



RAA Regional Roads Assessment

Yorke Peninsula



October 2014



RAA

The logo for RAA (Regional Roads Assessment) features three yellow diagonal stripes above the letters 'RAA' in a bold, black, sans-serif font.

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Executive Summary

RAA released *Backwater to Benchmark* in 2005 followed by *Towards 2020* in 2009. The reports provided a technical assessment of the National Highway Network, including some state highways, and identified key recommendations for infrastructure improvements. RAA recognises however that local roads represent the greatest proportion of the infrastructure network in South Australia. Noting their functional importance, these roads should therefore be subject to similar assessment.

In February 2014, RAA conducted a regional road assessment on the Yorke Peninsula. The assessment identified the following issues which were common throughout the network on the peninsula:

- Narrow lanes
- Narrow, or absence of, sealed shoulders
- Absence of edge line marking
- Fading or worn road markings
- Asphalt edge break and edge drop
- Adverse cross falls on unsealed shoulders
- Limited warning signs, particularly for intersections

RAA also noted infrastructure improvements on some roads and welcomes these upgrades. Noted improvements include re-sealing, pavement rehabilitation, seal widening and limited sections of barrier installation. It was apparent however that these were targeted at specific roads with particular issues and did not form part of a mass action treatment. To realise the greatest safety benefit, mass action plans are recommended over the traditional black spot approach for future application of the treatments.

The following table summarises the key recommendations for each road or section on the peninsula:

Table 1 – Summary of Recommendations

Highway	Recommendations
B85 Copper Coast Highway	<ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.5m ▪ Increase shoulder seal width to a minimum of 1m ▪ Audio tactile line marking (ALTM) may be a suitable interim measure ▪ Install roadside barriers to protect hazards
B89 Port Broughton Road	<ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.2m in either direction ▪ Construct a 400mm minimum sealed shoulder ▪ Install ALTM edge of carriageway lines ▪ Undertake unsealed shoulder rehabilitation
B89 Spencer Highway	<p><i>Arthurton and Port Broughton</i></p> <ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.2m ▪ Construct a 500mm minimum sealed shoulder ▪ Apply edge of carriageway lines, preferably with ATLM ▪ Install barriers for steep embankments greater than 3m or

Highway	Recommendations
	<p>drops of 1 to 2m if located on outside of bends</p> <ul style="list-style-type: none"> ▪ Regrade and compact shoulders (unsealed shoulder rehabilitation) to remove edge drop <p><i>Moonta to Maitland</i></p> <ul style="list-style-type: none"> ▪ Rehabilitate pavement ▪ Install line marking to edge of carriageway <p><i>Maitland to Minlaton</i></p> <ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.2m ▪ Construct a 300mm minimum sealed shoulder
<p>B86 Yorke Highway</p>	<p><i>Minlaton to Warooka</i></p> <ul style="list-style-type: none"> ▪ Refresh line marking ▪ Build shoulders to remove adverse cross fall ▪ Construct a 300mm minimum sealed shoulder ▪ Provide edge line marking ▪ Install barrier protection for drops of 2m or greater and on the outside of bends <p><i>Curramulka to B88 St Vincent Highway</i></p> <ul style="list-style-type: none"> ▪ Install intersection warning signs ▪ Repair edge break ▪ Construct a 300mm minimum sealed shoulder ▪ Provide edge line marking ▪ Pavement rehabilitation
<p>B88 St Vincent Highway</p>	<p><i>Stansbury to Coobowie</i></p> <ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.5m ▪ Construct a 300mm minimum sealed shoulder ▪ Repair edges of asphalt failure ▪ Refresh line marking at intersections ▪ Undertake a program to install intersection ahead warning signs ▪ Install barrier protection for significant hazards such as power poles <p><i>Pine Point to Stansbury</i></p> <ul style="list-style-type: none"> ▪ Protect steep embankments with barrier system ▪ Vegetation trimming along shoulders ▪ Apply seal treatment to improve texture quality

Highway	Recommendations
B88 Coast Road	<ul style="list-style-type: none"> ▪ Undertake pavement rehabilitation
B88 Yorketown – Edithburgh Road	<ul style="list-style-type: none"> ▪ Increase the seal prior to Edithburgh ▪ Apply edge lines for the entire road ▪ Grade unsealed shoulders to the height of the seal ▪ Undertake pavement rehabilitation where required to correct the edge break in asphalt
B88 Yorketown – Warooka Road	<ul style="list-style-type: none"> ▪ Construct a 300mm minimum sealed shoulder ▪ Install audio tactile line marking ▪ Install intersection warning signage ▪ Replace damaged or faded signs ▪ Install barrier protection for power poles ▪ Consider realignment of y-intersections
Minor Roads North (North of Maitland)	<p><i>Port Broughton to Bute</i></p> <ul style="list-style-type: none"> ▪ Undertake pavement rehab 1km before Axford Road ▪ Repair asphalt edge ▪ Update warning signage ▪ Rehabilitate unsealed shoulder sections <p><i>Kadina to Bute</i></p> <ul style="list-style-type: none"> ▪ Repair asphalt edges ▪ Update warning signage ▪ Rehabilitate unsealed shoulders ▪ Install barrier protection <p><i>Kadina to Moonta</i></p> <ul style="list-style-type: none"> ▪ Provide barrier protection for power poles <p><i>Arthurton Road</i></p> <ul style="list-style-type: none"> ▪ Construct a 300mm minimum sealed shoulder ▪ Provide edge of carriageway lines ▪ Refresh line marking <p><i>Kulpara – Maitland Road</i></p> <ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.2m ▪ Construct a 300mm minimum sealed shoulder ▪ Mark edge of carriageway lines ▪ Rehabilitate pavement <p><i>Agery Road</i></p> <ul style="list-style-type: none"> ▪ Construct a 300mm minimum sealed shoulder ▪ Apply edge of carriageway lines

Highway	Recommendations
	<ul style="list-style-type: none"> ▪ Repair edge break / increase seal on bends ▪ Install barrier protection or warning signs for water main and power poles <p><i>Bute to Kulpara Road</i></p> <ul style="list-style-type: none"> ▪ Install barrier protection to protect from drops and poles ▪ Increase road width to provide minimum 3.2m lanes with 300mm sealed shoulders ▪ Apply edge line marking ▪ Undertake pavement rehabilitation to reduce edge break ▪ Install advance warning signs for intersections on bends
<p>Minor Roads Central (Between Maitland and Minlaton)</p>	<p><i>Maitland – Port Victoria Road</i></p> <ul style="list-style-type: none"> ▪ Repair edge break ▪ Refresh lining ▪ Install barrier protection for power poles <p><i>Mount Rat Road</i></p> <ul style="list-style-type: none"> ▪ Apply edge of carriageway lines ▪ Refresh line marking
<p>Minor Roads South (South of Minlaton)</p>	<p>RAA recommends the following treatments for all southern roads:</p> <ul style="list-style-type: none"> ▪ Construct lanes to a minimum of 3.2m ▪ Construct sealed shoulders to a minimum 300mm ▪ Rehabilitate unsealed shoulders (grading) ▪ Install intersection warning signs ▪ Install barrier protection on bends

1 Introduction

RAA released *Backwater to Benchmark* in 2005 followed by *Towards 2020* in 2009. The reports provided a technical assessment of the National Highway Network, including some state highways, and identified key recommendations for infrastructure improvements. RAA recognises however that local roads represent the greatest proportion of the infrastructure network in South Australia. Noting their functional importance, these roads should therefore be subject to similar assessment.

RAA has committed to undertake regional road assessments in the following regions:

- Yorke Peninsula
- Eyre Peninsula
- Riverland
- Mid-North
- Outback

The scope of the highway assessment is primarily targeted at the B-class signed routes although some minor roads are also discussed as part of the regional roads package.

In February 2014, RAA conducted a regional roads assessment of the Yorke Peninsula. This report examines the Peninsula's roads and provides recommendations for consideration by the state government and local road authorities.

The roads reviewed within this report are:

- B85 Copper Coast Highway
- B89 Port Broughton Road
- B89 Spencer Highway
- B86 Yorke Highway
- B88 St Vincent Highway
- B88 Coast Road
- B88 Yorketown – Edithburgh Road
- B88 Yorketown – Warooka Road
- Minor Roads North (North of Maitland)
- Minor Roads Central (Between Maitland and Minlaton)
- Minor Roads South (South of Minlaton)

2 B85 Copper Coast Highway

2.1 Introduction

The Copper Coast Highway is the main arterial access to the Yorke Peninsula, connecting Port Wakefield to Wallaroo over a distance of 58km. RAA assessed the highway in *Backwater to Benchmark* in 2005 and *Towards 2020* in 2009. *Backwater to Benchmark* identified the need to address failing pavement sections along the corridor, the upgrade of intersections as well as shoulder sealing and lane widening. These recommendations were reiterated in *Towards 2020* which also recommended the installation of roadside barriers as well as longer term recommendations for a bypass of Port Wakefield and four additional overtaking lanes.

The 2014 traffic volumes along the Copper Coast Highway generally range between 2,200 and 2,800 vehicles per day, with as many as 6,600 vehicles per day travelling between Kadina and Wallaroo. These figures represent a 13.5% increase since 2009 and the volumes between Kadina and Wallaroo have increased by 50% during the same period. The Copper Coast Highway is notorious for the extensive delays occurring at the intersection with the Augusta Highway and RAA recommends this intersection be addressed in the medium term.

The HGV volumes range between 290 and 750 vehicles per day with the highest volume occurring between Kadina and Wallaroo. The total HGV volume makes up 13% of the total traffic volume, a 0.5% increase since 2009.

2.2 Crash Statistics

Table 2 summarises the number of crashes that have occurred along the Copper Coast Highway, between Port Wakefield and Wallaroo.

Table 2 – Crash Summary - Copper Coast Highway

Crashes	Number	%
Total	117	100
Casualty Crashes	47	40
Fatal / Serious Injury	15	13

The two highest ranking crash types are Hit Fixed Object (26 crashes) which are a result of run-off road incidents and rear end crashes (24 crashes). While a high number of rear end crashes occur, these tend to be focussed around Wallaroo and Kadina and tend to be linked to driver error rather issues surrounding the highway. Of more concern is the number of instances of hit fixed object crash types, which highlight the need for hazard protection and measures to prevent vehicles departing the traffic lane in the first instance.

2.3 Highway Geometry

Departing Port Wakefield, it was noted that sealed shoulders have been provided with a width of approximately 1m, although a couple of sections were also noted having a 1.8m sealed shoulder. Unfortunately, such wide sealed shoulders have only been provided for a modest section. Immediately following Kulpara, the shoulder width drastically reduces to just 100mm but does increase to 300mm after Lime Kiln Road and remains this width through to Kadina. Beyond the seal, unsealed shoulders vary in width from 1.8 to 2.3m along the highway.

Lane measurements indicated that the lane widths varied between 3.1 and 3.3m, with an average of 3.2m along the length of the highway. Although the lane widths and sealed shoulders offer a combined seal width of approximately 3.5m in either direction, the function of the highway and HGV composition, particularly at the western end, would suggest that lane widths of 3.5m would be appropriate.

The assessment noted the presence of two overtaking lanes between Port Wakefield and Kulpara. The first lane is located in the northbound direction shortly after Port Wakefield and the second lane is in the northbound direction just prior to Kulpara, to cater for the HGVs climbing through the hills. For the remainder of the highway, a number of long straight sections were noted that offered good visibility. As such overtaking lane provision is likely adequate at this time and infrastructure improvements should instead be targeted at crash reduction countermeasures.

2.4 Pavement Condition

The ride quality between Port Wakefield and Kulpara is reasonable, offering a moderately smooth ride with some bumps and undulations in the road surface. The assessment however noted a number of sections after Kulpara, particularly within the vicinity of Bowry Road and the Viterra grain silo. This continues after Paskeville where a sign warning road users of an uneven surface for the next 4km has been installed. Just prior to Kadina, there are many sections which demonstrate a good ride quality, offering the road user a much smoother ride.

The texture of the pavement surface was noted as being good for most of the highway, offering a reasonably coarse texture that should provide good drainage and skid resistance properties. There were however some sections where bitumen bleeding was noted beneath one or both wheel paths and it is recommended that these sections are monitored and re-surfaced accordingly to ensure that skid resistance is maintained. These sections include passing through Kulpara and to the west of the intersection with Haines Road, between Paskeville and Kadina.

The assessment noted a number of areas throughout the highway where patching, primarily under the passenger wheel path had been carried out. While in many instances this detracted from the ride quality, it is encouraging to note the level of ongoing maintenance. Between Paskeville and Kadina, crack sealing has been carried out on a number of sections, suggesting that the pavement foundations are slowly failing and in time, pavement rehabilitation may be required.

It is worth noting that asphalt edge break appears to be a problem along the highway with edge break noted in a number of areas. This can be dangerous, particularly when the edge break is up to 50mm or more above the unsealed shoulder as it can make steering the vehicle back onto the asphalt difficult, particularly when towing a trailer or caravan.

The assessment also noted a lot of loose material on the unsealed shoulders to the west of the intersection with Lime Kiln Road. This can pose a risk to vehicles that drift onto the shoulder at speed, as the loose material can result in loss of control of the vehicle creating a run-off road incident.

2.5 Signs, Line Marking & Delineation

Between, Port Wakefield and Kadina, the line marking is in good condition and audio tactile line marking (ATLM) has been provided on the edge of carriageway lines. This treatment should reduce run-off road crashes by warning the motorist if they drift from the traffic lane. West of Kulpara, the use of ATLM ceased, however edge of carriageway lines were still provided. The quality of the line marking was generally regarded as good, offering clear lines that offered good contrast to the pavement.

In addition to the lining provided, yellow raised reflective pavement markers (RRPMs) are installed down the centreline of the road to improve low light and wet weather delineation.

The line marking was found to be less effective between Wallaroo and Kadina. This part of the assessment was conducted after high rainfall and many of the lines, particularly edge lines were lost in the light and had water ponding over them. There were however red RRPMS provided at the edge of the highway and yellow down the centreline.

2.6 Traffic Hazards

A number of traffic hazards were identified along the highway. To the west of Lime Kiln Road, between Kulpara and Kadina, stobie poles run parallel with the road within 5 to 8m of the roadway. At this point a large pressure water line also runs along the road and it is recommended that these hazards are protected with a barrier system. In addition to the safety risk that the water line poses to vehicles that run-off the road, a vehicle strike to the line would likely cause severe disruption to the communities that it supplies and would be costly to repair. Around the same location, a sweeping bend was noted to have stobie poles running along the road on the outside of the bend. These would warrant barrier protection since there is a higher risk that vehicles will run off the highway on bends.

To the west of the turnoff for Lochiel, there is a long straight where stobie poles were noted at approximately 4m from the seal. Again, protection is recommended for these sections.

It is encouraging however to note that barrier protection has been installed for some of the steep embankments along the road side. Two instances were noted on bends to the west of Beaufort Road between Port Wakefield and Kulpara where a W-beam barrier was protecting road users from drops of around 10m.

2.7 Recommendations

The quality of the Copper Coast Highway is generally good throughout, however a number of improvements may be made to cater for the function of the route and reduce the instance of run-off road crashes.

RAA recommends the following treatments for the highway:

- Increase lane widths to a minimum of 3.5m
- Increase shoulder seal width to a minimum of 1m
- ATLM may be a suitable interim measure
- Install roadside barriers to protect hazards

3 B89 Port Broughton Road

3.1 Introduction

At just 18km long, the B89 Port Broughton Road connects Kadina to Alford where the B89 then continues as the Spencer Highway on to Port Broughton.

3.2 Crash Statistics

Table 3 summarises the crashes that have occurred along Port Broughton Road.

Table 3 – Crash Summary – Port Broughton Road

Crashes *	Number	%
Total	36	100
Casualty Crashes	12	33
Fatal / Serious Injury	6	17

* Contains some crash data from Spencer Highway between Alford and Port Broughton

The primary crash type on this road is hit fixed object, indicating that there are a high number of run-off road crashes. Right angle crashes is the second highest crash type which may be as a result of limited visibility at many of the intersections along the route.

3.3 Highway Geometry

The lanes throughout Port Broughton Road are maintained at 3.1m with a 2.1 to 2.8m unsealed shoulder. During the assessment, the team passed a couple of heavy vehicles and the experience highlighted the narrowness of the highway.

It is worth noting that a steep cross fall over the unsealed shoulders was identified at a few locations. This is a risk for vehicles that run onto the shoulder as an adverse cross fall is likely to pull the vehicle off to the side.

It is recommended that lane widths are increased to between 3.2 and 3.4m per lane and a minimum shoulder seal of 300mm is constructed.

3.4 Pavement Condition

The ride quality is generally good throughout the road with a few exceptions demonstrating a poor quality with a series of bumps and undulations. Texture of the road surface throughout the highway was also reasonably good although some bitumen bleeding was noted approximately 5km north of Kadina.

One particular problem noted along the road was asphalt edge break which occurred at various locations along the highway and provided a reasonable drop between the asphalt and unsealed shoulder in some locations. There was evidence that edge break had been repaired at other locations but it would be recommended that pavement rehabilitation along the edges is carried out.

The assessment observed that the quality of the unsealed shoulders is also poor. In addition to the adverse cross fall, there is a lot of rutting and loose material that may increase the risk of a run-off road incident. It is recommended that a rehabilitation program is carried out to regrade and compact the shoulders where loose material is a problem.

3.5 Signs, Line Marking & Delineation

Due to the narrow nature of the carriageway, edge lines have not been provided. Given the narrow width of the highway, it is recommended that the seal is extended in the first instance to allow provision of edge lines which should preferably be ATLM.

3.6 Traffic Hazards

While dense vegetation lines the highway in areas, the primary hazard along the highway is the combination of narrow lanes and poor shoulder surface conditions. The risk of run-off road crashes is high as a result and this is reflected by the crashes that are summarised in section 3.2.

3.7 Recommendations

RAA recommends the following treatments for Port Broughton Road:

- Increase traffic lane width to a minimum of 3.2m in either direction
- Construct a 400mm minimum sealed shoulder
- Install ALTM edge of carriageway lines
- Undertake unsealed shoulder rehabilitation

4 B89 Spencer Highway

4.1 Introduction

At 207km long, the Spencer Highway is one of the major north-south arterial routes on the Peninsula. It connects the towns of Port Pirie, Port Broughton, Alford, Wallaroo, Moonta, Maitland and Minlaton. While the Spencer Highway runs between Port Pirie and

Minlaton, it is only classified as the B89 between Port Pirie and Alford as well as between Moonta and Minlaton.

The 2014 traffic volumes show that the annual average daily traffic (AADT) varies between 440 and 1,600 vehicles per day, with the highest volume travelling between Moonta and Wallaroo. Traffic estimates show that traffic has increased on average by approximately 31% since 2009. Heavy vehicle volumes range between 42 and 370 vehicles per day, again with the highest volume travelling between Moonta and Wallaroo and the HGV volumes account for approximately 15% of the total traffic.

4.2 Crash Statistics

A summary of the crashes on each of the sections of the Spencer Highway is outlined in Table 4.

Table 4 – Crash Summary - Copper Coast Highway

Section		Total	Casualty	Fatal / Serious Injury
Alford – Wallaroo	Crashes	29	14	3
	% Total	100%	48%	10%
Wallaroo – Moonta	Crashes	9	5	1
	% Total	100%	56%	11%
Moonta – Maitland	Crashes	32	10	3
	% Total	100%	31%	9%
Maitland – Minlaton *	Crashes	37	10	6
	% Total	100%	27%	16%
Total	Crashes	107	39	13
	% Total	100%	36%	12%

* Contains some crash data between Minlaton to Yorketown

The primary crash type on the Spencer Highway is right angle crashes, suggesting that there may be issues with visibility or geometry at the intersections along the route. The exception is Wallaroo to Moonta, which has a high number of head-on crashes, and Maitland to Minlaton where the primary crash type is hitting fixed object, though right angle crashes rank second. For the remainder of the highway, the second highest crash type is hit fixed object indicating that run-off road incidents occur frequently.

4.3 Highway Geometry

Between Alford and Port Broughton, the lane widths on the Spencer Highway average between 3.1 and 3.2m and there are unsealed shoulders between 2.7 and 2.8m in width. About 5km prior to Port Broughton, the width of the carriageway increases to provide lane widths of between 3.2 and 3.5m, with a one metre sealed shoulder which then reduces to 500mm with a one metre unsealed shoulder.

On the section of highway between Moonta and Maitland, lane widths are 3.2m and the sealed shoulder varies by section between no provision and around 300mm. Unsealed shoulders are generally between 1.8 and 2m.

The traffic lanes along the highway should be increased in width to ensure that all lanes meet a minimum of 3.2m. The shoulder seal of 500mm should be applied to the remainder of the highway between Alford and Port Broughton.

The highway is disappointingly narrow south of the intersection with Mount Rat Road. Measurements show the traffic lanes are between 2.7 and 2.9m wide with no sealed shoulder provided. During the survey a heavy vehicle was observed drifting onto the unsealed shoulder to allow safe passing of other traffic, which is unacceptable. The lane widths are inconsistent with the northern section of the highway and many of the other minor roads in the area. The seal width should be increased to provide a minimum of 3.2m lanes and 300mm sealed shoulder.

Between Maitland and Minlaton, sealing works have produced lane widths of between 3.2 and 3.3m. At the time of the audit, the edge lines had not been applied but given the width of the seal; it is assumed that the intention is also to provide sealed shoulders of between 300 and 500mm.

4.4 Pavement Condition

North of Alford, it appears that the pavement has recently been resealed and was found to provide a smooth ride and a coarse texture, offering good skid resistance. About 20km prior to Port Broughton, several sections of the highway had been patched and while this has remedied the pavement failure, the patchwork has reduced the overall ride quality through the section. The ride quality then remains smooth to Port Broughton with a good texture, although again, there is some evidence in remote sections of bitumen bleeding which may affect skid resistance.

A recurring problem on the highway from Alford to Port Broughton is asphalt edge drop which was measured up to between 50 and 80mm along some stretches. This can create a problem for vehicles and particularly trailers that drift onto the shoulder, as it makes recovery back on to the seal more difficult and extremes in height of edge drop can damage tyres.

Between Moonta and Maitland, the ride quality on the highway was noticeably poor, offering a rough ride. This is particularly true approximately 19km south of Moonta, where warning signs have been erected to advise motorists about the uneven road surface. Isolated sections of rutting were noted which also coincided with bitumen bleeding in the wheel path, potentially reducing the skid resistance of the pavement. Shoulders along the highway appear to have been re-graded; offering a better surface quality, however in some areas there is still an adverse cross fall on the shoulder that could affect vehicle steering if the vehicle runs onto the shoulder at speed.

The assessment noted that the ride quality on the Spencer Highway between Mount Rat Road and Minlaton was far rougher than that experienced on Mount Rat Road. This could however reflect the vehicle volumes, which are higher on the Spencer Highway, leading to accelerated wear. The shoulders along the Spencer Highway provide a reasonably good surface having appeared to have been re-graded recently.

Between Maitland and Minlaton, there were a number of sections that had steep cross falls on the unsealed shoulders. These should be built up to reduce the risk of rollover crashes should an errant vehicle deviate from the highway

4.5 Signs, Line Marking and Delineation

The highway between Arthurton and Port Broughton lacks edge of carriageway lines and this would be a primary recommendation as the absence of edge of carriageway makes the edge of the seal difficult to see and poorly delineates bends in low light.

The quality of the line marking at intersections and centreline was in reasonable condition but raised reflective pavement markers (RRPMs) may be beneficial for delineating intersections and bends in wet weather or low light.

While edge of carriageway lines have not been provided along the entire highway between Moonta and Maitland, RAA noted that edge lines have been provided on bends, to improve low light delineation. The assessment noted at one location approximately 17km south of Maitland, overtaking was permitted on a bend, despite reduced visibility. It is recommended that the solid centreline is extended as far as necessary around the bend to prevent risky overtaking manoeuvres. After this, edge of carriageway lines are provided along the highway but show signs of fading in some areas.

Approaching Maitland, there is a staggered intersection on a bend, leading to Junction Road and Tiddy Avenue without warning and it is recommended that advance warning signs be provided to warn approaching motorists about the intersection.

The intersection noted the presence of a hazard chevron board on a bend 9km south of Maitland. It is recommended that this be replaced with Chevron Alignment Markers (CAMs) to better delineate the bend at night.

4.6 Traffic Hazards

Dense vegetation lines both sides of the highway pose a risk for vehicles running off road. In many instances, the vegetation was found to lie within three metres of the traffic lane but between Moonta and Maitland, the vegetation had grown over the unsealed shoulder, further reducing the effective shoulder width. Unfortunately due to the extent of the vegetation, removal would not be practical and barrier protection may be considered for individual vegetation hazards that are considered to be a particular risk.

Some minor drops were noted along the highway that ranged up to 1m. These can pose a risk to vehicles that depart the highway as steep embankments as low as 1m can cause vehicles to rollover. Adverse cross falls in the unsealed shoulder were identified at some of these locations and shoulder grading or barrier protection would be recommended for these drops, particularly when they occur on the outside of the bend. Steep embankments of between 3 and 4m high were identified just north of the intersection of Bute Boundary Road and these should certainly be protected with barriers. Drops higher than 3m should be considered for protection, not only because of rollover risk but also because the damage sustained to vehicles is likely to be higher and vehicles that run-off the road may not necessarily be within sight of passing traffic.

4.7 Recommendations

RAA would recommend the following treatments for the Spencer Highway:

- Between Arthurton and Port Broughton
 - Increase lane widths to a minimum of 3.2m Construct a 500mm minimum sealed shoulder
 - Apply edge of carriageway lines, preferably with ATLM
 - Install barriers for steep embankments greater than 3m or drops of 1 to 2m if located on outside of bends
 - Regrade and compact shoulders (unsealed shoulder rehabilitation) to remove edge drop
- Moonta to Maitland
 - Rehabilitate pavement
 - Install edge of carriageway lines
- Maitland to Minlaton
 - Increase lane widths to a minimum of 3.2m Construct a 300mm minimum sealed shoulder

5 B86 Yorke Highway

5.1 Introduction

The B86 Yorke Highway is an arterial road connecting Adelaide to the southern most points of the Yorke Peninsula. At 182km long, the Yorke Highway branches from the Copper Coast Highway and runs south along the coast of the Gulf of St Vincent before heading in a south westerly direction to Minlaton and then to the south west of the Peninsula. The Yorke Highway passes through the towns of Ardrossan, Minlaton, Warooka and Marion Bay.

Currently, an average of 743 vehicles use the Yorke Highway each day, with 1,200 vehicles per day along the busiest section, immediately south on Minlaton. Traffic volumes have increased by 9% on average over the last five years. Heavy vehicles make up approximately 10% of the total traffic volume and the total volume of heavy vehicles has increased on average by a staggering 57% over the last five years.

5.2 Crash Statistics

A summary of the crashes on each of the sections of the Spencer Highway is outlined in Table 4.

Table 5 – Crash Summary - Copper Coast Highway

Section		Total	Casualty	Fatal / Serious Injury
Ardrossan - Minlaton	Crashes	18	8	4
	% Total	100%	44%	22%
Minlaton - Warooka	Crashes	14	7	5
	% Total	100%	50%	36%
Total	Crashes	32	15	9
	% Total	100%	47%	28%

The primary crash type on the Yorke Highway is hit fixed object crashes indicating that fatigue and inattention are common issues and suggests that barrier protection should be considered for protection of major roadside hazards. The second most common crash type is rollover crashes, which again may be caused by fatigue or inattention.

5.3 Highway Geometry

The lane widths on the Yorke Highway were found to be between 3.1 and 3.2m, with a 3m unsealed shoulder. While there was no sealed shoulder provided, the carriageway tended to increase in width on the outside of bends. The assessment cited that despite the lane widths, when passing heavy vehicles, the road highway felt reasonably narrow and there was a tendency to edge to the side of the seal.

5.4 Pavement Condition

The assessment found that the pavement offered a reasonably good ride quality, offering a smooth ride with only few undulations. The texture quality was also found to be good, offering a coarse texture which should provide good skid resistance. In some areas such as between Curramulka and the intersection with the B88 St Vincent Highway, some sections of bitumen bleeding was noted under the wheel paths. Edge break of the asphalt along the edge of the highway was the only major defect found and the road authority has made attempts to repair the sections affected. Longer term repair options including seal extension should be considered to reduce ongoing maintenance.

It is also worth noting that between Curramulka and the B88 St Vincent Highway, some sections were noted to have rutting and egg shell cracking suggesting that pavement rehabilitation is required in these areas.

The quality of the shoulders was good and appeared to have been recently graded in many areas, although some sections were noted as having adverse cross fall and should be built up to provide a safe running surface.

5.5 Signs, Line Marking & Delineation

The quality of the line marking along the Yorke Highway is average. While the line marking looks reasonably good, it does not always offer good contrast to the road and on a number of occasions was noted as not being visible in the distance. Centre lines exist throughout the highway but edge of carriageway lines have not been provided, neither have raised reflective pavement markers. Lining shows signs of fading further on and is severely worn on approach to Warooka.

The assessment found that the line marking at the intersection with Port Vincent Road was badly worn and requires reinstatement.

As a narrow carriageway has been identified as an issue when passing heavy vehicles, it would be recommended that the seal is extended to allow edge lines to be marked.

It was noted on bends that although barrier protection has not been offered to protect from significant vegetation or embankments, hazard marker posts have at least been provided and are closer spaced on the bends to assist with night time delineation.

Some signage deficiencies were noted in regard to warning signs for intersections. The intersection for Twelve Mile Road did not have advance warning signs and this is particularly important as the intersection is found at the crest of a hill, reducing sight distance.

5.6 Traffic Hazards

The highway assessment found that there were steep embankments along some sections of the highway, with drops of up to 2m. These should be protected, particularly on bends, because the steep embankments increase the risk of a vehicle rollover, and therefore the severity of a crash if a vehicle departs the highway.

South of the cross road intersection with Mount Rat Road, W-beam barriers have been provided on bends and at the side of the highway to protect from vegetation and steep embankments of up to 3 in height.

5.7 Recommendations

The following treatments are recommended for the Yorke Highway:

Minlaton to Warooka

- Refresh line marking
- Build shoulders to remove adverse cross fall
- Construct a 300mm minimum sealed shoulder
- Provide edge line marking
- Provide barrier protection for drops of 2m or greater and on the outside of bends.

Curramulka to B88 St Vincent Highway

- Install intersection warning signs
- Repair edge break

- Construct a 300mm minimum sealed shoulder
- Provide edge line marking
- Rehabilitate pavement

6 B88 St Vincent Highway

6.1 Introduction

The B88 St Vincent Highway is 101km long and connects the B86 Yorke Highway, south of Ardrossan to Coobowie where the B86 then becomes Coast Road and continues south to Edithburgh. The highway passes through the towns of Pine Point, Port Julia, Port Vincent, Stansbury, Wool Bay and Coobowie.

In 2014, traffic volumes along the St Vincent Highway varied between 230 and 1,400 vehicles per day, with the highest volumes occurring between Port Vincent and the intersection with Stansbury Road. The average traffic volume on the highway has increased by 18% since 2009. On average, heavy vehicles account for approximately 21.5% of the total traffic volume, an increase of 13.4% over the last 5 years. The highest volume of heavy vehicles occurs between Port Vincent and the intersection with Stansbury Road which sees an average of 500 heavy vehicles per day, 35.5% of the total traffic volume.

6.2 Crash Statistics

A summary of the crashes on each of the sections of the St Vincent Highway is outlined in Table 6.

Table 6 – Crash Summary - Copper Coast Highway

Section		Total	Casualty	Fatal / Serious Injury
Pine Point to Stansbury	Crashes	15	7	5
	% Total	100%	47%	33%
Stansbury to Coobowie	Crashes	4	3	3
	% Total	100%	75%	75%
Total	Crashes			
	% Total	100%	53%	42%

The primary crash type on the St Vincent Highway is hit fixed object, highlighting the need to protect roadside hazards where practicable. The second highest crash type is right angle crashes which points to issues at intersections either with their design or high instances of drivers failing to stop or give way.

6.3 Highway Geometry

Lane widths along the St Vincent Highway range from 3.2 to 3.5m, with a 2m unsealed shoulder. Since traffic volumes along the St Vincent Highway are notably higher than other roads in the area, lanes widths should be provided at a minimum of 3.5m with a

300–500mm sealed shoulder. On approach to Stansbury, the highway benefits from edge lines and a sealed shoulder of around 1m.

North of Stansbury, the highway has a wide cross section offering generous lane widths and a sealed shoulder of approximately 1m. The assessment did however note that the shoulder was narrower in places as a result of overhanging roadside vegetation, and vegetation trimming would therefore be recommended.

6.4 Pavement Condition

A recurring theme on the Yorke Peninsula is the breaking of asphalt along the edges of the highways and this was recorded a few times along the St Vincent Highway. The overall quality of the pavement is not too bad. The roads authority has undertaken patching in a number of areas which has affected the ride quality but otherwise the highway offers a reasonably comfortable ride. No significant issues were identified with texture or rutting so the primary recommendation should focus on repairing the edge of the asphalt and smoothly transitioning the sealed and unsealed surfaces.

With only minor undulations detected north of Stansbury, the highway offers a reasonably smooth ride quality. About 7km prior to Port Vincent, the pavement appeared to have quite a polished surface under the wheel paths, which may affect skid resistance and the application of a further seal may be considered to improve the texture quality.

6.5 Signs, Line Marking & Delineation

North of Coobowie, there are no edge lines however shoulders and edge lines are provided north of the intersection leading to Yorketown, perhaps to cater for the high volumes of vehicles, particularly the grain traffic that uses this section of the highway.

The assessment noted that many of the intersections along the highway, which may not be obvious to the driver due to location or sight distance, lack advance warning signs. This should be considered since right angle crashes are the second most common type of crash on the highway. Line marking was also worn and badly faded at some intersections which may be a contributing factor in motorists failing to obey the controls. It is therefore recommended that a program of sign installation and line marking renewal is applied throughout the highway.

6.6 Traffic Hazards

Power poles run along the highway for a distance north of Coobowie, these are estimated to be 2.3 to 3m from the seal and well within the clear zone. Barrier installation should therefore be considered for these sections.

Between Stansbury and Port Vincent, some embankments were found just after cuttings and were unprotected so barrier installation should be considered where these embankments exceed 2m in height.

6.7 Recommendations

The St Vincent Highway is one of the busiest highways on the peninsula. Generally the condition and ride quality of this highway is good, however considering the higher traffic volume, RAA feels there are a number of improvements that can be made that will reflect its functional importance, particularly for the grain industry.

Stansbury to Coobowie

- Increase lane widths to a minimum of 3.5m
- Construct a 300mm minimum sealed shoulder
- Asphalt edge repair
- Refresh line marking at intersections
- Install intersection ahead warning signs
- Install barrier protection at significant hazards such as power poles

Pine Point to Stansbury

- Protect steep embankments with barrier system
- Trim vegetation along shoulders
- Apply seal to improve texture quality

7 B88 Coast Road

7.1 Introduction

The B88 Coast Road is perhaps the shortest B class road on the Yorke Peninsula. At just 6km long, it connects Edithburgh to Coobowie where the B88 continues north as the St Vincent Highway.

Despite the size of the road, around 650 vehicles travel between Edithburgh and Coobowie per day, however this figure has decreased by 19% over the last five years

7.2 Crash Statistics

No crashes have been recorded between Edithburgh and Coobowie for the last five years.

7.3 Highway Geometry

Lane widths along the road are approximately 3.2m with a 2m unsealed shoulder. No edge lines or sealed shoulders are provided.

7.4 Pavement Condition

The road surface is generally good in terms of ride quality, texture and rutting, however the assessment noted that the road surface across the causeways was broken and quite uneven and it is recommended that pavement rehabilitation be undertaken.

7.5 Signs, Line Marking & Delineation

No issues were identified on the road with signs or line marking.

7.6 Traffic Hazards

There were no significant hazards on this road. W-beam barriers have been provided on some bends to protect from drops and other hazards and RAA welcomes these improvements.

7.7 Recommendations

The road between Edithburgh and Coobowie is in reasonably good condition and with a lack of crash history and diminishing traffic volumes, there are few recommendations that can be submitted for this road. RAA believes the priority should be pavement rehabilitation to repair the road on the sections of causeway.

8 B88 Yorketown Road

8.1 Introduction

The B88 Yorketown Road runs for 16km in the south of the peninsula between Yorketown and Edithburgh. The 2014 traffic volumes indicate that about 600 vehicles use the road each day, a 30% increase since 2009. Only 6% of the traffic is commercial vehicles and this figure remains unchanged for the last five years.

8.2 Crash Statistics

Table 7 summarises the crashes that have occurred along Yorketown Road.

Table 7 – Crash Summary – Yorketown Road

Crashes *	Number	%
Total	10	100
Casualty Crashes	3	33
Fatal / Serious Injury	0	0

The primary crash type on this road is hit fixed object followed by right angle crashes, however it's worth noting that only one of the crashes was a right angle crash so there is no sound correlation with the road environment. Given that of all the crashes, only three involved minor injury and the remainder were property damage only, this suggests the crashes were low impact and likely to have occurred around the townships than in the country areas.

8.3 Highway Geometry

On the Edithburgh Road, lanes are similar to many in the area at around 3.2m, however edge of carriageway lines provide a minimal shoulder seal and there are unsealed

shoulders ranging between 2 and 2.5m. The edge lines and shoulder seal stops approximately 11km prior to Edithburgh, where the total seal reduces in width.

8.4 Pavement Condition

The ride quality on the Edithburgh road is reasonably good, offering a smooth and comfortable ride for the motorists. The texture quality was also found to be good, offering a coarse texture with good skid resistance and there were no sections of rutting identified. The road does however suffer from edge drop as most of the roads on the peninsula do, so it is recommended that the additional material is graded and compacted into the shoulder to raise the shoulder height to meet the seal. The assessment also noted the edge of the asphalt is breaking at numerous locations and while repair attempts have been made, the bitumen remains quite badly broken in several areas. This is a particular problem since the lanes are visibly narrow and could be a risk for vehicles that drift on the road.

8.5 Signs, Line Marking & Delineation

There were no issues identified with sign and line marking on the road. Edge lines are provided up to approximately 11km prior to Edithburgh. RAA wishes to see the seal extended to allow provision of edge lines for the entire length of road.

8.6 Traffic Hazards

After Yorketown, some power poles were found within the clear zone of the road and protection from the poles would be recommended.

8.7 Recommendations

Generally the Yorketown Road provides motorists with a reasonably good drive. The key recommendations RAA proposes for the road are:

- Increase the seal prior to Edithburgh
- Apply edge lines for the entire road
- Grade unsealed shoulders to the height of the seal
- Undertake pavement rehabilitation where required to correct the edge break in asphalt

9 B88 Yorketown – Warooka Road

9.1 Introduction

The B88 Yorketown – Warooka Road runs between Yorktown and Warooka for approximately 21km. At Yorketown, it continues east as the Yorketown Road through to Edithburgh.

Traffic volumes have increased by approximately 36% over the last five years with an average of 950 vehicles per day travelling along the road and the busiest section, immediately east of Warooka, supporting 1,600 vehicles per day. Heavy vehicles account for almost 12% of the total traffic volume and have more than tripled in the last five years.

9.2 Crash Statistics

Table 8 summarises the crashes that have occurred along Yorketown – Warooka Road.

Table 8 – Crash Summary – Yorketown – Warooka Road

Crashes	Number	%
Total	21	100
Casualty Crashes	7	33
Fatal / Serious Injury	3	14

Hit fixed objects and rollover crashes share equal place on the Yorketown – Warooka Road indicating a high number of run off road incidents which could be a result of fatigue and inattention. This highlights the need for hazard protection and other measures that would assist in preventing a run-off incident in the first place such as audio tactile line marking for edge lines.

9.3 Highway Geometry

Lane widths along the road vary between 3.1 and 3.2m in either direction. Towards Yorketown, the lane widths have visibly increased on bends to between 3.3 and 3.4m which provides additional security for vehicles that drift a little when traversing the bend. Shoulders are unsealed and are approximately 2m wide throughout the road. In some parts, the shoulder was noted as having an adverse cross fall which could direct vehicles off the road if hit at speed and should be built up to provide a safe running surface.

9.4 Pavement Condition

Texture was found to be reasonably good throughout the road but some sections were noted as shiny beneath both wheel paths indicating some bitumen bleeding has occurred. Asphalt edge break was also recorded at a couple of locations and it is recommended that edge repair is undertaken. Approximately 6km west of Warooka, the pavement condition was noted as deteriorating, particularly in terms of ride quality. There were a number of bumps and undulations in the road providing a rougher ride and rutting was also recorded under the passenger wheel path, continuing through to Yorketown.

9.5 Signs, Line Marking & Delineation

Signage was an issue on the Yorketown – Warooka road, notably the absence of warning signs and some signs having faded. Approximately 1km west of Warooka, there is a bend with a Y-intersection that joins the road on the outside of the bend. No advance warning of this was provided and signage advising of the intersection is

recommended to guide motorists to the potential hazards ahead. A similar situation occurs again approximately 6km west of Warooka and the give way signs at the intersection have faded. It is recommended that signage along the route is reviewed and, where faded, are replaced.

While line marking was found to be generally clear and visible, offering good contrast, it was noted that it was faded in many areas in the last 6km prior to Warooka. It is recommended that the approach to Warooka is refreshed.

9.6 Traffic Hazards

Stobie poles are located within 4m of the seal at two locations; immediately east of Warooka and immediately west of Yorketown. These should be protected to reduce the consequence of run-off road crashes at these locations.

Other traffic hazards exist from the quality of the asphalt and unsealed shoulders. Edge break combined with adverse cross falls over the shoulder may increase the risk of a vehicle departing the highway boundary, and remedial work to correct these defects should be undertaken as part of ongoing maintenance.

The Y-intersections along the route do not position motorists on the side roads with an ideal line of site. Combined with the lack of warning that vehicles may be turning on to Warooka – Yorketown road on the bends, there is an elevated risk of intersection crashes. At a minimum, warning signs should be erected but any Y-intersections should be re-aligned to provide motorists on the side roads with increased sight distance with no blind spots.

9.7 Recommendations

The following treatments are recommended for the Yorketown – Warooka Road:

- Construct a 300mm minimum sealed shoulder
- Install audio tactile line marking
- Install intersection warning signage
- Replace damaged or faded signs
- Install barrier protection for power poles
- Consider realignment of Y-intersections

10 Minor Roads - North (North of Maitland)

10.1 Introduction

In addition to the B-class signed roads, the scope of RAA's highway assessment was broadly increased to include a number of minor roads in the region. North of Maitland, the following roads were assessed:

- Port Broughton – Bute Road
- Bute – Kulpara Road

- Kulpara – Maitland Road
- Kadina – Bute Road
- Kadina – Moonta Road
- Agery Road (Kadina to Arthurton)
- Ardrossan Road (Arthurton to Ardrossan)

Traffic volumes on the roads in the northern region vary between 440 and 700 vehicles per day, a 17% increase since 2009. On average, 11% of the traffic comprises of heavy vehicles. This figure has risen by 3% since 2009.

A regional summary of the findings for the roads above is provided in the following sections.

10.2 Crash Statistics

Crash statistics for the northern roads are detailed in Table 9.

Table 9 – Crash Summary – Minor Roads North (North of Maitland)

Road		Total	Casualty	Fatal / Serious Injury
Port Broughton – Bute Road	Crashes	18	11	5
	% Total	100%	61%	28%
Bute – Kulpara Road	Crashes	12	3	1
	% Total	100%	25%	8%
Kulpara – Maitland Road	Crashes	24	9	4
	% Total	100%	38%	17%
Kadina – Bute Road	Crashes	16	5	2
	% Total	100%	31%	13%
Kadina – Moonta Road	Crashes	17	7	1
	% Total	100%	41%	6%
Agery Road (Kadina to Arthurton)	Crashes	6	2	1
	% Total	100%	40%	15%
Arthurton Road to (Arthurton Ardrossan)	Crashes	8	3	2
	% Total	100%	38%	25%
North Region Minor Roads Total	Crashes	101	40	16
	% Total	100%	40%	16%

Of the roads examined, the Port Broughton to Bute Road has the highest number of casualty and fatal/serious injury crashes. While Kadina – Moonta Road and Agery Road have the second highest casualty crashes, Kulpara to Maitland Road has the second highest instance of fatal or serious injury crashes.

The primary and secondary crash types vary from road to road but there is a trend in hit fixed object crashes which may reflect a combination of driver inattention and the narrow lanes and lack of shoulders found throughout. The second most common crash type is right angle crashes, suggesting issues with a number of intersections in the area. The

second most common crash type on Port Broughton to Bute Road is rollover crashes which may reflect a number of embankments at the roadside that are unprotected. Between Kimba and Moonta the second most common type of crash is rear end crashes but few of these have occurred and of those that have, these are likely to occur in the township.

10.3 Highway Geometry

Port Broughton to Bute

Lane widths were recorded at 3.2m with an unsealed shoulder of between 1.8 and 2.5m. The highway has unsealed shoulders ranging between 1.2 to 2.5m. The highway passes through cuttings at some sections and the unsealed shoulder reduces to 1m or less through these sections.

Kadina to Bute

Lane widths between Kadina and Bute are 3.2m with a 2m unsealed shoulder.

Kadina to Moonta

Lane widths between Kadina and Moonta are 3.2m with a 500 – 800mm sealed shoulder. It's encouraging to note that on some bends, the sealed shoulder has been increased up to between 1.5 and 2m on the outside of the bend, to assist vehicles in recovering if they drift from the traffic lane. Beyond the sealed shoulders, a further 1 to 1.2m of unsealed shoulder is provided.

Arthurton Road

North of Ardrossan, the road has wide traffic lanes at 3.6 to 3.9m in either direction. This compensates for a lack of sealed shoulders, although this could effectively be provided by reducing the traffic lane width with the provision of an edge of carriageway line. The unsealed shoulder along this road ranges from 1.9 to 2.2m. The road widths reduce near to the intersection for Clinton Road.

Kulpara – Maitland Road

Kulpara – Maitland Road is very narrow at only 2.7 to 2.8m for either lane. About 5km west of Arthurton, the seal has been extended to between 3.5 and 3.7m in either direction. It is assumed that this has been done so that edge of carriageway lines will eventually be provided, offering a 3.2m lane width and 300 to 400mm sealed shoulder. The wide road continues for about 1km prior to reducing back to about 2.7m for each lane. It is highly recommended that the seal extension is continued throughout the road and that if sections vary significantly, "Road Narrows" warning signs should be provided at the end of each wide section of road.

Agery Road

Road measurements indicated that Agery Road has 2.9m wide lanes in either direction with a 2m unsealed shoulder. Approximately 15km north of Arthurton, the lanes narrow to 2.8m. Despite this width, the edge of the asphalt is visibly better which encourages

motorists to use the full lane and not to hug the centre of the road. North of Friars Gate Road, the seal increases to provide lane widths of about 3.2m which continues on to Kadina.

Bute to Kulpara Road

The lane widths on the Bute to Kulpara Road were measured to be 3.1m in either direction, with a sealed shoulder of between 0.5 to 1m. An unsealed shoulder of approximately 2m wide runs along most of the road.

10.4 Pavement Condition

Port Broughton to Bute

The ride quality is fairly average, offering a mixture of smooth and bumpy sections of road. South of the intersection with Tower View Road and Bute Boundary Road, the ride quality was found to be poor, due to the rough surface of the road, creating noticeable bumps and undulations. This coincides with deterioration in the pavement, where crash sealing and patching was observed along the road. The texture in this area was also slightly smoother due to the bitumen seeping through the surface aggregate.

Approximately 1km after Axford Road, the pavement was noted to be in a particularly poor condition, with visible corrugations in the surface and pavement rehabilitation would be required through the section.

Edge break was noted along many sections of the highway with drops of between 50 and 80mm recorded between the asphalt and the unsealed shoulder. These drops should be repaired to reduce the risk to vehicles.

The unsealed shoulder was considered to be in a poor condition along many sections of the highway, with erosion noted at a number of locations. Adverse cross fall was also noted along some sections of the shoulder and re-grading of the shoulders would be recommended.

Kadina to Bute

The ride quality of the road surface is poor leaving Kadina but about half way between Kadina and Bute, improves to offer a smoother ride with isolated areas with rough and bumpy surfaces. The pavement offers a coarse texture and good skid resistance although some minor patches of bitumen bleeding were noted. About 20km prior to Bute, edge break is an issue with some sections noted as having drops of 50 – 80mm between the asphalt and unsealed shoulder. Some repairs have been carried out on edge break but many more sections are failing.

The unsealed shoulders had a lot of loose material in some areas and grading, and further compaction would be recommended.

Kadina to Moonta

The pavement between Kadina and Moonta is in reasonably good condition offering a smooth ride and a well textured surface that aids drainage and skid resistance.

Arthurton Road

The ride quality along Arthurton Road is notably good, offering a smooth and comfortable ride and represents the benchmark for the standard that other roads in the area should be upgraded to. The pavement offers a coarse texture that it likely to offer good skid resistance and drainage and there are no signs of rutting along the road. The unsealed shoulders have also been graded and offer a reasonably good surface. Despite the grading, there was at least one instance where the shoulder had an adverse cross fall and additional material should be graded and compacted in to provide a gentle slope across the shoulder.

Kulpara to Maitland Road

The quality of the pavement along the Kulpara to Maitland Road is poor. East of Maitland, the ride quality was found to be rough and rutting was recorded in numerous locations. Several areas have suffered from edge break, some have been patched but others remain in a crumbling state. The pavement has also cracked in several areas and it appears the roads authority has undertaken a crack sealing program as bitumen emulsion has been spread over the cracks. A number of areas have been patched under the wheel paths which further detract from the ride quality.

It's worth noting that where the seal has been extended, the unsealed surface has not been built up. The result is effectively a rut that runs along the transition point between the old and new sealed surfaces. It is expected that this will trap or channel water during rainfall and could increase the risk of aquaplaning.

Agery Road

The ride quality along Agery Road is generally smooth with some isolated patches of poorer ride quality. Stops along the road confirmed that the texture was coarse, offering good drainage performance and skid resistance. Some eggshell cracking was however noted indicating that patching or rehabilitation will be required in the future.

Some sections suffered from asphalt edge break, notably on the inside of bends. This is a concern since there is a tendency to hug the bend as vehicles travel round and may create issues if vehicles inadvertently drop onto the unsealed shoulder. It is recommended that the seal be increased on the bend to provide a safety net for vehicles that cut the bend too fine and also for vehicles that may drift from the lane on the outside of the bend.

Bute to Kulpara Road

While the texture on the road was found to be coarse, the assessment noted a number of areas demonstrating bitumen bleeding. Some isolated sections of rough ride quality were also identified. A common problem throughout the road stems from the increase in sealed surface. The joint between the old and new surface creates a rut along the length of the seal. During the assessment, there was heavy rain and water was found to pool within the depression which could increase the risk of aquaplaning. Edge break was found at some sections and rehabilitation may be required to contain this. It is worth noting however that where repairs have occurred, the asphalt was again starting to break.

10.5 Signs, Line Marking & Delineation

Port Broughton to Bute

Bend warning signs along the highway were not always found to be correct. While warning signs were provided on approach to cross road intersections, the intersections sometimes occurred on a bend but standard signs were used instead of the cross road on bend warning signs. While this does not necessarily create risk, the signage should be correct to better inform motorists of the location of the intersection.

Kadina to Bute

The assessment noted that at the intersection for Pine Forest, a cross road warning sign had been provided but this should be updated to indicate that the intersection occurs on a bend.

There is no edge of carriageway lines on the Kadina to Bute Road and this would be highly recommended given the relatively narrow lanes and poor shoulders. The seal would require to be extended to provide edge of carriageway lines while maintaining a 3.2m lane width. The quality of the line marking down the centre was good, the lines were clearly visible and offered good contrast to the pavement surface.

Arthurton Road

The assessment identified line marking as a problem in Arthurton Road. No edge lines have been provided along the road and the centreline marking has started to fade in many areas and was not clearly visible when looking into the distance. At other sections, the line marking has completely broken or faded and requires urgent refreshing.

Kulpara to Maitland Road

The quality of the line marking was found to be poor with several areas in which line marking was broken or faded. Where light coloured asphalt has been used, there is little contrast between the asphalt and the line marking.

Agery Road

The line marking is reasonably good along Avery Road though lacks contrast on the sections that have been constructed with a lighter colour aggregate.

Bute to Kulpara Road

Despite the wet conditions, the quality of the line marking on the Bute to Kulpara Road was good. The lines were clearly visible against the wet surface and offered a good contrast to the pavement.

Like other roads on the Yorke Peninsula, warning signs were lacking on approach to intersections, particularly those on bends and installing signage to draw attention to these hazards would be recommended.

10.6 Traffic Hazards

Port Broughton to Bute

Dense vegetation down many sides of the highway located within 3 to 4m of the seal. Some small drops of up to 1m either side of the road create a vehicle rollover risk.

Kadina to Bute

Dense vegetation lines the highway between Kadina and Bute within approximately 3 to 4m of the seal, although for some sections, vegetation is as close as 1m. Prior to Lime Kiln Road, a roadside memorial by a fallen tree acts as a sombre reminder of risks of run-off road crashes. Barrier protection may be considered for this stretch to protect from the significant gum trees however an element of vegetation removal and road widening may be required to accommodate this treatment.

Kadina to Moonta

Medium to large shrubs line either side of the highway within approximately 3 or 4m of the seal. Departing Kadina, stobie poles were recorded approximately 3m from the traffic lane.

Arthurton Road

Vegetation generally tends to grow along both sides of Arthurton Road approximately 2m from the carriageway, posing a high risk for run-off road crashes. Some small drops of up to 1m were also recorded which could cause vehicles to rollover if they depart the road.

Kulpara to Maitland Road

Vegetation runs along both sides of the road however the primary road hazard is a combination of poor pavement conditions and very narrow lanes which significantly increase the chances of run-off road crashes, particularly in wet weather or at night.

Agery Road

Dense vegetation lines either side of road and is set back on average 4m from the seal. An SA Water high pressure supply line runs along the side of the road about 16km south of Kulpara and is within 4m from the seal. Barrier protection should be considered for the water line, not only from a road safety perspective but to protect the vital infrastructure. Vehicle strikes, particularly heavy vehicles, may result in a severed line which can cut the supply to rural towns for extended periods while repairs are undertaken. Around the same area, stobie poles were noted on the outside of a bend and again require protection since the risk of run-off crashes are increased on bends.

Bute to Kulpara Road

Stobie poles were found within 4 to 4m of the seal in some areas with a couple of bends identified with poles within 1 to 2m on the inside of the bend. Barrier protection should be considered at these locations and poles on the inside of bends should also have hazard boards applied to increase conspicuity in wet weather and low light conditions.

10.7 Recommendations

Port Broughton to Bute

- Rehabilitate pavement 1km before Axford Road
- Repair asphalt edge
- Update warning signage
- Unsealed shoulder rehabilitation

Kadina to Bute

- Repair asphalt edge
- Update warning signage
- Rehabilitate unsealed shoulder
- Install barrier protection

Kadina to Moonta

- Install barrier protection for power poles

Arthurton Road

- Construct a 300mm minimum sealed shoulder
- Provide edge of carriageway lines
- Refresh line marking

Kulpara to Maitland Road

- Increase lane widths to a minimum of 3.2m
- Construct a 300mm minimum sealed shoulder
- Mark edge of carriageway lines
- Rehabilitate pavement

Agery Road

- Construct a 300mm minimum sealed shoulder
- Apply edge of carriageway lines
- Repair edge break/increase seal on bends
- Install barrier protection from waterline and power poles

Bute to Kulpara Road

- Install barrier protection to protect from drops and poles
- Increase lane widths to a minimum of 3.2m
- Construct a 300mm minimum sealed shoulder
- Apply edge line marking
- Rehabilitate pavement to reduce edge break
- Install advance warning signs for intersections on bends

11 Minor Roads - Central (Maitland to Minlaton)

11.1 Introduction

RAA assessed the minor regional roads within the central belt of the peninsula, between Maitland and Minlaton. In this area, the following roads were assessed:

- Maitland – Port Victoria Road
- Maitland – Ardrossan Road
- Mount Rat Road
- Dans Road / Port Vincent Road / Minlaton Road

Traffic volumes on the roads in the northern region vary between 320 and 700 vehicles, which equates to an average increase of 12% since 2009. The volume of heavy vehicles has increased by 70% over the last five years and now account for 17% of the total traffic on these roads.

A regional summary of the findings for the roads above is provided in the following sections.

11.2 Crash Statistics

Crash statistics for the central roads are detailed in Table 10.

Table 10 – Crash Summary – Minor Roads – Central (Maitland to Minlaton)

Road		Total	Casualty	Fatal / Serious Injury
Maitland – Port Victoria Road	Crashes	7	2	1
	% Total	100%	29%	14%
Maitland – Ardrossan Road	Crashes	15	4	1
	% Total	100%	27%	7%
Mount Rat Road	Crashes	5	3	1
	% Total	100%	60%	20%
Dans Road / Port Vincent Road / Minlaton Road	Crashes	7	4	2
	% Total	100%	57%	29%
Central Region Minor Roads Total	Crashes	34	13	5
	% Total	100%	38%	15%

The primary crash type for the central region is split between right angle and hit fixed objects. The second highest crash type is vehicle rollovers. This again points to the high number of run-off road crashes that occur on the Yorke Peninsula and also identifies the need to examine intersections to ensure that visibility is maintained and the intersection priorities are clearly indicated.

11.3 Highway Geometry

Maitland – Port Victoria Road

Lane widths on the Maitland to Port Victoria Road were found to be 3.2m with no sealed shoulder provided, however 2m wide unsealed shoulders run along both sides of the road.

Maitland to Ardrossan Road

The lane widths on Maitland to Ardrossan Road are 3.2m with a 300 – 500mm sealed shoulder and 1.5 to 1.8m unsealed shoulder. It appears that some sections of the highway have benefitted from a seal extension to increase the lane and shoulder widths.

Mount Rat Road

From Port Victoria, lane widths along Mount Rat Road were approximately 3.5m with no sealed shoulder provided and unsealed shoulders are around 2m wide. Between the Spencer Highway and Curramulka, widths averaged 3.2m, again with no sealed shoulder although unsealed shoulders of up to between 3 and 4m were found along the section.

11.4 Pavement Condition

Maitland – Port Victoria Road

The highway assessment found that the ride quality along the Maitland to Port Victoria Road was poor, with a number of bumps and undulations that made for an uncomfortable ride. Rutting and scattered aggregate loss was noted in a few locations and the pavement may benefit from rut filling in these areas. Asphalt edge break was a common problem along the road and recorded on numerous sections with drops of up to 50mm between the asphalt and unsealed shoulder recorded in some areas.

Maitland to Ardrossan Road

It's encouraging to note that many sections of this road have benefitted from seal widening, which has provided wider lanes and a wider sealed shoulder. Some sections have also benefitted from pavement rehabilitation, running along the edge of the highway. Despite this, the assessment identified sections with rutting and bitumen bleeding under one or both wheel paths. Some sections of the highway have been patched and while the patching leads to a rough ride quality, it has addressed the pavement failure. Along some sections of the road, a partial re-seal of the pavement has been performed at the edge of the highway but bitumen bleeding is particularly noticeable through these sections suggesting it was possibly applied in hot weather.

The shoulders along the Maitland to Ardrossan Road appear to have been recently graded and offer a good running surface, reducing the risk of loss of control for vehicles that run onto the shoulder.

Mount Rat Road

Mount Rat Road was found to offer good ride quality, providing motorists with a generally smooth driving experience with only a few sections with minor vertical deflections. The assessment identified a few sections suffering from bad bitumen edge break and these should be addressed as part of ongoing maintenance. Shoulders however were found to have been graded between the Spencer Highway and Curramulka which has improved the surface for vehicles that run on to the shoulder.

Dans Road / Port Vincent Road / Minlaton Road

Along Dans Road, Port Vincent Road & Minlaton Road, there are several instances of bad asphalt edge break with drops between the asphalt and unsealed shoulder of between 50 and 80mm which is concerning. Edge repair and shoulder grading should be undertaken to remedy these issues.

11.5 Signs, Line Marking & Delineation

Maitland – Port Victoria Road

Approximately 3km south of Maitland, the assessment noted that the line marking was in poor condition with faded and broken lines and it is recommended that lines are refreshed in this area. The absence of warning signage to indicate intersections on bends was noted prior to some of the bends along the road.

Maitland to Ardrossan Road

The quality of the line marking along the Maitland to Ardrossan Road was found to be good, offering a clear line with good contrast to the pavement with no signs of breaking or fading. It was however noted that the lines were not as clear in the distance suggesting that the paint is losing its retro reflective properties, although this is a problem with the standard line marking material used throughout metro and regional SA.

Mount Rat Road

Like many of the roads in the area, Mount Rat Road has some intersections occurring on bends, however the signage does not properly reflect this hazard. Edge lines are not provided on this road and it is recommended that edge lines are applied.

The centre line markings were found to be faded in many areas to the point they may not offer low light delineation and these should be refreshed as a matter of priority. Between the Spencer Highway and Curramulka, line marking was almost invisible on many sections.

11.6 Traffic Hazards

Maitland to Port Victoria Road

Vegetation is more scattered along the Maitland to Port Victoria Road and the landscape opens up with fields and grass reserves either side of the road. Dense vegetation grows along the road in the last 5km prior to Port Victoria. South of the intersection for Lizard Park, stobie Poles are located about 5m from the edge of the seal. While this is set

back, the poles are still located within the clear zone and barrier protection should be considered.

Maitland to Ardrossan Road

Departing Maitland, large gums and eucalypts run along the road. Protection may be considered for significant gums located adjacent to the edge of carriageway. Vegetation then continues at around 2 to 2.5m from the seal. Despite the close proximity of the vegetation, barrier protection has not been offered on the outside of bends. This is highly recommended since run-off road crashes due to fatigue and inattention are far more likely to occur on bends than on straight sections.

Mount Rat Road

To the west of Curramulka, some significant drops were noted to either side of the road. These drops would cause vehicles to rollover if departing the highway and increase the severity of a crash. It is recommended that barrier protection is provided to protect motorists from these embankments.

Dans Road / Port Vincent Road / Minlaton Road

Power poles were noted along sections of Dans, Port Vincent and Minlaton Roads within approximately 3m from the seal, with one pole estimated to be only 1m from seal 15km prior to Minlaton.

Prior to Curramulka, roadside vegetation encroaches on the edge of the seal and should be trimmed to provide shoulder space and reduce the risk of vehicle collisions.

11.7 Recommendations

RAA would recommend the following treatments for the central roads:

Maitland – Port Victoria Road

- Repair edge break
- Refresh lining
- Install barrier protection for power poles

Mount Rat Road

- Apply edge of carriageway lines
- Refresh line marking

12 Minor Roads – South (South of Minlaton)

12.1 Introduction

RAA's assessment of the unclassified roads south of Minlaton included:

- Minlaton – Stansbury Road
- Minlaton – Yorketown Road
- Stansbury Road

Traffic volumes on these two roads vary between 260 and 420 vehicles per day, a 13% increase since 2009. On average, 8% of the traffic comprises of heavy vehicles which has risen by 2% since 2009.

12.2 Crash Statistics

Crash statistics for the northern roads are detailed in Table 11.

Table 11 – Crash Summary – Minor Roads – South (South of Minlaton)

Road		Total	Casualty	Fatal / Serious Injury
Minlaton – Stansbury Road	Crashes	13	2	1
	% Total	100%	15%	8%
Minlaton – Yorketown Road	Crashes	37	10	6
	% Total	100%	27%	16%
Stansbury Road	Crashes	6	2	0
	% Total	100%	33%	0%
South Region Minor Roads Total	Crashes	56	14	7
	% Total	100%	25%	13%

The most common crash type in the southern region is hit fixed object crashes which reflect the dense vegetation and roadside hazards along the road. The second most common crash type is right angle crashes suggesting there may be issues at some intersections with either visibility or motorists failing to obey the traffic controls.

12.3 Highway Geometry

Minlaton to Stansbury Road

The lane widths on the Minlaton to Stansbury Road are approximately 3 to 3.2m wide with no sealed shoulder provisions. Unsealed shoulders of 1.8 to 2m are provided along either side of the highway. The lanes feel reasonably narrow to drive on and passing oncoming traffic, particularly heavy vehicles can be daunting.

Stansbury Road

Traffic lanes along Stansbury Road varied between 3.1 and 3.2m with a 2m unsealed shoulder. Approximately 1km west of the intersection with the B88 St Vincent Highway, the road width increases to approximately 3.3m per lane with a 500mm sealed shoulder.

12.4 Pavement Condition

Minlaton to Stansbury Road

The Minlaton to Stansbury Road provides an average ride experience with a mostly smooth ride, with some isolated rough areas. Patching has been undertaken to repair asphalt break at the edge of the road, however there continue to be edge drops of around 50mm in a number of areas resulting in a risk to vehicles running onto the shoulder. The assessment noted that in many areas, shoulders were in a poor condition, with scouring and material break on the surface.

Stansbury Road

There were no notable issues found with ride quality or rutting on Stansbury Road. Texture quality was found to be good, offering a coarse texture which may aid with drainage and skid resistance. It appears that in many areas, the pavement has been re-sealed in recent times.

12.5 Signs, Line Marking & Delineation

Stansbury Road

Due to the recent re-seals, the quality of the line marking was found to be very good, offering clear marking with good contrast to the road. Additionally, white raised reflective pavement markers (RRPMS) have been installed down the centreline of the road which will improve low light and wet weather delineation. Edge of carriageway lines have been provided for approximately 1km west of the intersection. It is recommended that this treatment be continued throughout the road.

Some intersection warning signs should be considered for the road. For example, the assessment found that the intersection for Weavers Hill Road occurs on a bend with no prior warning of the intersection was provided.

12.6 Traffic Hazards

Minlaton to Stansbury Road

The Minlaton to Stansbury Road has some unprotected drop-offs at the side of the road which has the potential to cause a vehicle rollover if a vehicle leaves the seal. A few kilometres before Stansbury, stobie poles were noted along the road within 4m from the seal, which continues around a bend, increasing the potential consequence of a run-off road crash on the bend. It is recommended that the poles are protected with a barrier system, particularly on the bend where there is a higher risk of vehicles departing the road.

Stansbury Road

Dense vegetation runs along the side of the road within 3m of the seal. Stobie poles were recorded at some of the locations within 4m of the seal. Barrier protection should be considered for these hazards including embankment drops of up to 2m which were also noted on one occasion.

12.7 Recommendations

RAA recommends the following treatments for all southern roads:

- Increase lane widths to a minimum of 3.2m
- Construct a 300mm minimum sealed shoulder
- Shoulder rehabilitation (grading)
- Install intersection warning signs
- Install barrier protection on bends

13 Summary & Recommendations

RAA conducted a regional roads assessment on the B-class road network on the Yorke Peninsula. The assessment identified issues and sought to provide recommendations for future funding priorities. A summary of the recommendations for each road or section is provided in Table 12.

Common problems that were identified were:

- Narrow lanes
- Narrow or absence of sealed shoulders
- Absence of edge lines
- Fading or worn road markings
- Asphalt edge break and edge drop
- Poor quality unsealed shoulders with adverse cross falls
- Limited warning signs, particularly for intersections

Such treatments should be addressed as part of a mass action treatment for the entire peninsula or may be confined to one road. The treatments become less effective when targeted at small sections of road as there is less consistency in their application.

Most of the treatments outlined in the table below are considered medium to long term options. RAA considers that the Federal Government should assist local and state authorities to achieve these targets through increasing funding.

Table 12 – Summary of Recommendations

Highway	Recommendations
B85 Copper Coast Highway	<ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.5m ▪ Construct a 1m minimum shoulder seal ▪ ATLM may be a suitable interim measure ▪ Install roadside barriers to protect hazards
B89 Port Broughton Road	<ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.2m in either direction ▪ Construct a 400mm minimum sealed shoulder ▪ Install ALTM edge of carriageway lines ▪ Undertake unsealed shoulder rehabilitation
B89 Spencer Highway	<p><i>Arthurton and Port Broughton</i></p> <ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.2m ▪ Construct a 500mm minimum sealed shoulder Apply edge of carriageway lines, preferably with ATLM ▪ Install barriers for steep embankments greater than 3m or drops of 1 to 2m if located on outside of bends ▪ Regrade and compact shoulders (unsealed shoulder rehabilitation) to remove edge drop <p><i>Moonta to Maitland</i></p> <ul style="list-style-type: none"> ▪ Rehabilitate pavement ▪ Install edge of carriageway lines <p><i>Maitland to Minlaton</i></p> <ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.2m ▪ Construct a 300mm minimum sealed shoulder
B86 Yorke Highway	<p><i>Minlaton to Warooka</i></p> <ul style="list-style-type: none"> ▪ Refresh line marking ▪ Build shoulders to remove adverse cross fall ▪ Construct a 300mm minimum sealed shoulder ▪ Provide edge line marking ▪ Install barrier protection for drops of 2m or greater and on the outside of bends <p><i>Curramulka to B88 St Vincent Highway</i></p> <ul style="list-style-type: none"> ▪ Install intersection warning signs ▪ Repair broken edges ▪ Construct a 300mm minimum sealed shoulder ▪ Provide edge line marking ▪ Rehabilitate pavement

Highway	Recommendations
B88 St Vincent Highway	<p><i>Stansbury to Coobowie</i></p> <ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.5m ▪ Construct a 300mm minimum sealed shoulder ▪ Asphalt edge repair ▪ Line marking program to refresh line marking at intersections ▪ Install intersection ahead warning signs ▪ Install barrier protection from significant hazards such as power poles <p><i>Pine Point to Stansbury</i></p> <ul style="list-style-type: none"> ▪ Protect steep embankments with barrier system ▪ Trim vegetation along shoulders ▪ Apply seal to improve texture quality
B88 Coast Road	<ul style="list-style-type: none"> ▪ Rehabilitate pavement
B88 Yorketown – Edithburgh Road	<ul style="list-style-type: none"> ▪ Increase the seal prior to Edithburgh ▪ Apply edge lines for the entire road ▪ Grade unsealed shoulders to the height of the seal ▪ Undertake pavement rehabilitation where required to correct the edge break in asphalt
B88 Yorketown – Warooka Road	<ul style="list-style-type: none"> ▪ Construct a 300mm minimum sealed shoulder ▪ Install audio tactile line marking ▪ Install intersection warning signage ▪ Replace damaged or faded signs ▪ Install barrier protection for power poles ▪ Consider realignment of Y-intersections to improve sight distance
Minor Roads North (North of Maitland)	<p><i>Port Broughton to Bute</i></p> <ul style="list-style-type: none"> ▪ Rehabilitate pavement 1km before Axford Road ▪ Asphalt edge repair ▪ Update warning signage ▪ Rehabilitate unsealed shoulders <p><i>Kadina to Bute</i></p> <ul style="list-style-type: none"> ▪ Repair broken asphalt edges ▪ Update warning signage ▪ Rehabilitate unsealed shoulders ▪ Install barrier protection <p><i>Kadina to Moonta</i></p> <ul style="list-style-type: none"> ▪ Install barrier protection or hazard warning signs for power poles

Highway	Recommendations
	<p><i>Arthurton Road</i></p> <ul style="list-style-type: none"> ▪ Construct a 300mm minimum sealed shoulderProvide edge of carriageway lines ▪ Refresh line marking <p><i>Kulpara to Maitland Road</i></p> <ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.2m ▪ Construct a 300mm minimum sealed shoulder ▪ Mark edge of carriageway lines ▪ Pavement rehabilitation <p><i>Agery Road</i></p> <ul style="list-style-type: none"> ▪ Construct a 300mm minimum sealed shoulder ▪ Apply edge of carriageway lines ▪ Repair edge break/increase seal on bends ▪ Barrier protection from waterline and power poles <p><i>Bute to Kulpara Road</i></p> <ul style="list-style-type: none"> ▪ Install barrier protection to protect from drops and poles ▪ Increase lane widths to a minimum of3.2m ▪ Construct a 300mm minimum sealed shoulder ▪ Apply edge line marking ▪ Rehabilitate pavement to reduce edge break ▪ Install advance warning signs for intersections on bends
<p>Minor Roads Central (Between Maitland and Minlaton)</p>	<p><i>Maitland – Port Victoria Road</i></p> <ul style="list-style-type: none"> ▪ Repair edge break ▪ Refresh lining ▪ Install barrier protection for power poles <p><i>Mount Rat Road</i></p> <ul style="list-style-type: none"> ▪ Apply edge of carriageway lines ▪ Refresh line marking
<p>Minor Roads South (South of Minlaton)</p>	<p>RAA recommends the following treatments for all southern roads:</p> <ul style="list-style-type: none"> ▪ Increase lane widths to a minimum of 3.2m ▪ Construct a 300mm minimum sealed shoulder \ ▪ Rehabilitate shoulders (grading) ▪ Install intersection warning signs ▪ Install barrier protection on bends

Appendix A

Pavement Performance Factors

Overview of Pavement Properties

Roughness

The pavement roughness refers to the irregularities in the road's surface in the direction of travel. These irregularities vary from 0.5 to 50m long and are measured in relation to the intended road surface and recorded in terms of the International Roughness Index (IRI). As the IRI increases, it indicates a rougher pavement surface which will produce an uncomfortable ride for the vehicle's occupants through bumps and undulations. Figure 1 shows the longitudinal profile of a road with an exaggerated surface. The red line indicates the intended surface level and the difference between the lines is the measured roughness.

The roughness is not only important for the ride quality experienced by the motorist but prolonged vehicle exposure to a rough road may also increase wear, maintenance and fuel consumption.

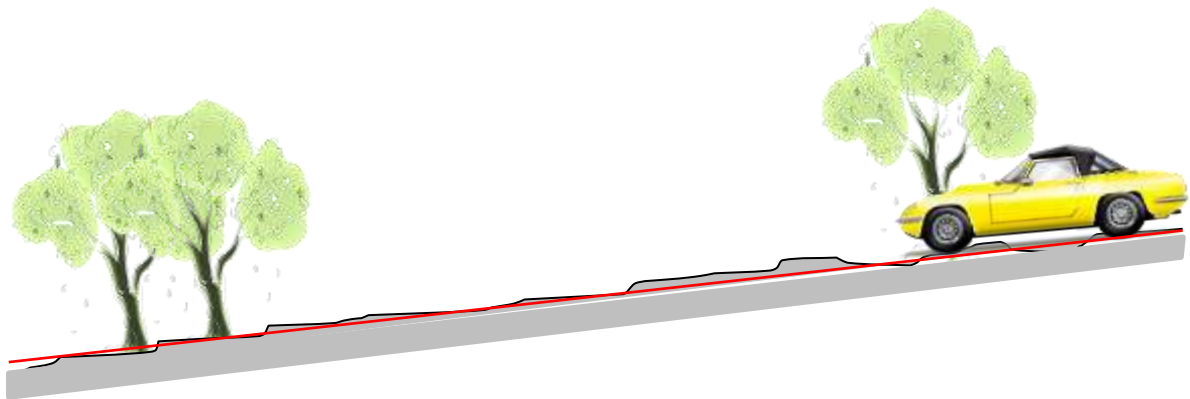


Figure 1 – Longitudinal Road Section

Rutting

A rut is a defect in the form of a longitudinal depression in the pavement surface. It usually occurs in the wheel path of vehicles (Figure 2) and is caused by high volumes of heavy vehicles over time. Ruts can also form as a result of environmental influences such as extensive rainfall combined with a poorly sealed surface. This can permit moisture to enter the pavement foundations which can weaken the structure or cause movement in the soil beneath, both of which can lead to rutting.

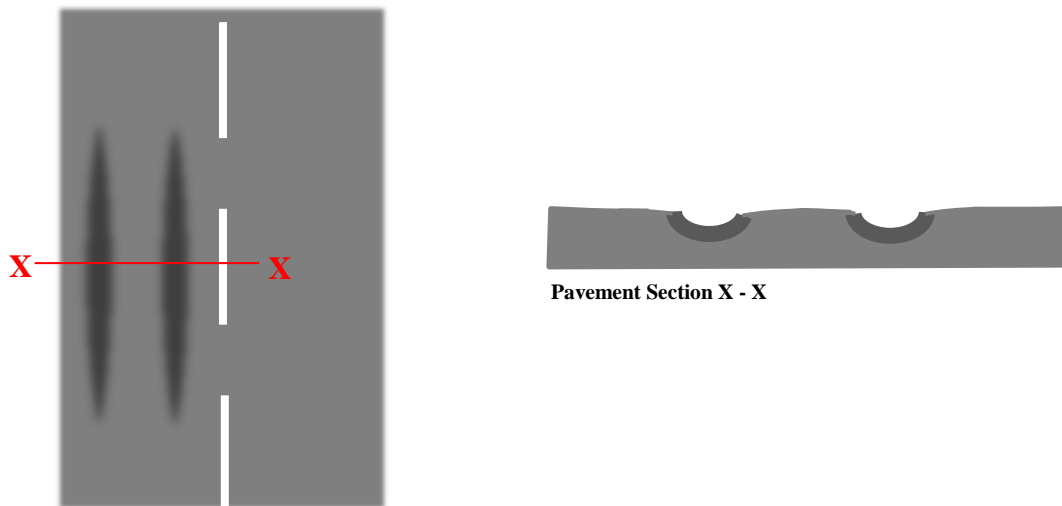


Figure 2 – Pavement Rutting

While rutting can lead to further pavement deterioration, several other problems may also arise as a result. Deep ruts can cause a “guide channel” for wheels and drivers may experience reduced steering performance or have difficulty with trailers tracking the vehicle. Ruts are also prone to filling with water which can increase the potential for aquaplaning, depending on the vehicle speed and depth of the rut. Drivers should always exercise caution when driving in wet weather but particularly on roads that are prone to bad rutting.

Texture

The pavement texture is important to ensure safety for motorists as it provides friction between the contact area of the tyre and the pavement surface. If there is insufficient friction between the tyre and surface, the braking distance will be significantly reduced and if the vehicle speed is too high, there may be a loss of control on curves and bends resulting in collisions with roadside objects.

There are two forms of texture within the road surface, the microtexture and macrotexture. The microtexture is created by the rough surface of the aggregate in the surface of the road and contributes to the friction that ensures the vehicle maintains contact with the road and provides good braking performance. The macrotexture is formed from the grooves created in the road surface by the different heights and shape of the aggregate and is important to ensure that rainwater drains away from the tyre, reducing the potential for aquaplaning.

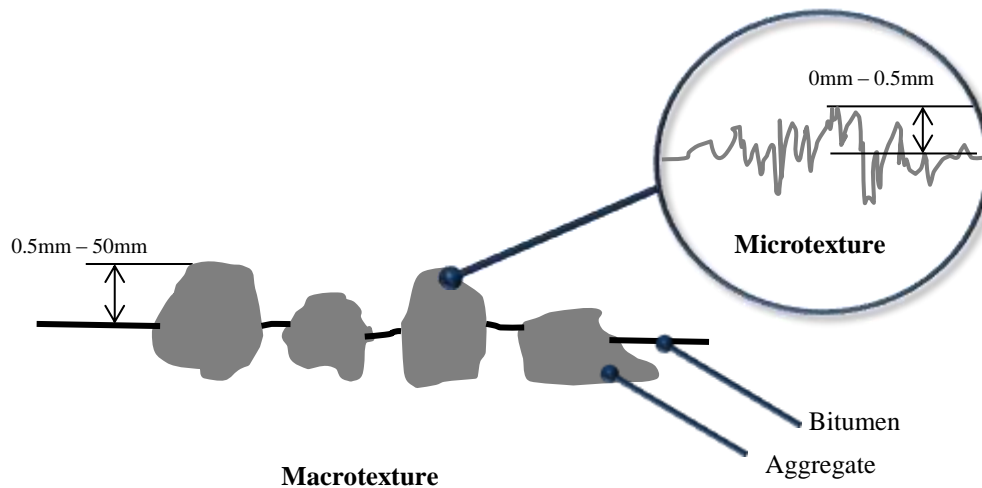


Figure 3 – Pavement Texture