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.

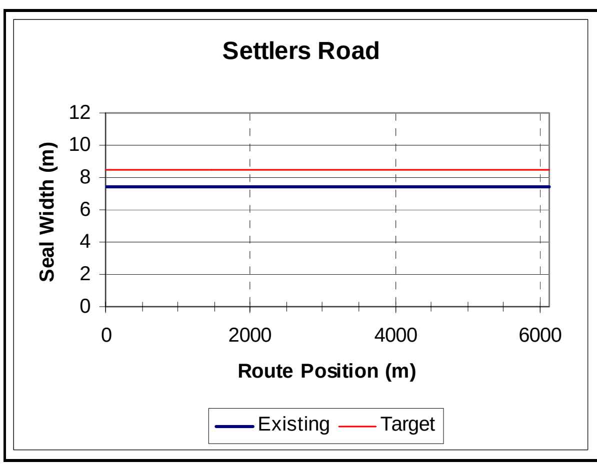
	Lane Width (m)		
Road Speed (km/h)	60	80	100
Desirable	**1.5**	**2.0**	**2.5**
Acceptable Range	1.2-2.5	1.8-2.7	2.0-3.0

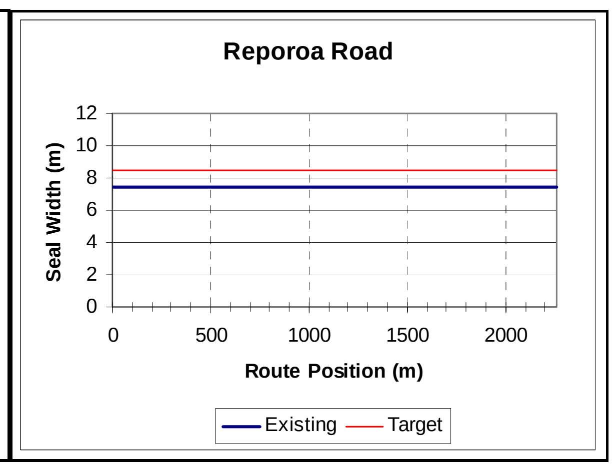
Table 24. Austroads bicycle lane and sealed shoulder dimensions

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.





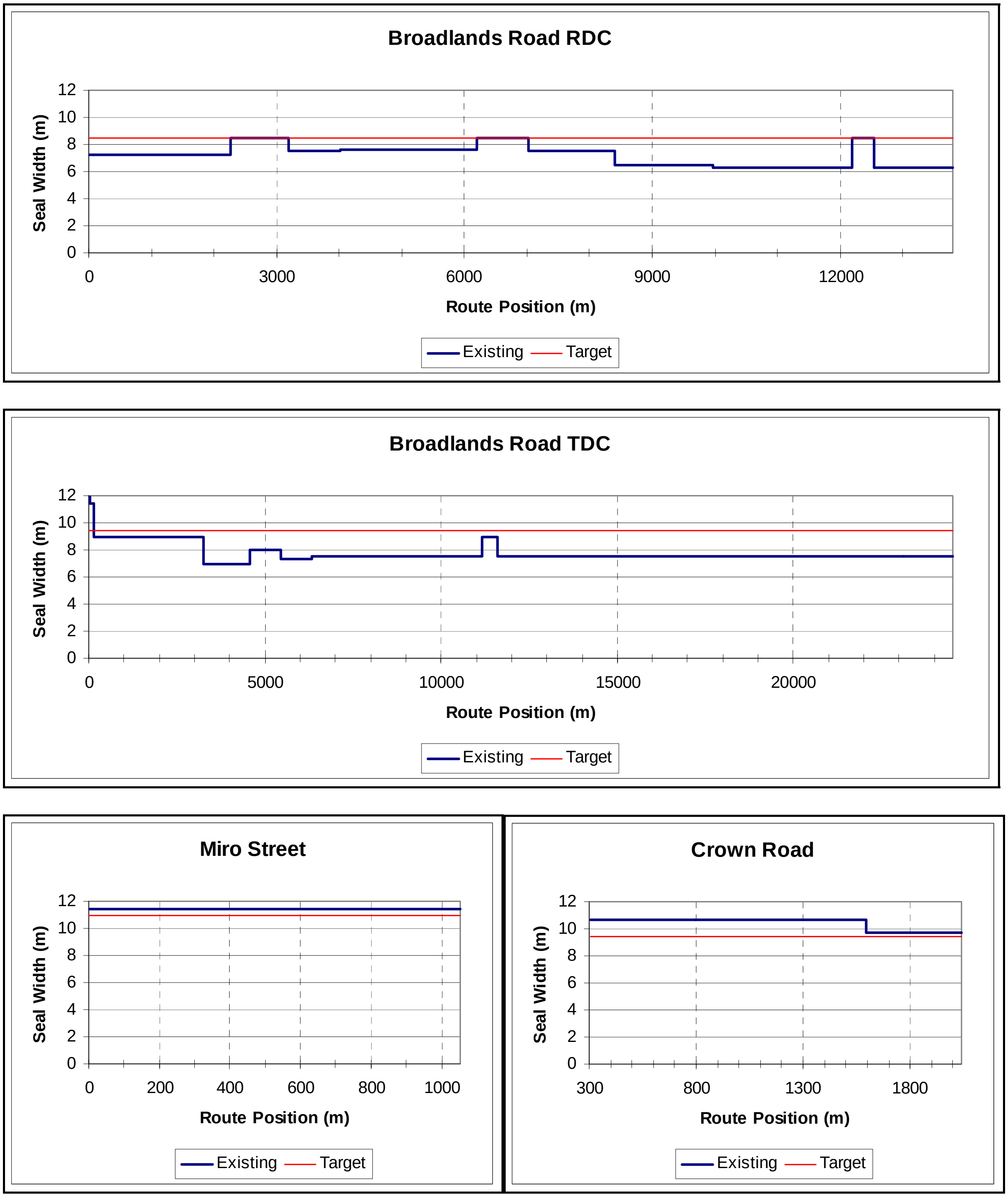


Figure 10. Seal widths on each subsection

<u>Improvement Proposals</u>

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

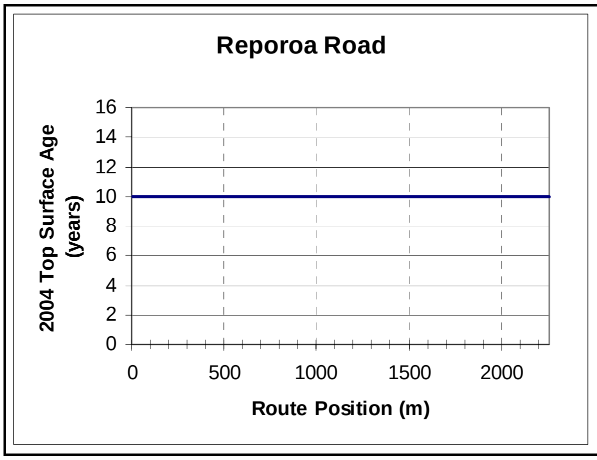
Maintaining the status quo seal width as traffic volumes increase will increase the potential for serious crashes, particularly involving cyclists and/or heavy vehicles. Overtaking and loss of control type crashes will probably continue to be over-represented.

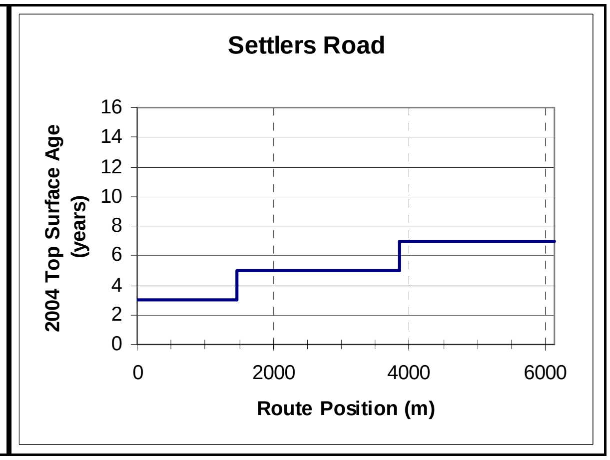
The recommended strategy is to increase seal width on the route, using a two-pronged approach:

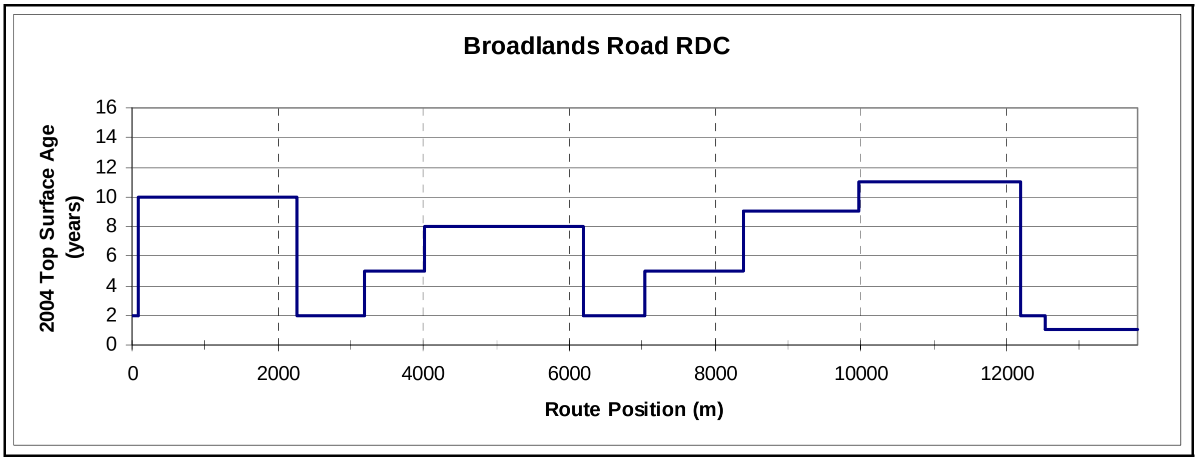
- Widen the seal to guideline standards where possible, in conjunction with reconstruction and rehabilitation works, or large maintenance patching.
- Identify specific projects involving creation of cycleways and/or increased shoulder widths on the route and apply for funding from Transfund's cycling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

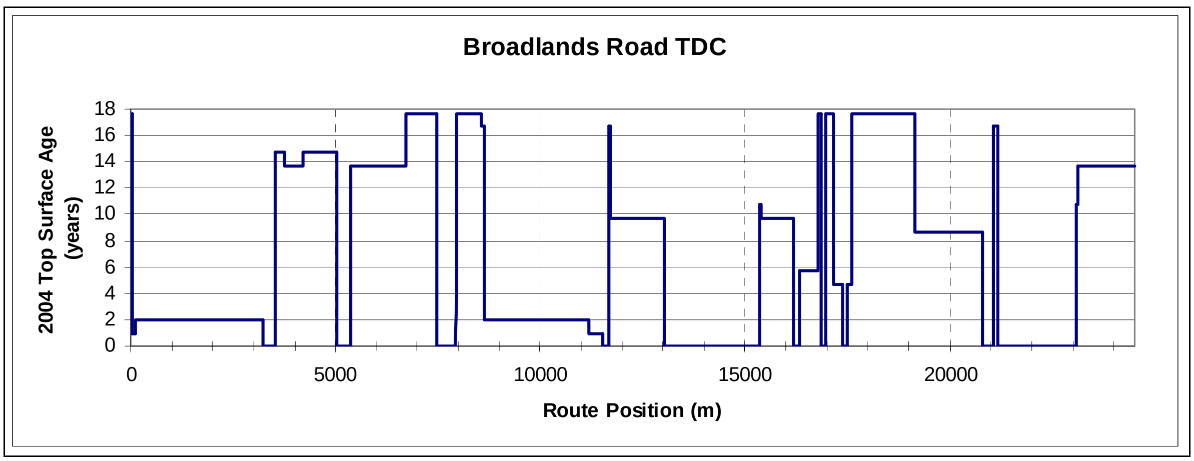
4.2.2 Top Surface Age

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)
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
Route Position (m)


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


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


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

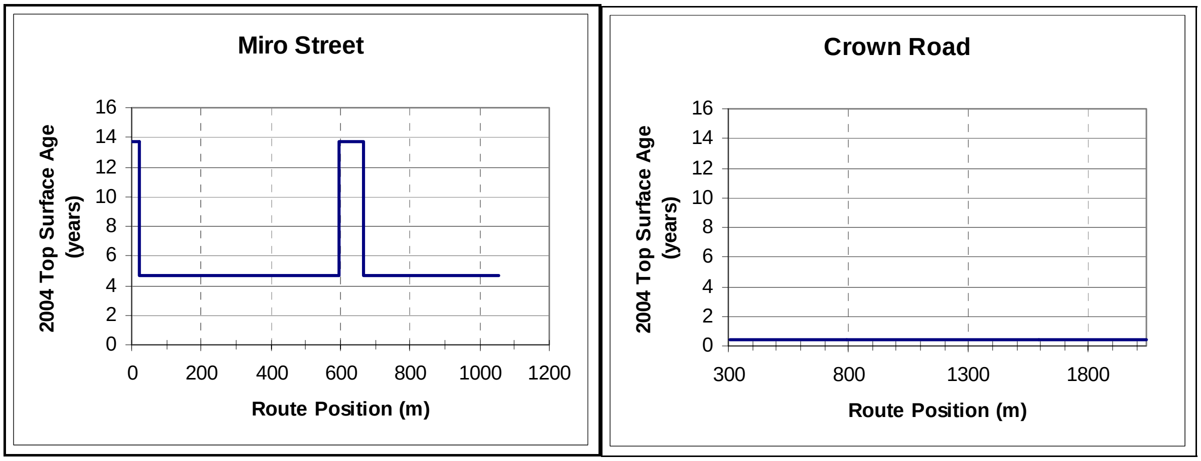


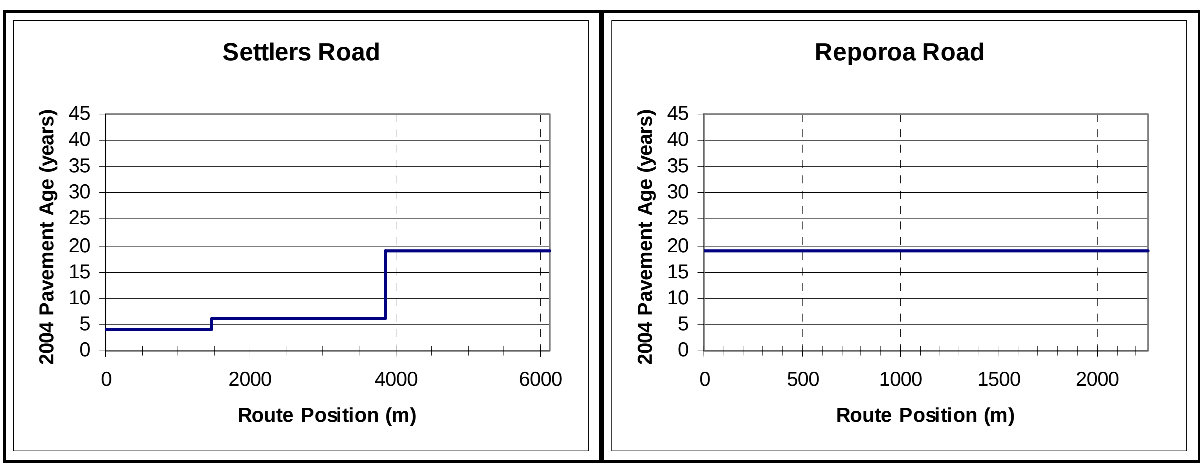
Figure 11. Top surface age

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.



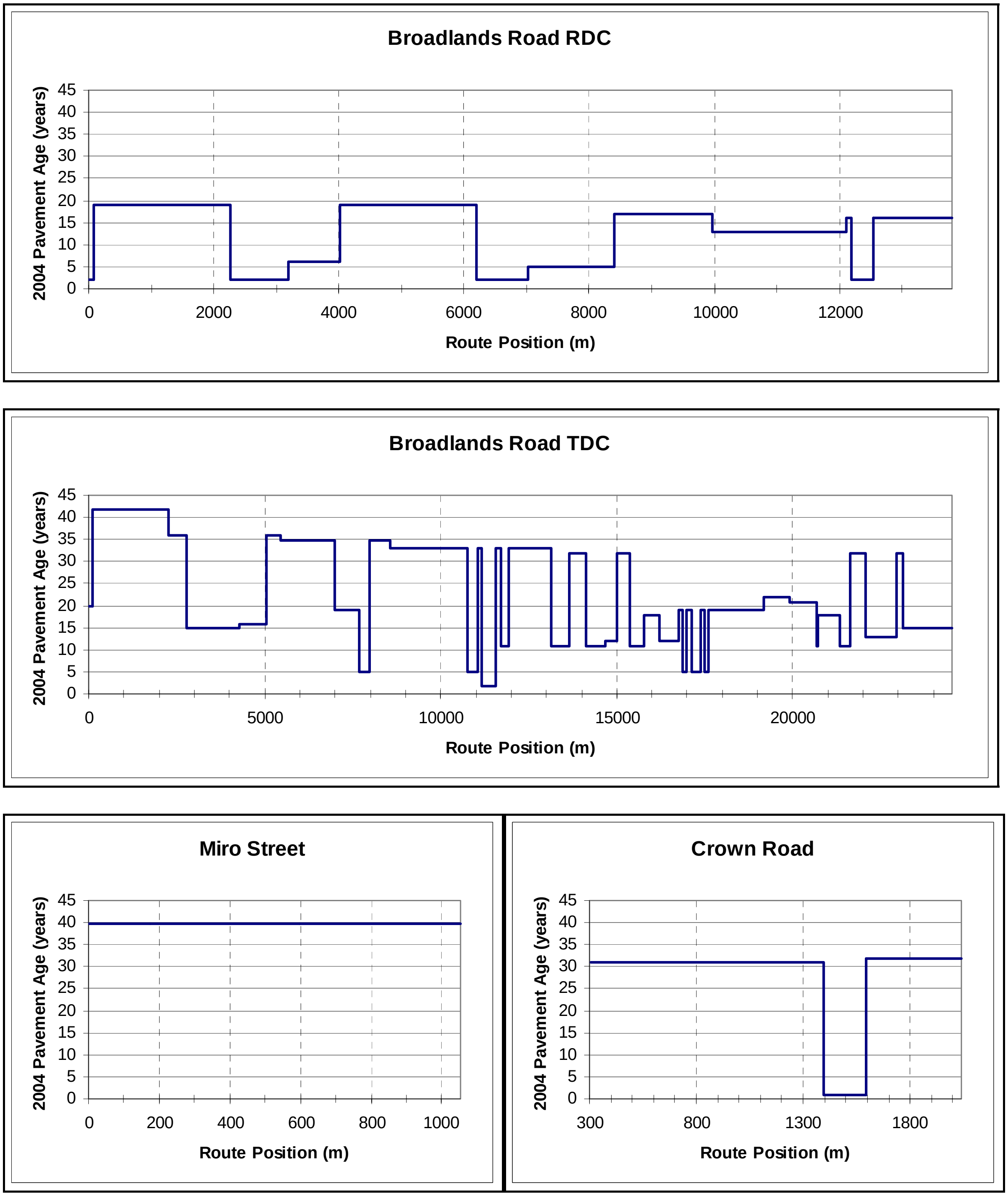


Figure 12. Pavement age

<u>Improvement Proposals</u>

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

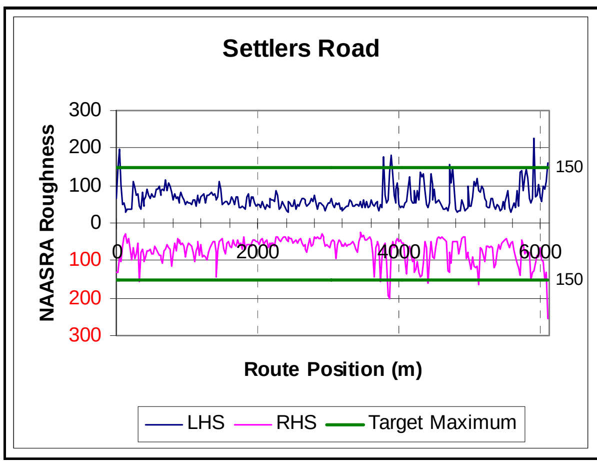
RDC state in their Roading Asset Management Plan that the target level of service is "more than 90% of all roads with 150 NAASRA counts or less".

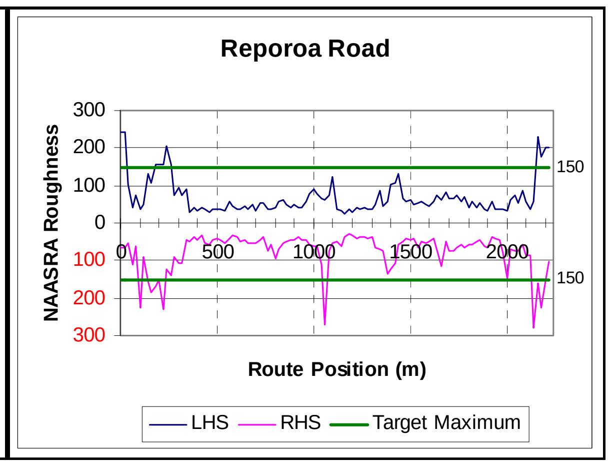
According to the TDC Roading Asset Management Plan, "TDC's 2003/04 Proposed Level of Service in their Annual Plan states that no more than 20% of the sealed road network will have a NAASRA roughness not greater than 130, and the average of all the sealed network shall be less than 90 NAASRA".

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.





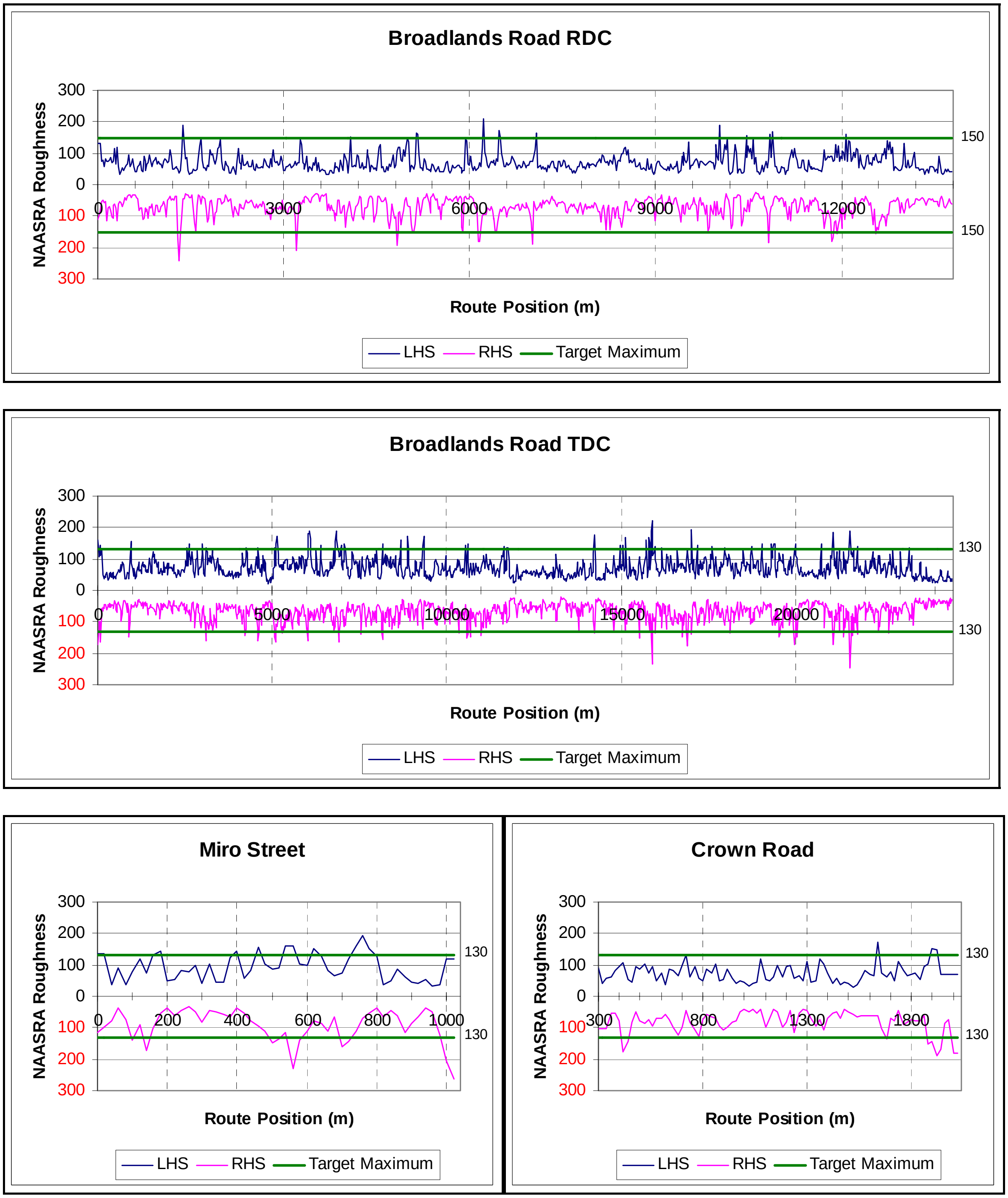


Figure 13. Roughness along each subsection

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

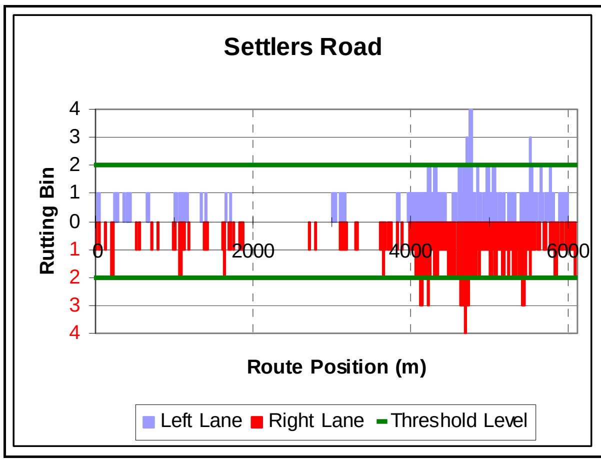
TDC's Roading Asset Management Plan states the target level of service in terms of wheel path rutting is to have less than or equal to 2% of the network with rutting greater than 30mm (bin 3 or higher). RDC does not give a target level of service in their Roading Asset Management Plan.

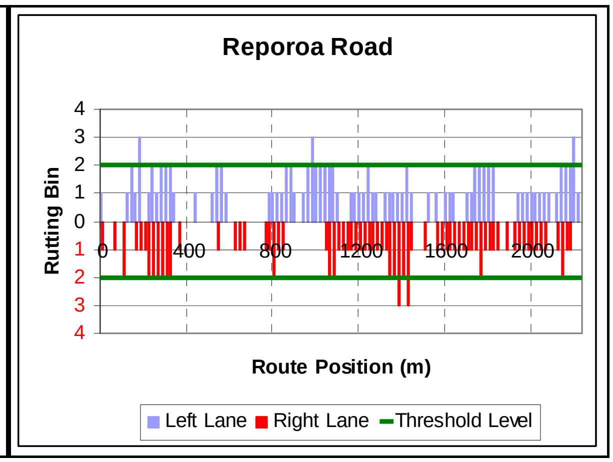
Rutting > 30mm has been used as the threshold level in this report.

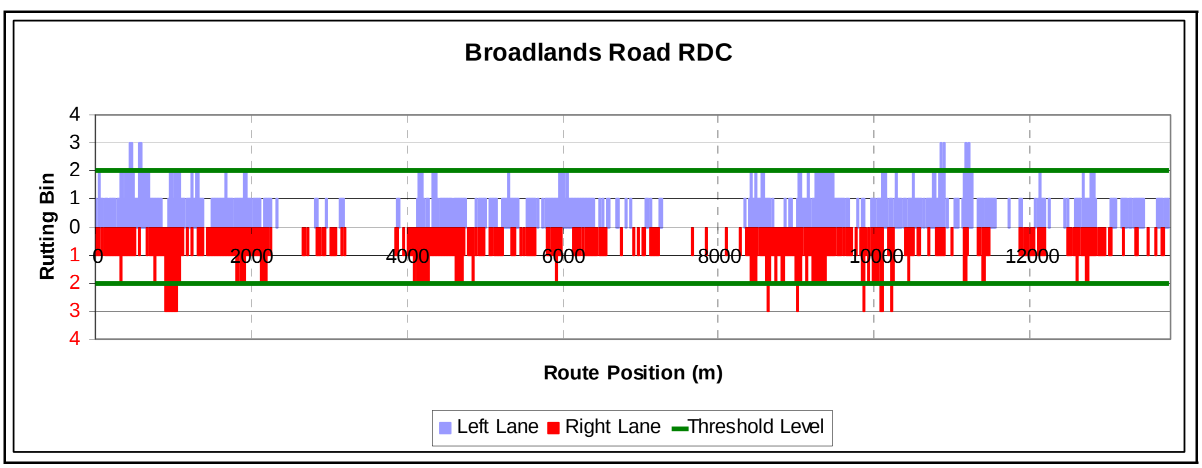
Existing Situation

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.







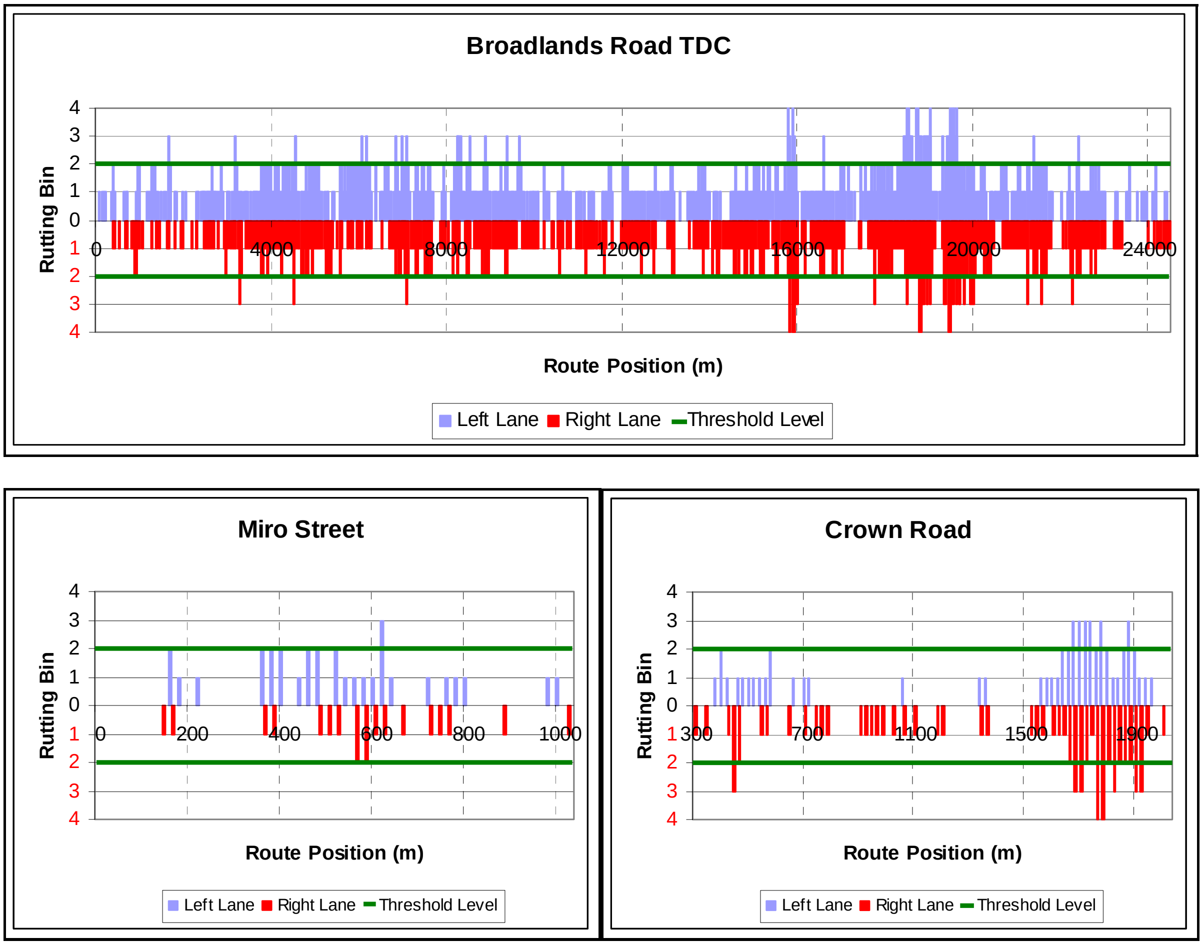


Figure 14. Rutting on each subsection

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

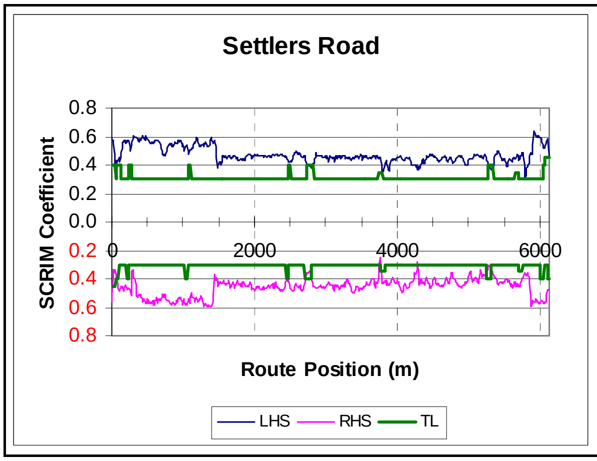
Table 29. Investigatory Skid Resistance Levels (abbreviated from TNZ T/10: 2002 Table 1)

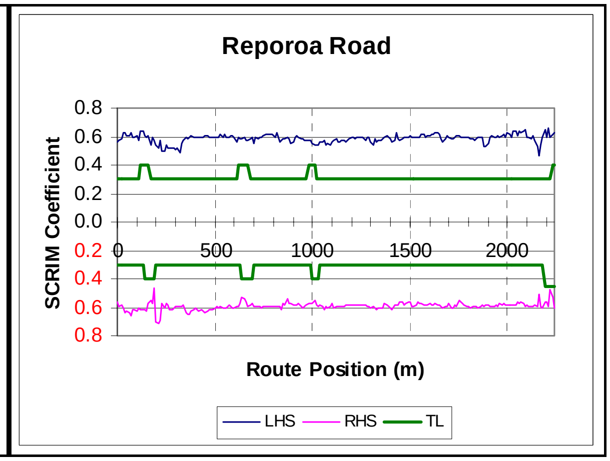
The Threshold Level (TL) is 0.10 below the IL. If the skid resistance falls below the TL, an investigation of the section of road is required to establish if treatment should be undertaken.

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.

<u>Existing Situation</u>

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.





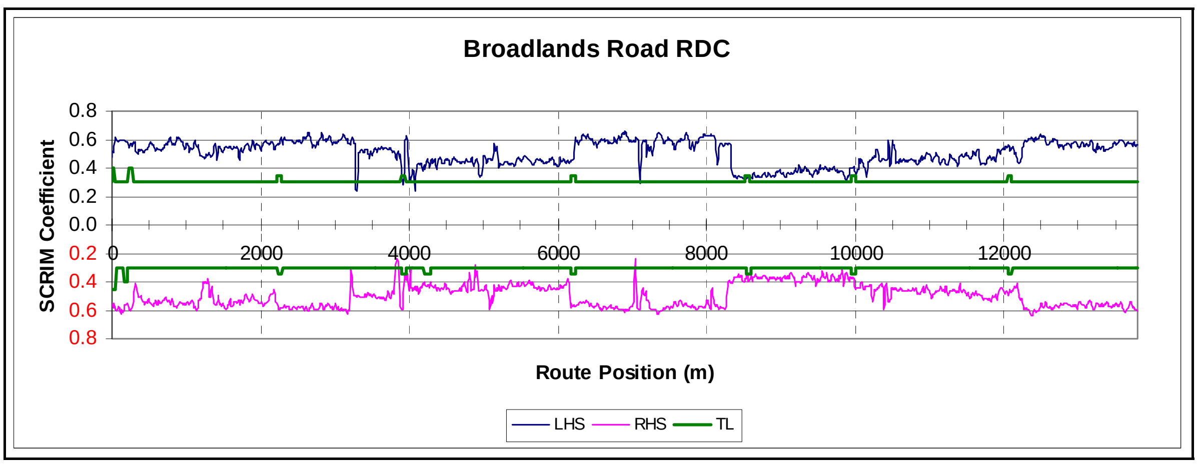


Figure 15. Skid resistance on each subsection

<u>Improvement Proposals</u>

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.

<u>Subsection 1</u>

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.

<u>Subsection 2</u>

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

<u>Subsection 3</u>

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

<u>Subsection 4</u>

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.

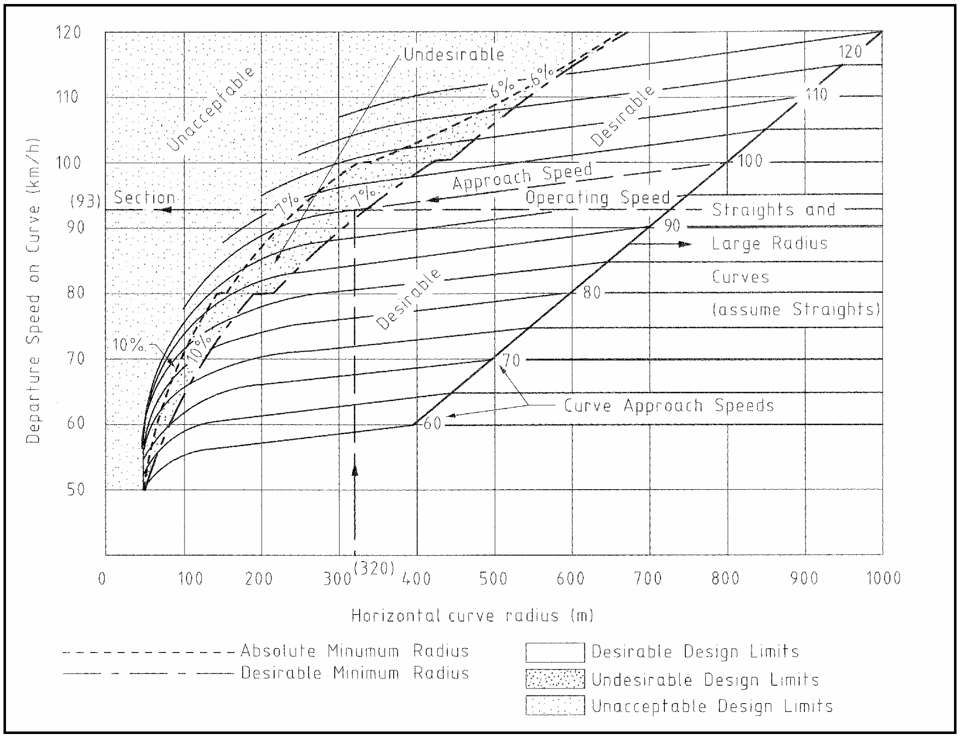


Figure 16. Deceleration plot for rural curves (reproduced from Austroads (2003))

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.

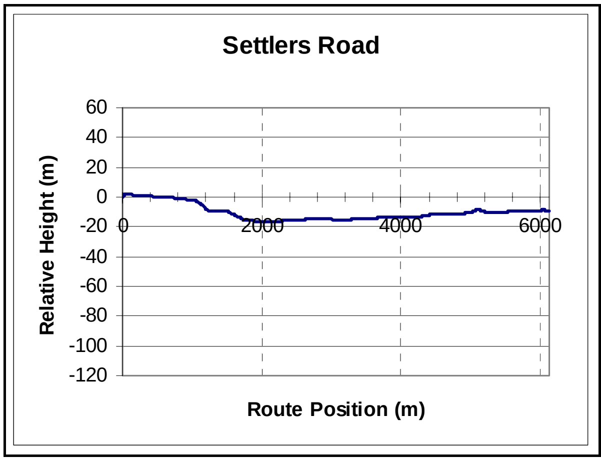
The study route runs through generally flat to rolling terrain, with Operating Speeds of 90-110 km/h. Based on this the general maximum grade has been assessed as 5%.

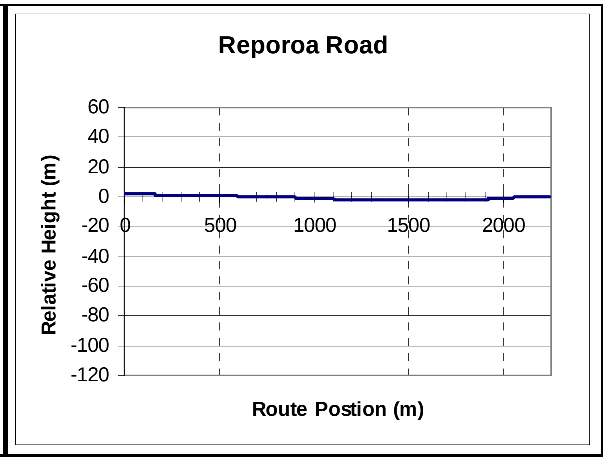
4.4.2 Existing Situation

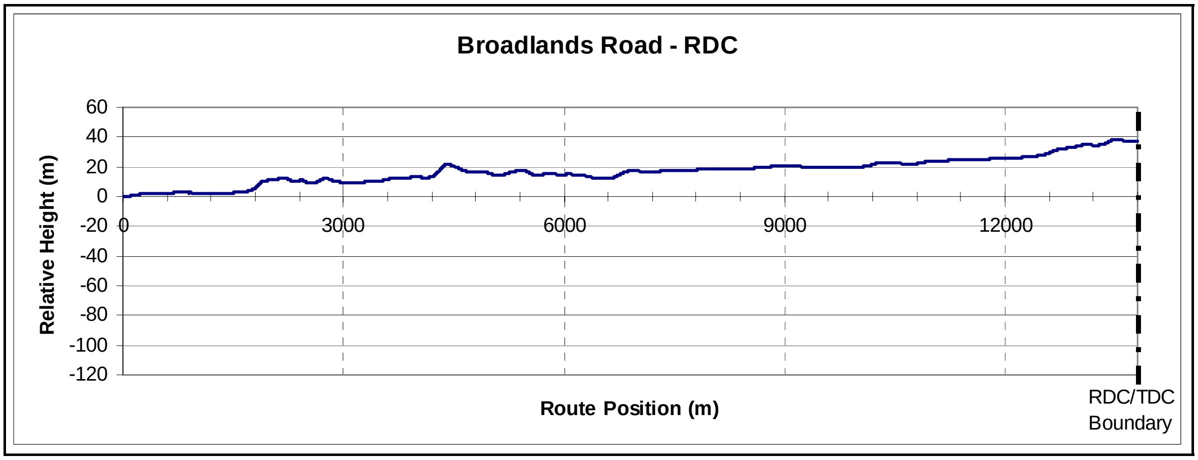
The study route runs mainly through flat to rolling terrain crossed by several small stream gullies. The route data sheets in Appendix 1 show vertical gradient along the study route, while the photos and graphs below show the vertical profiles of each subsection.

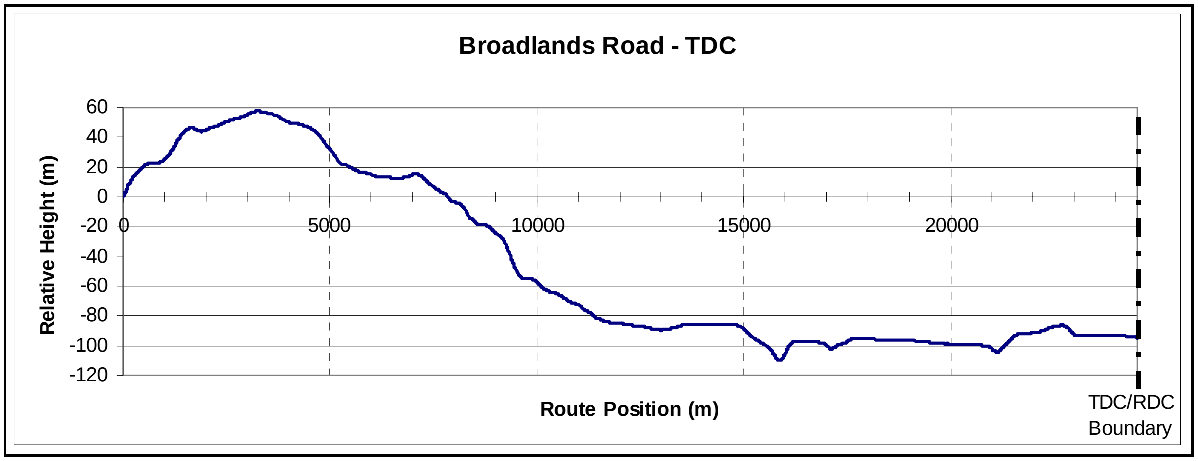
Figure 17. Varying vertical profile on Broadlands Road TDC

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.









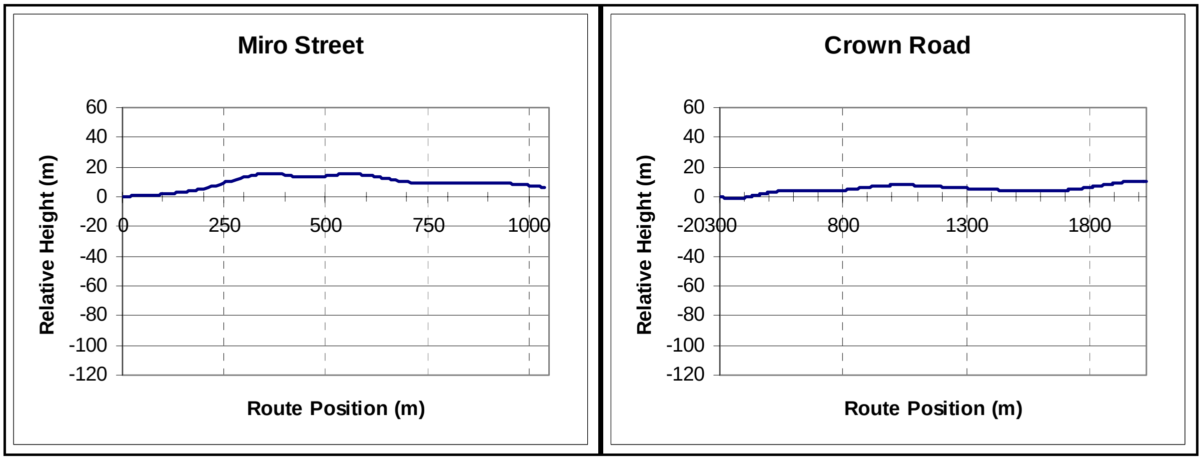


Figure 18. Vertical profile of each subsection

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.

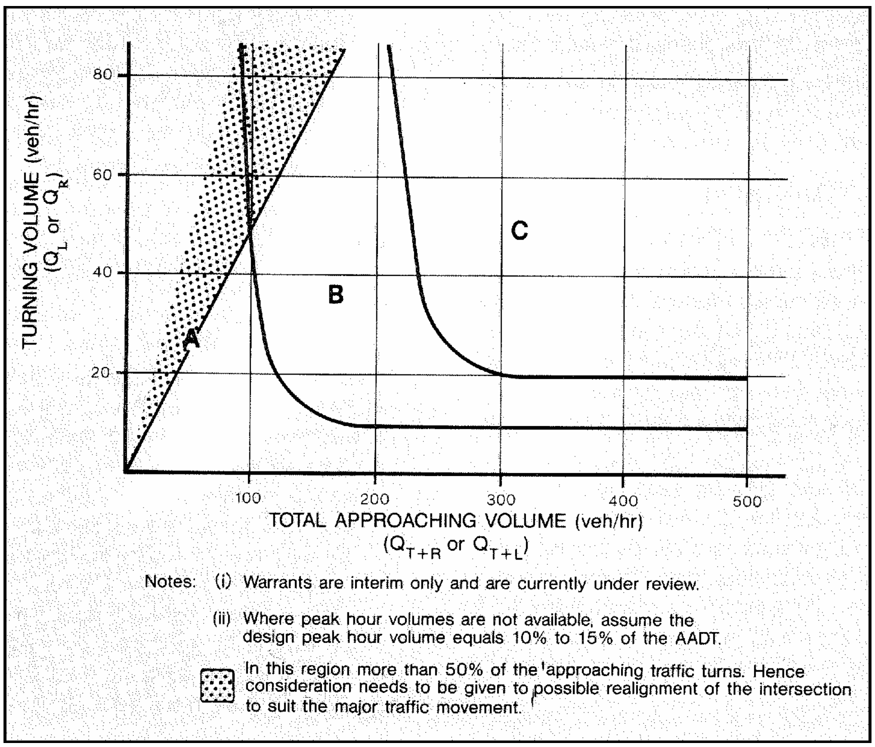


Figure 19. Turning lane volume warrants

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.

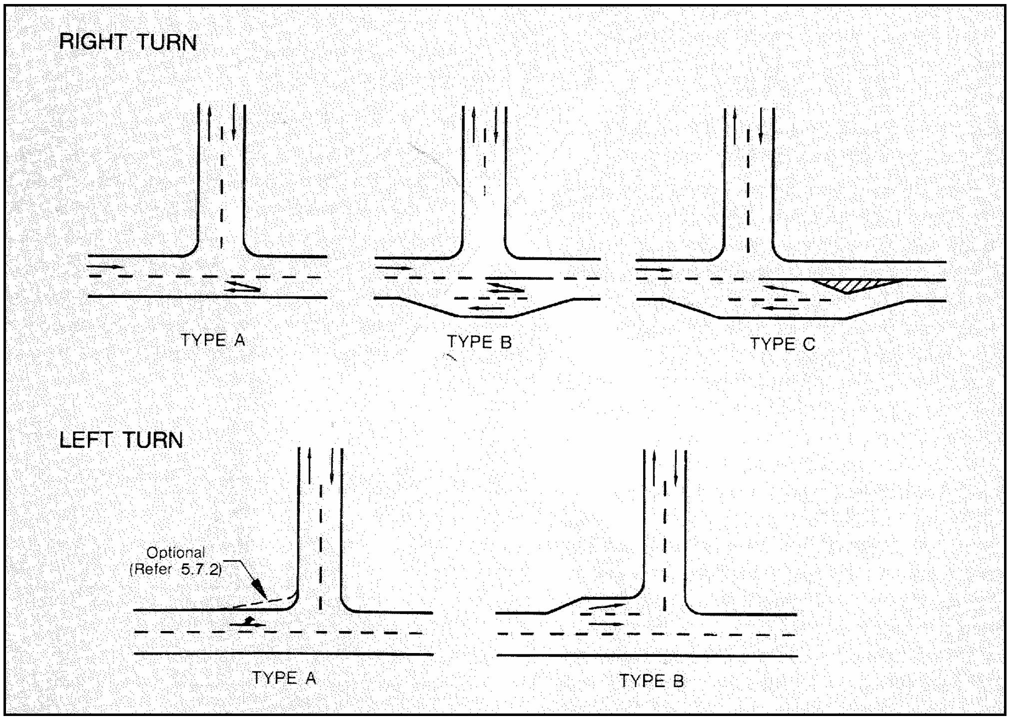


Figure 20. Turning lane treatments from Austroads (1988)

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.

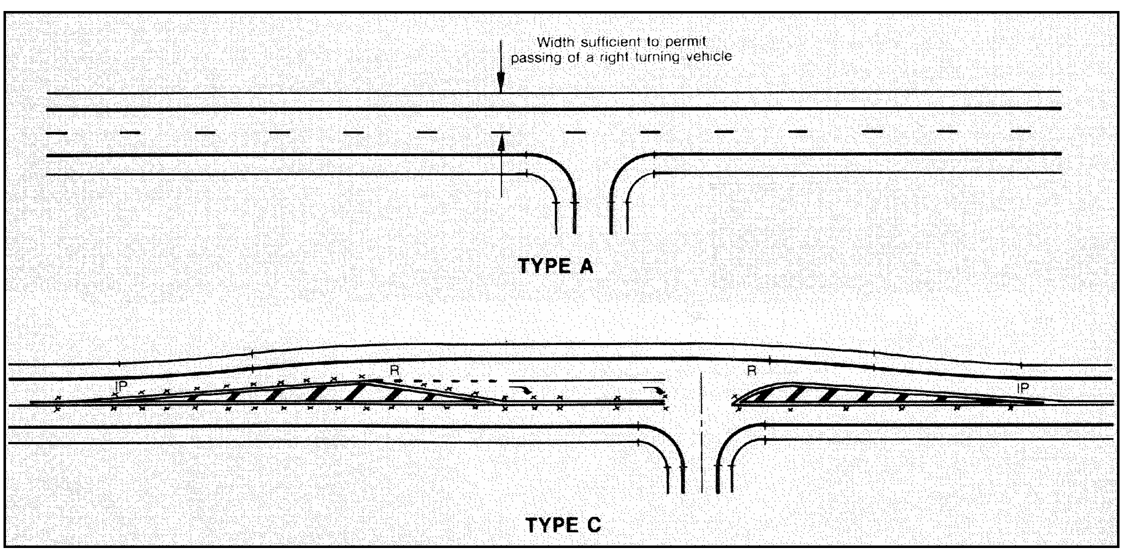


Figure 21. Right turn treatments

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

<u>Urban</u>

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.

<u>Settlers Road/Loop Road Intersection</u>

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.

<u>Broadlands Road/Miro Street/Tauhara Road Intersection</u>

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:

<u>Subsection 1 – Settlers Road</u>

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.

<u>Subsection 2 – Reporoa Road</u>

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

<u>Subsection 3 – Broadlands Road RDC</u>

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.

<u>Subsection 4 – Broadlands Road TDC</u>

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

<u>Subsection 5 – Miro Street</u>

Miro Street is predominantly urban, with kerb and channel.

<u>Subsection 6 – Crown Road</u>

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.

<u>Climbing Lane</u>

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.

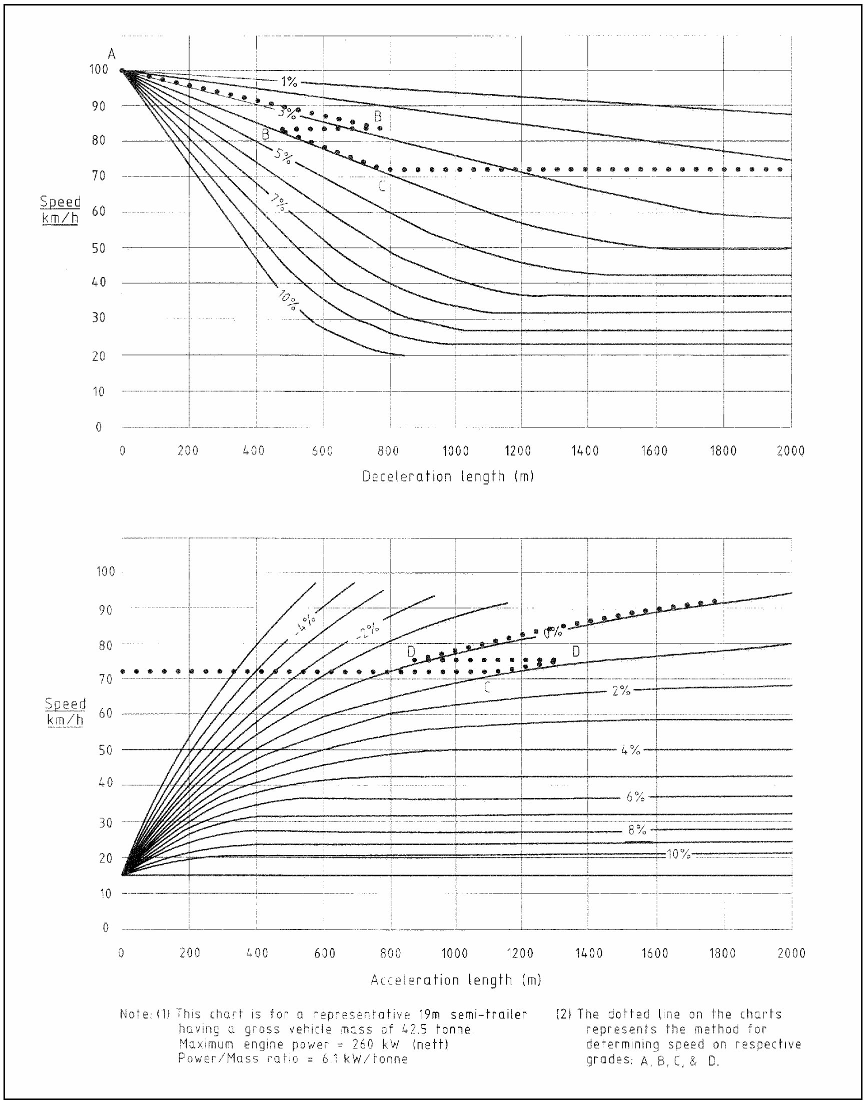


Figure 23. Austroads truck performance curves

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.

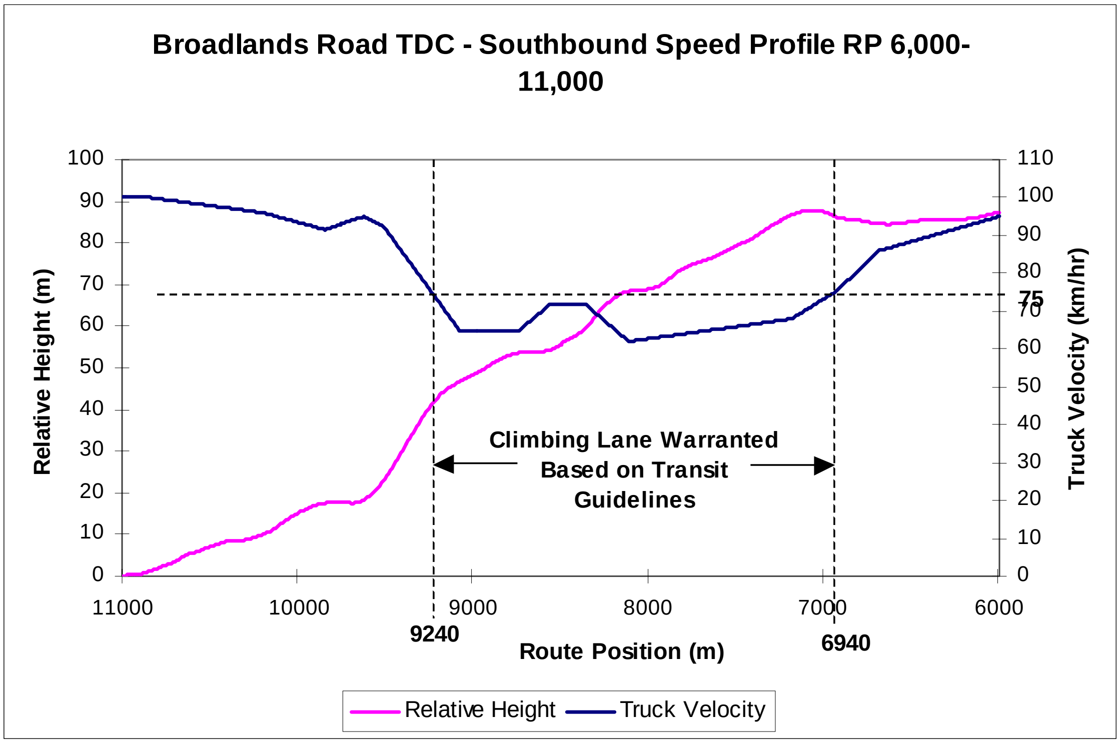


Figure 24. Climbing lane warrant (using Transit criteria)

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.