceous gravels stand steeply in the short to medium term.
   - Moderate settlement is expected under fill, with some softer areas also expected.

2. Waitahanui Breccia:
   - Variable sands and pumiceous gravels
   - Cut slopes typically stand at angles of 1H:1V. Erosion Control is required on cut slopes.
   - Cuts through the welded sands stand vertically in the short to medium term.
   - Cuts through the gravel sized material tend to fritter back to a 40^{o} slope angle

3. Hinuera Formation:
    - Highly variable interbedded silts, sands and pumiceous gravels
    - Silt deposits can be wet and sensitive and difficult to work with. Generally not suitable for fill.
    - Shallow cut slopes in silty soils typically stand at angles of 2H:1V. Erosion Control is required on cut slopes.
    - Cuts through the sands and pumiceous gravels stand near vertical up to 1.5m
    - Moderate settlement is expected under fill, with some softer areas also expected.

4. Haparangi Rhyolite:
    - Silts and sands
    - Cut slopes stand at 1.5H:1V

Cut slopes in pumice sands are highly erodible. Accepted practise in pumice sands is to cut slopes as steep as possible to limit the flow of surface water on the slope face. Shallow cuts may be constructed vertically, with sufficient set back from the alignment to prevent debris falling onto the carriageway. As the topography is relatively flat and we envisage that the cuts and fills will be relatively shallow. The proximity of the faulting and the near surface geothermal activity also make shallow, lightweight embankments necessary. Structures, services and drainage should to be designed to accommodate the differential settlement expected due to ground subsidence from the extraction of geothermal groundwater.

6 Existing Environment

6.1 Topography

The topography of the study route is generally rolling to flat as the road traverses the plains of the Waikato River with minimal use of cut and fill. Generally the route follows the near level plains formed by the Taupo pumice alluvium. There are numerous stream and drain crossings, some in deep gullies.

6.2 Land Use

The land use along the road can generally be described as:

- Pastoral farming through the majority of the study length;
- Urban activity in the settlements of Reporoa and on the outskirts of Taupo;
- Urban, industrial and community activities around the settlement of Broadlands;
- Lifestyle blocks;
- Small amounts of relatively isolated industrial activity. (for example Ravensdown Fertiliser Storage);
- Urban industrial activity on Miro Street;
- Forestry;
- Timber processing;
- Geothermal Power Station;
- Small amounts of crop farming;
- Small amounts of sheep farming;
- Recreational activity (Pony Club, Riding for Disabled, Centennial Raceway).

The economy of the area serviced by Broadlands Road is strongly dependent upon agriculture and to a lesser extent forestry. The predominant economic activity along much of Broadlands Road is dairy farming. This can generate high numbers of HCVs with daily tanker collections to farms. In addition, the growing, tending and harvesting of planted forests and the Geothermal Power Station have an impact on the transportation network.

There is a proposal to expand the Centennial Park raceway adjacent to the Broadlands Road/Centennial Drive intersection. This will impact on the traffic function of the road during major events. Details of the traffic effects from the assessment of environmental effects for this proposal are included in Appendix 5 of this report.

6.3 Ecology

Broadlands Road passes through a landscape that has been highly modified by farming practices and other human activities. Much of the forest habitat that would once have occupied the corridor has been replaced by vegetation characteristic of intensive agriculture, for example pasture.

The Waikato River and its tributaries form the principal natural drainage system for the study area. Many of its tributaries pass under the existing road. Artificial drains have also been cut in farmland adjacent to the existing highway. Maps of the area also indicate that small ponds may be present although this requires verification in the field. These rivers, streams and ponds will provide habitat for aquatic plants, fish, birds and aquatic invertebrate communities. They may also have associated terrestrial plant species and communities in their riparian margins. The main potential issues associated with rivers, streams and ponds are:

- loss of habitat,
- impacts on wildlife corridors, particularly passage of migratory fish in rivers and streams,
- management of construction activities to avoid/control downstream effects of sedimentation.

6.4 Landscape

The landform of the project area is that of the Waikato River alluvial flood plain. The majority of the route parallels the Waikato River, which is located to the west. The topography along the project length is flat to gently undulating. The majority of the route has been developed for either agricultural or forestry purposes with the occasional farm shelterbelt or hedgerow and clumps of mature trees. The route also traverses three urban areas, which include Reporoa, Broadlands and the eastern fringes of Taupo.

An effective way of integrating road changes into the surrounding pastoral landscape is to maintain as much as possible of the road margins in pasture. Any borrow or spoil disposal areas that may be required should be managed so that the resultant surface can be rehabilitated and returned to productive use. Landscape impacts can be minimised during the design phase by limiting vegetation removal, limiting the extent of earthworks, providing gentle grades and well rounded profiles for batters, shaping the tops of cut batters, rehabilitating riparian margins impacted by the proposal, limiting the bulk of structures and top soiling and grassing, or planting batters as appropriate.

6.5 Archaeological Sites

The District Plan, Historic Places Trust Register and the New Zealand Archaeological Association database have all been searched. No directly affected sites have been identified in the immediate vicinity of Broadlands Road. However, archaeological surveys may be required as part of any further detail design works, because although sites in the vicinity of works have not been identified in the existing information sources this is not a guarantee that there are no sites, only that the sites are not known.

7 Statutory Requirements

7.1 Introduction

Any future upgrading and improvements for the study route will be subject to a number of statutes and resource management requirements. The study area lies within both the Rotorua District and Taupo District. The information supplied below outlines these statutory requirements.

7.2 Land Transport Management Act (LTMA)

Any projects arising out of the this Report will be subject to the requirements of the LTMA if the RDC or TDC will be applying for Transfund funding. The sections below provide an overview of the requirements under the LTMA. A more in-depth analysis of identified projects with respect to the LTMA is provided in Section 9.10, and Appendix 8, of this Report.

7.2.1 Introduction

The principle purpose of the Land Transport Management Act 2003 (LTMA) is to establish a more comprehensive policy framework to guide decisions on how land transport networks in New Zealand are developed and funded. The LTMA creates a framework for decisions about the allocation and prioritisation of funding for land transport.

Section 3(1) of the Act states that, "the purpose of the Act is to contribute to the aim of achieving an integrated, safe, responsive, and sustainable land transport system".

The Act introduces criteria guided by the wider strategic direction set out in the New Zealand Transport Strategy (NZTS).

7.2.2 Funding of Activities (Projects)

An activity is defined under the LTMA as a land transport output or capital project, or both. Pursuant to Section 20(2) of the Act, in approving a project Transfund must take into account how the activity:

- Assists economic development;
- Assists safety and personal security;
- Improves access and mobility;
- Protects and promote public health; and
- Ensures environmental sustainability.

Furthermore in approving an activity, Transfund must take into account any current national land transport strategy, relevant regional land transport strategy, and National Energy Efficiency and Conservation Strategy.

Accordingly it is important that each activity can demonstrate how it can meet the criteria above. It is important to note that Transfund must only take into account the criteria set out above.

7.2.3 New Zealand Land Transport Strategy

Section 20(2)(b) of the LTMA requires Transfund to take into account any national land transport strategy when approving a proposed Project. The New Zealand Land Transport Strategy (NZLTS) is aimed at creating a sustainable transport system that is also affordable, integrated, safe and responsive to New Zealanders needs. The Strategy recognises the importance of efficiency to achieving the vision, the need for people to have access to affordable and effective transport choices and local services, and considers more fully the needs of all people.

The vision from the NZLTS is:

"By 2010 New Zealand will have an affordable, integrated, safe, responsive and sustainable transport system."

The vision is underpinned by four key principles:

- Sustainability
- Integration
- Safety
- Responsiveness.

7.2.4 Waikato Regional Land Transport Strategy

Section 20(2)(b) of the Act requires Transfund to take into account any regional land transport strategy when approving a proposed project.

7.2.5 National Energy Efficiency and Conservation Strategy (NEECS)

Section 20(2)(b) of the Act requires Transfund to take into account the National Energy Efficiency and Conservation Strategy (NEECS), when approving a proposed project.

The NEECS sets a range of energy efficient targets for the national economy. It also sets out specific objectives for transport energy reduction and efficiency improvements as follows:

- Reducing energy use through reducing the need for travel.
- Progressively improve the energy performance of the transport fleet

- Improving the provision and uptake of low energy transport options.

A number of refined goals are outlined in 'The Strategic Approach' and include:

- Reducing fuel consumption
- Developing more efficient urban transport forms and systems
- Improving traffic flow.

7.3 Resource Management Act

The Resource Management Act 1991 (RMA) provides the decision-making framework within which to assess options, determine the environmental effects and mitigation measures, and also define the statutory processes that will influence the project outcomes. The purpose of the RMA is to promote the sustainable management of natural and physical resources. Mitigation measures will need to be incorporated in any final road design to ensure that the quality of the environment is maintained or enhanced.

7.4 Historic Places Act (1993)

There are no identified sites in the District Plans, Historic Places Trust Register and the New Zealand Archaeological Association database in the immediate vicinity of the existing road. This does not mean that sites are not located in the project locality and detailed surveys may be required at a later stage.

7.5 Regional Council Plans and Documents

The study length is located within the Waikato Region. It is advisable that the requirement for resource consents be confirmed with Environment Waikato (EW) before lodging any application. Possible resource consent requirements for roading improvements include consents such as:

- Earthworks
- Work in the bed of a waterway
- Culvert extension
- Discharge/diversion of water

The following Regional Council plans and documents are relevant to this study:

<u>Waikato Regional Council (Environment Waikato)</u>

- Waikato Regional Policy Statement (Operative);
- Proposed Waikato Regional Plan;

- Transitional Regional Plan;
- Operative Waikato Regional Land Transport Plan.

7.6 Rotorua and Taupo District Plans

District Plan rules will be used as a baseline comparison for any Notice of Requirement that is lodged for a new Designation. The Taupo and Rotorua Plans are generally consistent with improving the safety of the roading network provided that adverse effects on the surrounding environment and community are avoided, remedied or mitigated.

7.6.1 Rotorua District Plan

Land use adjacent to the existing Broadlands Road may hinder any proposals to widen the Road. Significant land uses recorded in the District Planning Maps include:

- Settlement of Reporoa
- Cemetery site located on the corner of Homestead Road and Broadlands Road;
- Water Supply located on the corner of Homestead Road and Broadlands Road;
- Recreation Reserve located 300m north of intersection of Homestead Road and Broadlands Road;
- Settlement of Broadlands;
- Gas pipeline (Taupo Lateral) adjacent to and passing under Broadlands Road around the settlement of Broadlands;
- Ohaaki Geothermal Power Station.

7.6.2 Taupo District Plan

Land use adjacent to the existing Broadlands Road may hinder any proposals to widen the Road. Significant land uses recorded in the District Planning Maps include:

- National Power Grid (with 20m buffer either side) passing across Broadlands Road just north of View Road;
- Centennial Park;
- Waikato Regional Council Depot (Pest Destruction and Water and Soil Purposes);
- Hot Ground Hazard Areas on the eastern fringes of Taupo;
- Taupo Eastern Arterial Route crossing Broadlands Road;

- Designation for Road widening on Tauhara Road adjacent to Broadlands Road/Miro Street intersection;
- Miro Street Reserve;
- Known contaminated sites on Miro Street (Sawdust and Mill Waste/Timber Treatment Site);
- Industrial zone/activity through Miro Street and Crown Road;
- Crown Road Berms (Reserve);
- Crown Park;
- Residential activity adjacent to Crown Road;
- Halley Park;
- Taupo Eastern Arterial Route on Crown Road;

7.7 Planning Guidelines

In order to avoid, remedy or mitigate any adverse environmental effects, the following are general principals and guidelines that should be considered with any proposed construction work.

(i) Early consultation should be initiated with tangata whenua, directly affected landowners and key stakeholders such as the Department of Conservation and Fish and Game.

(ii) Mitigation measures such as earth bunds, fencing, planting, etc should be investigated early to enable these to be incorporated into the design of any improvements.

(iii) Sediment control is a fundamental issue that regional councils require to be addressed. Fish and Game has also raised this as an important matter. Early consideration of sediment control and incorporation of control measures into the design is likely to expedite processing of resource consents with Environment Waikato.

(iv) Further consultation should be undertaken with the New Zealand Historical Places Trust regarding the need for Archaeological Assessments.

8 Consultation

8.1 Introduction

This section of the report focuses on the consultation that has been undertaken with statutory bodies, tangata whenua, and key stakeholders who are likely to be affected by, or who have an interest in any development of Broadlands Road. The following groups have been consulted:

- Department of Conservation
- New Zealand Road Transport Authority
- New Zealand Land Transport Safety Authority
- New Zealand Automobile Association
- Environment Waikato/Environment BOP
- New Zealand Police
- New Zealand Ironman Association
- Bike Taupo
- Reporoa Resident and Ratepayers Association
- Fish and Game Council
- Iwi

The following information provides a summary of the key issues raised. The terminology used is predominantly that provided by the consulted parties.

8.2 Department of Conservation (DOC)

Both the Bay of Plenty and Tongariro/Taupo conservancies were contacted. The main concern raised by DOC is in regard to access to both the Rotokawa Conservation Area and the Broadland Scenic Reserve. If any work is proposed to be undertaken, then further discussions will need to take place with DOC.

8.3 New Zealand Road Transport Authority

- Increase in number of trucks now using the road instead of State Highway has grown immensely (300+ trucks per day).
- The road is very narrow in places, when 2 trucks pass in opposite directions there is not much room for error.
- The road has no shoulders in many places so trucks cannot pull over safely to allow vehicles to pass.
- There are no passing lanes.
- The road is lethal in the wet as water sits in the wheel wells that the trucks travel as the road has sunk.
- Cars find themselves aqua planing on the water.

8.4 New Zealand Land Transport Safety Authority

- No specific issues

8.5 New Zealand Automobile Association

- Mix of inter-provincial and heavy traffic.
- Traffic volumes likely to continue to increase
- Possible need for passing lanes as a result of increased traffic and mix of traffic.
- Increased volume of logging trucks
- Residential and lifestyle blocks continue to develop along this section of road
- Need to look closely at impact of Taupo Bypass on traffic volumes
- Increased need for maintenance due to increased number of HMV's using road.

8.6 Environment Waikato/Environment BOP

- Planning for the Strategy Study is consistent with the policy objectives of the Regional Land Transport Strategy, which encourages Road Controlling Authorities to undertake corridor studies of their networks and identify areas of deficiencies and improvements.
- At the regional level we are very interested in future planning for this road and are willing to contribute in more detail as the Strategy Study progresses. We will also be able to advise you on environmental issues associated with any potential improvements that you may identify.
- As part of the new transport management regime under the Land Transport Management Act 2003 and the New Zealand Transport Strategy we would encourage you to identify opportunities to enhance alternative modes of transport such as walking and cycling and identify ways in that these modes can be accommodated.

Bill McMaster, the programme manager for land transport for Environment Waikato, has also consulted with EBOP in the construction of these comments.

8.7 New Zealand Police

- Main concern is the safety aspect of road widening.
- Recommended that any road widening is accompanied by consideration to employ steps to 'calm' traffic travelling along the road. These can include widening of centreline within guidelines. Use of diagonal stripes on the shoulders. Bringing the shoulders closer to the centreline at times narrowing the roadway to 'calm' traffic. Rumble strips on centreline where no passing lines are employed and use of cats eyes on not only the centreline but also the shoulder lines on bends.

8.8 New Zealand Ironman Association

Numerous attempts were made to gain comment from this organisation. At the time of collating this report we had not received any response.

8.9 Bike Taupo

- Broadlands Road is an important cycling route
- Road width not wide enough. Provision for a designated cyclist lane needed. Road widening required.
- Existing bridges restrict safe passage for cyclists. Signs required warning motorists of hazard to cyclists.
- Need for cyclist facilities via the industrial area in Miro Street and Crown Road.

8.10 Reporoa Resident and Ratepayers Association

- Carriageway is too narrow for the size and volume of traffic that use it
- Water build up is a danger to cars.
- The intersection at Homestead Road is very dangerous for turning traffic, both into and out of Homestead Road.
- Lack of width creates problems with heavy traffic and cyclists.
- Roadside marking needs to be improved, particularly in the areas most affected by fog.

8.11 Eastern Fish and Game Council

- Identified five areas of environmental sensitivity, Mangatete, Torepatutahi, Kaiwhitiwhiti, Kereua and Pueta Streams. These streams have significant trout spawning and rearing values and provide invaluable habitat to waterfowl within the district.
- Provided a number of generalised conditions regarding roading development and bridge reconstruction in close vicinity to the sites identified above.

8.12 Iwi

The following contacts were sent information on the Broadlands Road Strategy Study, and were asked for comments relating to the study.

- Mrs Emily Rameka (Tauhara Hapu Resource Management Act Committee)
- Mr Peter Clarke
- Mr Te Reo Whakakotahi Wall
- Mr Harvey Karaitiana
- J Rameka
- Warwick Rika (Te Runanaga O Ngati Whaoa)
- Rawiri Te Whare (Te Runanga O Ngati Tahu)

The contact list was derived from lists supplied by the Iwi Liaison officers in both Taupo and Rotorua District Councils.

Consultation has identified the importance of stream crossings and their margins, and the need to mitigate any impacts on these features arising from any road construction or alteration. Although few details have been supplied, traditional geothermal sites have also been identified as areas of importance to the Tangata Whenua. It is recommended that prior to any further development of Broadlands Road, extensive consultation with iwi be undertaken to ensure that sites and issues of importance are identified early on.

9 Route Strategy

9.1 Constraints to Improvements

In addition to constraints identified in Section 7 of this report, any improvement work on the study route could be constrained by the level of available funding to RDC and TDC.

The location of services in the road corridor could also be a constraint to improvements such as realignments or seal widening works. Known services include:

- High-pressure natural gas pipeline adjacent to the road reserve on Broadlands Road, from View Road north to Broadlands township
- TelstraClear fibre optic cable in the road reserve on the eastern side of Broadlands Road TDC, Broadlands Road RDC and Settlers Road.
- Telecom copper cables in the road reserve at various locations on the study route.
- A private effluent pipeline running along the eastern side of Broadlands Road, from View Road north to Tasman Forests.
- Low voltage overhead power transmission lines.

9.2 Access and Road Protection

The declaration of roads as Limited Access Roads (LAR's) is an access management tool available for contributing to the control of the interface between the road and adjacent land in a way that protects the utility and amenity of both. By reducing or controlling access to arterial roads and influencing development along the road margins, the detrimental effects on the safety and efficiency of the road for roads users will be minimised.

The main candidates for LAR status on the study route appear to be Broadlands Road RDC, Broadlands Road TDC, and Settlers Road, which mainly act as strategic arterial routes. Reporoa Road is a relatively low-use local access road, Miro Street is an urban commercial/industrial access road in addition to its arterial role, while Crown Road will change significantly as a result of construction of the proposed ETA.

9.2.1 The LAR Process

The Local Government Act 2002 allows continued use of Section 346 of the Local Government Act 1974, which specifies how by special order Councils can declare a road in their district to be a limited access road. The following provisions apply in the declaration of a limited access road:

(a) "Every declaration shall refer to a plan showing –

(i) The length of road to be declared LAR

(ii) Any crossing places to be authorised

(iii) The boundaries of all road frontages of each parcel of land adjoining the road

(iv) The title references to every parcel of land referred to above

(b) Every such declaration shall indicate where the plan is held and may be inspected;

(c) The Council shall forward to the District Land Registrar a certificate authenticated by the Council (together with a copy of the plan mentioned above) describing every parcel of land that is affected by the LAR. The District Land Registrar will record it against the titles to all these parcels of land.

(d) The Council will send (or have sent) a copy of the certificate to the owner and occupier of any land affected by the declaration."

The Act goes on to detail the rights and powers of landowners and Council regarding access to and from a limited access road.

We consider that LAR status should be considered for Broadlands Road RDC, Broadlands Road TDC, and Settlers Road. As traffic or roadside development increases, so does the potential for conflict between through and turning/manoeuvring traffic. Applying this status will provide a useful tool for TDC and RDC to have a measure of control over access to this strategic arterial route, whether from rural-residential or farming/forestry developments along the route, especially considering the expected traffic growth.

9.3 Passing Opportunities

Passing opportunities on the study route are generally good due to the fairly straight flat nature of route. However, overtaking type crashes are over-represented on Broadlands Road as a whole.

Passing opportunities on Broadlands Road TDC could be improved by constructing a climbing lane in the southbound direction from RP 6,940-9,240, where the extended uphill gradient tends to slow heavy vehicles.

Other methods of improving the safety of passing manoeuvres include:

- Seal widening works, which will improve the current situation where there is little room for error in the passing manoeuvre, particularly where heavy vehicles are involved. The majority of groups consulted for this study noted the narrow seal width as a major issue for road users.
- Targeting maintenance on areas with significant rutting, as identified in Section 4.2.5 of this report, to improve safety in wet conditions

9.4 Horizontal and Vertical Alignment

This study has not identified any major realignment works along the study route. A number of curves, identified in Section 4.3 of this report, have radii less than desirable based on the approach speeds to the curves. We recommend a strategy of improving either the warning signage on each of these curves, or curve easing/realignment works, or both, to mitigate the potential safety hazards at these curves.

To achieve a workable programme that will maximise benefits we recommend prioritising the treatment of curves with the greatest potential safety hazard, followed in turn by less hazardous curves. The two main factors used in the prioritisation process are the crash history and the radius of the curve.

Table 39 and Table 40 give a prioritised list of the curves identified for treatment for each district. Curves recommended for realignment are identified in Section 9.10, and detailed in Appendix 8, of this report.

Priority	Subsection	Route Position (m)	Proposed Treatment
1	Settlers Road	5,300	Realignment
2	Settlers Road	2,500-2,750	Realignment
3	Broadlands Road	9,900	Signage
4	Settlers Road	1,100	Signage
5	Broadlands Road	2,780	Signage

Table 39. Rotorua District Council prioritised curves for treatment

Priority	Subsection	Route Position (m)	Proposed Treatment
1	Broadlands Road	23,500	Realignment
2	Broadlands Road	5,330	Realignment
3	Broadlands Road	11,700	Realignment
4	Broadlands Road	17,660	Signage
5	Broadlands Road	13,550	Signage
6	Broadlands Road	17,150	Signage
7	Broadlands Road	15,460	Signage

Table 40. Taupo District Council prioritised curves for treatment

Vertical alignment, as described in Section 4.4 of this report, is generally satisfactory. No improvement works are proposed in this report.

9.5 Cross Section

9.5.1 Width

As detailed in Section 8 of this report, feedback from the majority of groups consulted for this report suggests seal width is a concern for road users on the study route.

A safe road corridor should have sufficient width to cater for all expected road users. Given the status of much of the route as a regional arterial some widening should be carried out on the route to provide a sealed shoulder. This will improve safety for all road users, including cyclists. Providing a wider road for vehicles will not necessarily encourage higher travel speeds – current experience suggests traffic is already travelling at high speed along the route.

Seal width can be judged for adequacy by considering the number of loss of control/head on and overtaking type crashes as a proportion of the total. For Broadlands Road in both districts overtaking type crashes are over-represented, while overall on the study route loss-of-control/head on type crashes are generally comparable with or below local and peer group statistics. With the exception of Settlers Road, the mid-block injury crash rate is also comparable with or below typical rates expected for similar roads.

Other factors that should be taken into account regarding seal width include the high volume of heavy vehicles as a proportion of the overall traffic stream, and the popularity of the route for competitive and recreational cyclists, including its use in the NZ Ironman race and as a training route for this event.

Transfund have a budget for subsidising shoulder widening construction as a cycle project. Possible projects have been identified in Section 9.10 of this report.

Seal widening should therefore be carried out:

- in conjunction with rehabilitation/renewal works as funding allows; and
- as cycle lane projects where funding applications are granted.

9.5.2 Consistency

Desirably some consistency should be applied along the study route in terms of seal width. Currently the seal width tends to vary between different sections that have been constructed at different times. If a consistent width is to be adopted it would be desirable to follow RDC and TDC respective guidelines.

9.6 Pavement

9.6.1 Rehabilitation/Renewal

Pavement rehabilitation/renewal work should be carried out in accordance with respective RDC and TDC Roading Asset Management Plans. These plans both specify that rehabilitation/renewal works be carried out based on the age and condition of the pavement.

Appendix 2 of this report gives prioritised time frames for rehabilitation of the study route based on these pavement factors. The required level of rehabilitation or renewal will depend on the age, condition and economic lives of the materials in the pavement.

Rehabilitation should be carried out progressively based on the prioritised time frames, as funding allows.

9.6.2 Surfacing

Resurfacing work should also be carried out in accordance with the Roading Asset Management Plan of each council. Appendix 2 lists prioritised reseals on the study route based on top surface age and condition.

Methods are available to provide a smoother texture sealed surface on shoulders to present a more comfortable surface for cyclists. However, while providing a desirable situation for cyclists, there is a potential safety issue associated with the differing friction of the surfaces for vehicles that 'hug' the shoulder or cut the inside of curves.

9.7 Intersections

The strategy for the study route should focus on upgrading intersections to consistent, currently accepted standards that drivers are familiar with. Section 4.5 of this report identifies a number of possible intersection improvements. Intersections should be investigated and upgraded, as funding allows, in a prioritised manner based on existing crash history and traffic volumes, as shown in Table 41 and Table 42 below.

Priority	Intersection	Treatment Type
1	Broadlands Road/Strathmore Road	Type A
2	Broadlands Road/Homestead Road	Type A
3	Broadlands Road/East Road	Type A
4	Broadlands Road/Earle Road	Type A
5	Broadlands Road/Allen Road	Type A
6	Broadlands Road/Vaile Road	Type A
7	Broadlands Road/Earle Road	Type A
8	Settlers Road/Wharepapa Road	Type A
9	Settlers Road/Loop Road	Type A – Consider closing

Table 41. RDC prioritised intersection upgrades

Priority	Intersection	Treatment Type
1	Broadlands Road/Centennial Drive	Left turn slip lane
2	Broadlands Road/River Road	Type A
3	Broadlands Road/View Road	Type A; Flaglighting
4	Broadlands Road/White Road	Type A
5	Broadlands Road/Tiverton Downs Road	Type A

Table 42. TDC prioritised intersection upgrades

Flaglighting is complete along the study route except for View Road and Loop Road. View Road should be flaglit as soon as practicable. We do not consider that Loop Road requires flaglighting and recommend that serious consideration be given to closing the Broadlands Road/Loop Road intersection.

9.8 Cyclists

With Taupo's rapidly increasing population, and the active nature of the residents it attracts, the number of cyclists using the study route can be reasonably expected to grow over the next 20 years, especially if Taupo continues to be the venue for the NZ Ironman race. These vulnerable road users are currently not well provided for on the majority of the study route.

TDC are considering an initiative involving provision of temporary educational signage along Broadlands Road highlighting to vehicles that this is a regular cycling route. Similar signs were erected by cycling groups prior to the 2004 NZ Ironman race and appeared to be effective. There would be some merit in RDC carrying out this exercise from the northern end of the study route, so drivers travelling in both directions along Broadlands Road are aware of the likely presence of cyclists.

Another strategy to cater for cyclists involves improving the seal width on the route, which will provide space for cyclists and separation from the traffic stream. Targeting seal widening as cycle projects is an opportunity to broaden the possible funding subsidies available from Transfund. A logical approach to this would be progressively extending the wide shoulders for cyclists from Taupo north, as has already been done on Broadlands Road in the northbound direction between Miro Street and Centennial Drive. These widening projects would be carried out in stages, beginning with the southbound shoulder between Centennial Drive and Miro Street.

Proposed cycle lane/shoulder widening projects are detailed in Section 9.10, and Appendix 8, of this report.

A sustainable strategy to improve cyclist safety on the route will involve a combination of the following measures:

- Providing educational/warning signage in the short term
- Carrying out road widening in conjunction with rehabilitation/renewal works
- Applying for Transfund funding for road widening as cycle projects

9.9 Signage

RDC and TDC recognize that the study route is a significant arterial route used by many as an alternative to SH5 between Rotorua and Taupo. The strategy regarding signage on the route should not necessarily be to encourage this type of use, but rather provide guidance to drivers once they are on the route. Currently there is little or no information signage on the study route to guide inter-regional motorists to their destinations.

One example is the southern end of Broadlands Road near Taupo. Southbound drivers intending to continue east along SH5 could have difficulty recognizing that the best route to take involves a left turn at Miro Street. Providing some signage here will benefit these road users.

Warning signage could be improved at several low-radius curves to better warn drivers of the severity of these curves. Section 9.4 of this report gives a prioritised list of curves that should be investigated and possibly improved.

Achieving consistency along the study route in signage such as warning signs and chevrons is also desirable. This could be done in conjunction with any signage improvements.

9.10 Projects

Projects identified in Rotorua District and Taupo District have been listed separately.

9.10.1 RDC

Project Name/RP	Description	Improvement Type	Cost Estimate ($K)	BCR
Settlers Road Realignment – RP 2,410-3,155	This project involves realigning the road to avoid two low-radius reverse curves and increasing seal width to 8.5m. There have been three reported loss-of-control crashes at these curves in a five-year period, one of which resulted in minor injuries.	Safety Improvement/ Efficiency	$545	**0.9**
Settlers Road Realignment – RP 5,065-5,590	This project involves the realignment of low-radius reverse curves that are a crash black spot. At present the low radius curves, narrow seal width and deficient skid resistance contribute to a number of loss-of-control type crashes. The new alignment will be straighter, with a seal width of 8.5m, and involves some cutting through a low hill. This will also require some land-take. However, the low severity of reported crashes (5 non-injury) results in relatively small benefits from crash savings and subsequently a relatively low BCR.	Safety Improvement/ Efficiency	$411	**0.8**

9.10.2 TDC

Project Name/RP	Description	Improvement Type	Cost Estimate ($K)	BCR
Broadlands Road Curve Easing – RP 5,185-5,420	This project involves easing the low-radius curve, improving the superelevation, and increasing seal width to 9.4m. It also involves a small amount of work to tie the View Road intersection into the realigned curve. There have been three reported loss-of-control crashes at this curve in the five-year period, including two minor-injury crashes.	Safety Improvement	$121	**2.9**
Broadlands Road Curve Easing – RP 11,485-11,700	This project involves easing the low-radius curve, improving the superelevation, and increasing seal width to 9.4m. This curve has been the scene of one reported loss-of-control/head on type crash in the five-year period.	Safety Improvement	$138	**1.5**
Broadlands Road Curve Easing – RP 23,235-23,470	This project involves the easing of a low-radius curve, improving the superelevation and increasing the seal width to 9.4m. This curve has been the scene of two recent loss-of-control crashes, one fatal and one minor injury. Four power poles would require relocation as part of this project.	Safety Improvement	$152	**1.9**
Broadlands Road Southbound Climbing Lane – RP 6,940-9,240	This project involves the construction of a 3.5m-wide climbing lane in the southbound direction. There is an extended uphill grade for southbound traffic, which can slow heavy vehicles.	Efficiency/Safety Improvement	$1,472 (includes rehab of existing	**1.4**

Project Name/RP	Description	Improvement Type	Cost Estimate ($K)	BCR
	Due to the age of much of the existing adjacent pavement, it would be recommended to carry out rehabilitation in association with construction of the climbing lane. This approach would result in overall cost savings compared to if rehabilitation was carried out separately.		pavement)	
Broadlands Road Cycle Lane / Shoulder Widening – RP 0-3,300	This project involves providing a 2.0m wide sealed shoulder in the southbound direction to provide for safe cyclist movement, to replicate the existing northbound cycle lane between Miro Street and Centennial Drive. Austroads (1999) recommends 2.0m as a minimum width in 100 km/h areas.	Cycle Project	$327	**1.6**
Broadlands Road Cycle Lane / Shoulder Widening – RP 3,300-5,300	This project involves extending the cycle lanes northwards, providing a 2.0m wide sealed shoulder in both directions between Centennial Drive and View Road.	Cycle Project	$459	**2.0**
Broadlands Road Cycle Lane / Shoulder Widening – RP 5,300-9,700	This project involves providing a 2.0m wide sealed shoulder in both directions between View Road and the southern edge of Broadlands Forest.	Cycle Project	$952	**1.7**
Broadlands Road Cycle Lane / Shoulder Widening – RP 9,700-16,100	This project involves providing a 2.0m wide sealed shoulder in both directions between View Road and the southern edge of Broadlands Forest.	Cycle Project	$1,337	**1.8**
Broadlands Road Cycle Lane / Shoulder Widening – RP 16,100-19,900	This project involves providing a 2.0m wide sealed shoulder in both directions between the southern edge of Broadlands Forest and White Road.	Cycle Project	$889	**1.5**

Project Name/RP	Description	Improvement Type	Cost Estimate ($K)	BCR
Broadlands Road Cycle Lane / Shoulder Widening – RP 19,900-24,500	This project involves providing a 2.0m wide sealed shoulder in both directions between White Road and the district boundary.	Cycle Project	$979	**2.1**

10 Conclusions/Recommendations

The key conclusions of this study are:

- Traffic volumes are expected to increase over the next 20 years or so at a rate above that seen historically, reflecting expected rapid population growth in the Taupo District. The staged construction of the proposed Eastern Taupo Arterial will have different effects on traffic volumes on each subsection of the route.
- The proportion of heavy vehicles in the traffic stream is expected to remain fairly constant.
- The level of service (LOS) on the study route is expected to be at LOS C or better until at least 2024.
- The seal width on the study route is generally below respective RDC and TDC guideline widths. The lack of seal width was identified as a major issue by many groups consulted for this study.
- The relatively straight and flat alignment of the study route means the alignment does not pose a constraint to passing opportunities.
- Some of the pavements in the Taupo District are relatively old, but are not necessarily showing significant signs of stress or deterioration.
- Several sections have been identified which have significant rutting and/or roughness.
- A large number of recreational and competitive cyclists use Broadlands Road, and this number is expected to increase.
- Broadlands Road has a high proportion of overtaking type crashes, but overall mid-block injury crash rates are comparable with national rates.

The main strategies for improving and upgrading the study route, to maintain a reasonable level of service and safety, are to:

- Rehabilitate pavements in accordance with RDC and TDC's respective Roading Asset Management Plans, and the prioritised programme given in Appendix 2 of this report.
- Improve seal width along Broadlands Road, Settlers Road and Reporoa Road in conjunction with rehabilitation and renewal works, and as subsidised stand-alone cycling projects.
- Realign or ease low radius horizontal curves and/or improve warning signage at these curves where appropriate.
- Provide consistency along the route in terms of seal width, intersection layout, and signage.

Projects

The tables below describe the major projects considered for the study length, their estimated cost, indicative BCR, and identified positive contributions to the goals of the

NZTS and hence LTMA. These contributions are detailed further in Appendix 8 of this Report.

Project Name	Cost ($K)	BCR	Contribution to NZTS Objectives
Settlers Road Curve Easing – RP 2,410-3,155	$545	**0.9**	• Safety and Personal Security • Economic Development
Settlers Road Realignment – RP 5,065-5, 590	$411	**0.8**	• Safety and Personal Security • Economic Development

Table 43. Rotorua District Projects

Project Name	Cost ($K)	BCR	Contribution to NZTS Objectives
Broadlands Road Curve Easing – RP 5,185-5,420	$121	**2.9**	• Safety and Personal Security
Broadlands Road Curve Easing – RP 11,485-11,700	$138	**1.5**	• Safety and Personal Security
Broadlands Road Curve Easing – RP 23,235-23,470	$152	**1.9**	• Safety and Personal Security
Broadlands Road Southbound Climbing Lane – RP 6,940-9,240	$1,472	**1.4**	• Safety and Personal Security • Economic Development
Broadlands Road Cycle Lane/Shoulder Widening – RP 0-3,300	$327	**1.6**	• Safety and Personal Security • Public Health • Environmental Sustainability
Broadlands Road Cycle Lane/Shoulder Widening – RP 3,300-5,300	$459	**2.0**	• Safety and Personal Security • Public Health • Environmental Sustainability
Broadlands Road Cycle Lane/Shoulder Widening – RP 5,300-9,700	$952	**1.7**	• Safety and Personal Security • Public Health • Environmental Sustainability
Broadlands Road Cycle Lane/Shoulder Widening – RP 9,700-16,100	$1,337	**1.8**	• Safety and Personal Security • Public Health • Environmental Sustainability
Broadlands Road Cycle Lane/Shoulder Widening – RP 16,100-19,900	$889	**1.5**	• Safety and Personal Security • Public Health • Environmental Sustainability
Broadlands Road Cycle Lane/Shoulder Widening – RP 19,900-24,500	$979	**2.1**	• Safety and Personal Security • Public Health • Environmental Sustainability

Table 44. Taupo District Projects

11 References

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Appendix 1

Route Information Sheets

Appendix 2

Prioritised Rehabilitation and Improvement Programme

Appendix 3

Traffic Volume Data and Projections

Appendix 4

Level of Service Calculations

Appendix 5

East Taupo Arterial and Centennial Park Development Traffic Effects

Appendix 6

Crash Data and Diagrams

Appendix 7

Photographs

Appendix 8

Project Feasibility Reports

1. Settlers Road Realignment RP 2,410-3,155
2. Settlers Road Realignment RP 5,065-5,590
3. Broadlands Road TDC Curve Easing RP 5,185-5,420
4. Broadlands Road TDC Curve Easing RP 11,485-11,700
5. Broadlands Road TDC Curve Easing RP 23,235-23,470
6. Broadlands Road Climbing Lane RP 6,940-9,240
7. Broadlands Road Cycle Lane RP 0-3,300
8. Broadlands Road Cycle Lane RP 3,300-5,300
9. Broadlands Road Cycle Lane RP 5,300-9,700
10. Broadlands Road Cycle Lane RP 9,700-16,100
11. Broadlands Road Cycle Lane RP 16,100-19,900
12. Broadlands Road Cycle Lane RP 19,900-24,500