ATSB
Australian Transport Safety Bureau

AUSTRALIAN TRANSPORT SAFETY BUREAU

RAIL INVESTIGATION REPORT

Collision between the passenger train 5AL8 and vehicles at the Salisbury Interchange level crossing,

Salisbury, South Australia
24 October 2002

COMMONWEALTH DEPARTMENT OF TRANSPORT AND REGIONAL SERVICES

Department of Transport and Regional Services

Australian Transport Safety Bureau

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CONTENTS

TERMS OF REFERENCE

The independent investigator appointed under section 41 of the Rail Safety Act 1996 is required to investigate and report to the Government on the following:

1. A description of the incident and the circumstances surrounding the incident
2. The causes and contributing factors
3. Whether the incident type should have been anticipated and the effectiveness of risk management strategies adopted
4. The adequacy of the emergency response to the incident by the rail organizations involved
5. The appropriateness and adequacy of any short, medium or long term remedial strategies put into place immediately after the incident
6. Any safety deficiencies identified and any safety actions taken or required
7. Any matters arising from the investigation, which would enhance the safety of rail operations.

The Investigation was conducted by C W Filor, Deputy Director, Surface Safety, Australian Transport Safety Bureau.

Advisers to the investigation were:

Mr Keith Hunt, General Manager Safety, Great Southern Railway

Mr Ron Kempster, Safety and Technical Investigation Manager, Australian Rail Track Corporation

Mr David Edwards, Executive Manager Safety, Pacific National Pty Ltd.

Mr George Erdos, Manager Safety and Technical Services, TransAdelaide

EXECUTIVE SUMMARY

At 15:33:01 on 24 October 2002 passenger train 5AL8 collided with a car and scheduled bus on the Salisbury Interchange controlled level crossing on Park Terrace. As a result of the accident four people were killed and 26 injured. A small sedan car and the bus were effectively destroyed. In addition two other road vehicles were damaged. The locomotive and the first vehicle of the consist sustained minor damage. There was no derailment of any rail vehicles.

The standard gauge track owned and operated by ARTC, runs parallel to two broad gauge tracks operated by TransAdelaide. These three tracks share the northern rail corridor, which runs through Salisbury.

As train 5AL8 approached the level crossing on Park Terrace from Adelaide, the driver and co-driver saw stationary road vehicles across the standard gauge track. The driver of the locomotive acted promptly in sounding a sustained warning on the horn, applying the emergency brakes and putting the throttle to idle. Two cars reversed clear of the track to a position between the standard gauge and the TransAdelaide tracks. The small sedan and the bus were unable to move because of other vehicles, though the driver of the sedan managed to jump out of her car and run clear.

The sighting distance from the train cab to the standard gauge crossing was approximately 250 m. The train could not stop in time to prevent the collision and came to a halt 183 m to the north of the Park Terrace level crossing.

The report concludes that the locomotive, rolling stock, rail, signalling infrastructure and the boom gate barriers at the crossing, up to the time of the collision, were in good condition and operated as designed.

Prima facie the road vehicles stationary on the rail tracks had entered the crossing when the drivers could not drive through the crossing because the crossing, or road beyond the crossing, was blocked. On this view the immediate causal factor was the non-observance of the Australian Road Rules 1999. From a systemic point of view, however, the accident was more complex with a number of causal factors relating to:

- road design (the number of entry/exit points);
- road traffic lights and the inter-link with the level crossing warning system;
- the width of the crossing;
- probable lack of awareness by road vehicle drivers of the road traffic rules as they relate to level crossings;
- the lack of 'near hit safety' reporting at level crossings;
- the lack of a focused body to oversight and undertake risk based assessments of level crossing safety.

The investigation found little evidence from records that Park Terrace level crossing was of public concern from a rail safety perspective. There were recorded concerns and direct observation that, when the traffic lights at the Salisbury Highway intersection were red, traffic did, on occasions, queue over the Park Terrace crossing. On the basis of direct observation, such an accident at Park Terrace was foreseeable.

The response to the accident by the emergency services and railway companies was timely. The first emergency persons to respond crawled beneath train 5AL8, a dangerous but understandable reaction to reach the injured. Police established tight control at the level crossing, but commuters and onlookers were able to access the adjacent lengths of track although the TransAdelaide passenger service continued running.

The report details 13 key conclusions:

1. The immediate cause of the collision between train 5AL8, the white Nova Holden WOJ 601 and Serco bus number 246 (VYV 786) was that the drivers of the road vehicles entered the level crossing, in contravention of the Australian Road Rules, at a time when they were unable to drive through the crossing and were blocked by other vehicles.
2. The driver and co-driver of locomotive NR 34, reacted promptly in sounding a warning of train 5AL8, applying emergency brakes and returning the throttle to idle. Neither the driver nor the co-driver could have taken any action that would have prevented the collision with the white Holden Nova or Serco bus number 246 (VYV 786) operating the 401 service.
3. Locomotive NR 34 and the 25 vehicles of the consist comprising train 5AL8 were in working order, were properly maintained and were fit for purpose. There were no deficiencies in the consist that contributed to the collision.
4. The railway infrastructure (track circuitry, signals, level crossing warning signals and the boom barrier) worked as designed within standard time limits.
5. Following the collision, the on train staff servicing the passenger vehicles of train 5AL8 acted promptly to assist the injured at the scene of the accident until they were able to relinquish care to the emergency services.
6. The response of the emergency services was timely.
7. The road traffic lights at the junction of Park Terrace, Gawler Street, North Lane and the Bus Interchange and the link with the level crossing warning signals worked as designed.
8. The road traffic signals at the Salisbury Highway/Park terrace intersection did not work as designed or as recommended by Australian Standard AS1742.14, in that the link with the railway crossing had been broken at some time and the special queue-clearing phase was not operational. There was no effective maintenance or checking system in place to monitor the continuing operation of the queuing phase of the lights and the links with the Traffic Control Centre. The non-operation of the special queuing phase was probably not a significant factor in the collision of 24 October.
9. The road traffic on the western side of the level crossing for traffic crossing Salisbury Highway or turning onto Salisbury Highway was halted at the traffic signals causing traffic to back-up over the level crossing.
10. The backing up of westbound traffic across some part of the level crossing was not unusual and had become an accepted factor of driving in Park Terrace.
11. The complexity of the Park Terrace road system over a distance of 175 m from the bus interchange turning just east of the level crossing to the stop line at Salisbury

Highway, increased the probability of road vehicles backing up to the level crossing in that:

- Road vehicles exiting or entering the Station car park and crossing or from the outside westbound lane, right turn lane, or attempting to enter the eastbound lane potentially restrict traffic flow.
- Road vehicles exiting or entering the Eureka Tavern car park across the traffic.
- Heavy traffic southbound on the Salisbury Highway restricts the opportunity for traffic in the left turn lane to join the Salisbury Highway.

12. Based on observed behaviour of road vehicle drivers, a collision between traffic queued at Park Terrace and a train was foreseeable. However, the absence of any specific reports of near miss incidents or accidents between trains and vehicles at Park Terrace had led to a belief that there was no significant risk.
13. The lack of initial site control following the collision and during the immediate emergency phase increased the risk of pedestrian onlookers being struck by trains, either through any possible movement of train 5AL8 or the TransAdelaide services.

The Salisbury level crossing review report by Mr Vince Graham of January 2003 made a number of recommendations (attachment 2), which are endorsed by this report. Mr Graham also made interim recommendations in early November that the track speed 500 m on either side of Park Terrace should be limited to 50 km/h. This report recommends that train speed restrictions introduced as a safety measure in the vicinity of level crossings should be further reviewed taking into account the new traffic arrangements and safety measures and the different types and characteristics of trains on the standard and broad gauge tracks.

In addition the report recommends:

RR20030001 Road traffic signals adjacent to level crossings be regularly monitored to ensure that all links and functions within the system are operational

RR20030002 Traffic flows through Park Terrace should be measured to assess the practicality of extending the timing on a link to force westbound traffic from Park Terrace to take account of the worst case timing scenario, while maintaining the existing timing of the boom barrier closing.

RR20030004 The rail industry should attempt to devise a confidential hazard reporting system that embraces the whole industry in the one system.

RR20030005 ARTC and TransAdelaide review their notification and communication procedures when responding to accidents on the shared rail corridor, particularly between the train control centres and the accident site.

RR20030006 The rail companies and emergency services examine ways in which early effective site control and control of public access might be further improved.

RR.20030007 Standards Australia develop a standard for the marking of a 'do not enter unless clear' area across level crossings, with a view to providing appropriate cues to help road vehicle drivers assess the space available on the other side of the crossing.

RR20030008 Transport SA should review the provisions of the Road Traffic Regulations 1996 to determine whether or not any existing penalty covering the drivers of vehicles that stop or park within the boundary of rail level crossings is appropriate.

INVESTIGATION METHODOLOGY

The purpose of this investigation was to enhance rail safety in the Adelaide Metropolitan network, first, by determining the sequence of events which led to the accident and second, by determining why those events occurred. Of particular importance was the need to understand what the accident revealed about the environment within which this particular rail operation was being conducted, and to identify deficiencies with the potential to adversely affect future safety.

The conduct and analysis of this accident was based on the Reason model[1] and the full report was written using the Australian Standard, Guidelines for railway safety investigation, AS 5022-2001.

During the investigation, information was obtained and analysed from a number of sources, including:

- Visits to the accident site;
- Inspection and analysis of the rollingstock involved in the derailment;
- Recorded train and Train Control information;
- Track, rolling stock and infrastructure maintenance records, procedures and standards;
- The history of organisational and infrastructure changes associated with the accident site;
- Interviews with personnel directly associated with the accident; and
- Interviews with management and safety personnel of organisations relevant to the accident.

In addition, technical analysis and reports were provided from relevant experts on aspects of:

- Rolling stock construction and design;
- Brake systems and pilot valves;
- Signalling and infrastructure.

The investigation team acknowledges the full cooperation received from all parties to this investigation, both individuals and organisations.

Video evidence was taken from:

- Security CCTV footage Salisbury Bus interchange
- Channel 7 and Channel 10 Adelaide Television

[1] REASON, J. 1990, Human Error, (Cambridge University Press: Cambridge).

REFERENCES

Australian Road Rules – Road Traffic Act

Australian Standard 1742.7, Manual of uniform traffic control devices – Railway Crossings

Australian Standard 1742.14, Manual of uniform traffic controls – Traffic Signals

Signal Manual of Recommended Practice, Section 3. Highway-Rail Grade Crossing Warning Systems, American Rail Engineering and Maintenance-of-Way Association

FIGURE 1:
Aerial view of the Salisbury area and Park Terrace

1 INCIDENT DESCRIPTION AND FACTORS

1.1 Overview – Rail

Adelaide is a major hub for inter and intra state rail transport. In terms of the inter-State rail network it is the junction of the standard gauge system from Brisbane to Perth via both Melbourne and Broken Hill and also the line to Adelaide. The standard gauge line is owned and operated by the Australian Rail Track Corporation (ARTC). The ARTC track shares a northern and southern rail corridor with the TransAdelaide rail network. The single line, 1435 mm standard gauge is laid parallel to the 1600 mm broad gauge, double line TransAdelaide network. The southern corridor extends from Belair to Keswick Station (Belair to Goodwood being single TransAdelaide track). The northern corridor extends from Keswick Station through Dry Creek to a point north of Salisbury, where the two systems diverge.

Traffic on the standard gauge line consists mainly of freight trains. But Great Southern Railway (GSR) operates 14 passenger trains that pass through Salisbury each week, including The Ghan two return services to Alice Springs and one return to Sydney, and the Indian Pacific Services operates two return services to Perth and one return to Sydney.

Park Terrace level crossing is 21.65 km north of the ARTC zero kilometre peg at Keswick Station. Automatic boom gate barriers protect the Park Terrace level crossing. Salisbury station is immediately adjacent to the north side of Park Terrace level crossing.

From Keswick Station, the track passes the freight yards at Islington and Dry Creek. From Dry Creek, for about 7.3 km, there is a climb on a light gradient to Salisbury. Approaching Salisbury from Adelaide the train corridor curves to the left for about 1200 m. The ARTC track is on the inside of this curve and the standard gauge track has a centre of radius between 1950 m and 1550 m. The TransAdelaide Station and the eastern side of the level crossing can be seen from over 300 m, but the western side of the crossing is not visible until the locomotive is about 250 m from the Park Terrace rail crossing. The standard gauge line speed prior to 25 October was 115 km/h. Down (north-bound) trains, however, do not normally reach maximum line speed as there is a temporary speed restriction at Dry Creek North of 40 km/h and there is a slight uphill gradient between Dry Creek and Salisbury. When the 40 km/h speed restriction is lifted trains are expected to attain 115 km/h through Salisbury.

Immediately east of, and adjacent to, Salisbury Station is the Salisbury Bus Interchange. These public utilities mark the west side of the Salisbury Centre. The Salisbury Centre consists of major retail outlets, other smaller retail outlets, small commercial businesses, the Salisbury Council Offices and Municipal Centre.

The afternoon peak traffic flow and pedestrian usage of the area is between 15:00 and 16:00, when schools close and shift rosters change at nearby factories. Between 15:00 and 16:00 there are eight TransAdelaide train services. In October 2002, some 22 buses on five service routes crossed the Park Terrace level crossing between 1500 and 1600

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[2] TransAdelaide Distances are measured from Adelaide Train Terminal. 1.516 m should be subtracted from the ARTC distances to arrive at TransAdelaide kilometre marks.

(11 in each direction). On a Thursday afternoon The Ghan passenger train, as train 5AL8, is scheduled to pass through Salisbury a little before 15:30.

Passenger train 5AL8 is operated by GSR. The train, from Adelaide to Alice Springs, is scheduled to depart Keswick Station on Monday and Thursday afternoons at 15:00.

Pacific National is contracted to provide the locomotive together with two drivers to GSR on a 'hook and pull' basis. Twenty GSR employees, headed by a Train Manager, staff the passenger carriages.

There has been a rail track through this corridor since 1857. The standard gauge inter-State track was built in 1982. Park Terrace, Gawler Street and Commercial Road became main routes to access the commercial and industrial centre of Elizabeth. With the development of north-west Adelaide and a build up of traffic congestion, a by-pass with underpass was constructed in 1992 to pass to the north of the Salisbury, Parabanks Shopping centre. In 1997 Gawler Street was realigned east of the rail crossing and the bus interchange enlarged. A pedestrian underpass, under the rail corridor, was filled in about this time as a public safety measure, to counter street crime.

1.2 Overview – Park Terrace road

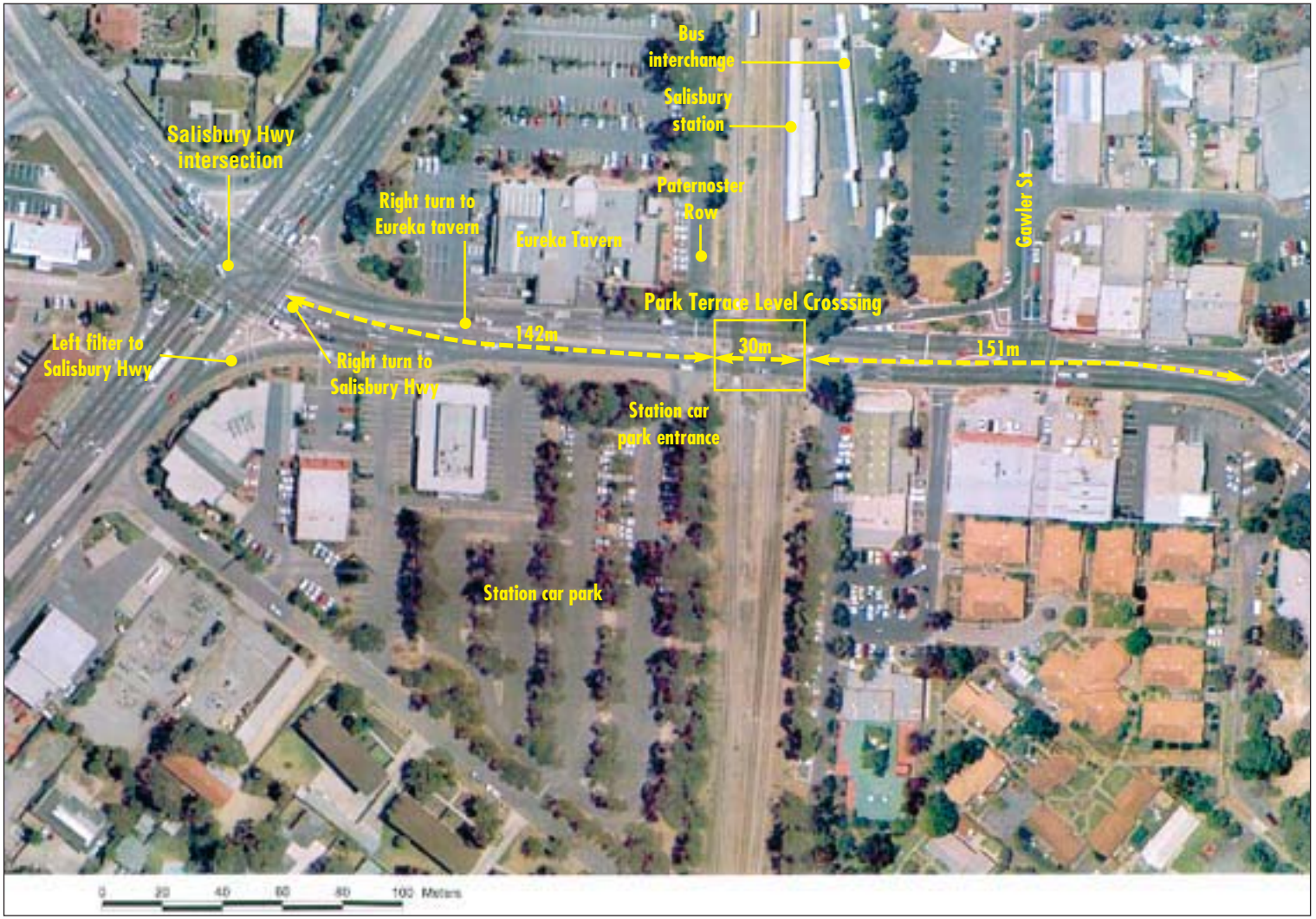
Park Terrace (the 'interchange area'), between Salisbury Highway and Wiltshire Street, is approximately 325 m long. The interchange area forms a southern road artery serving Salisbury rail station, the bus interchange and the important commercial and civic area of Salisbury Town Centre. The end of the school day and the change of shifts at nearby industrial complexes between 15:00[3] and 16:00 is the time of peak traffic activity and significant pedestrian activity in the area of Salisbury Centre. Daily traffic flows across the Park Terrace rail crossing are about 25% higher than forecast when Salisbury Highway was extended northwards to underpass the rail lines in 1993 (being about 22,000 vehicles per day now, while planning forecasts were for about 17,500 per day for the forecast year of 1996). Peak hour flows (total two way traffic) across the rail crossing are now about 15% higher than in the planning forecasts.

The 30 m wide rail crossing, 142 m from Salisbury Highway and 151 m from Wiltshire Street, bisects the interchange area. There are two eastbound and two westbound through traffic lanes between Salisbury Highway and Wiltshire Street. Either side of the crossing the through traffic lanes are augmented by traffic turning lanes providing access to roads and facilities either side of the interchange area. Also, buses that access Salisbury Highway from the bus interchange turn right on to the interchange area and cross the eastbound lanes to enter the westbound lanes.

The intersection with Salisbury Highway to the west is a major four-way traffic intersection. The intersection has a set of 25 vehicle lanterns and eight pedestrian lanterns on 12 traffic light poles positioned on median and corner traffic islands to control traffic flow and pedestrian crossings. Two straight ahead lanes, together with right and left turn lanes from Salisbury Highway enter Park Terrace. Four lanes exit Park Terrace (one left turn lane, two straight ahead lanes and one right hand turn lane). There is a left turn into the Station car park and a right hand turn into the Eureka Tavern. Vehicles entering Park Terrace from the west may cross the rail crossing

[3] All times are given in Australian Central Summer Time

FIGURE 2:
Park Terrace - Level Crossing and road alignment



or turn left into the Eureka Tavern, or Paternoster Row or right (across the west-bound stream) into the station car park. Once across the rail crossing there is a right turn lane to North Lane and a left turn lane into Gawler Street and the retail and civic complex. Eastbound traffic remains on Park Terrace or turns left under signal control into Wiltshire Street.

To the east, the junction of Wiltshire Street and Park Terrace is controlled by traffic lights comprising a set of 15 vehicle lanterns and 6 pedestrian lanterns positioned on 10 traffic light poles. For traffic approaching from the eastern part of Park Terrace there is a right turn lane into Gawler Street and a left turn into North Lane. Once across the railway crossing travelling west there is a left turn into the station car park and a left turn lane into Salisbury Highway, two lanes for traffic going straight ahead and a right turn lane.

1.3 Sequence of events

1.3.1 Sequence of events from Keswick up to the time of the accident.

Train 5AL8 consisted of locomotive No. NR 34, a motor rail car and 24 rail vehicles. The total length of the train was marginally less than 617 m with a total mass of 1335.8 tonnes, 1203.8 tonnes excluding the locomotive.

The two drivers[4] assigned to take train 5AL8 from the Keswick rail terminal to Tarcoola, the crew change-over point, reported for duty at the Pacific National depot at 13:30. They transferred to the Keswick Terminal, arriving at about 14:30 and started their pre-departure procedures. This consisted of taking possession of and checking the train mechanical inspection certificate, the holding certificate and completing and signing their own test and inspection of the brakes throughout the length of the train. They also checked the fuel, lubricating oil and water levels in the locomotive systems as well as testing the communications equipment. Other than two, minor, non-safety related defects that did not impair the locomotive's performance; the train was in full working order.

Train 5AL8 departed Keswick Station at 15:05, five minutes behind schedule, with 282 passengers, 2 drivers and 20 passenger service staff.

The train proceeded with its headlight on high beam. The co-driver contacted ARTC Train Control at 15:06 and was told that there was a train crossing ahead. At 1508 the way was clear and the co-driver reported the weight, length and number of rail vehicles to the Train Controller. Close to the bridge at the exit to the Adelaide Freight Terminal both drivers saw a male trespasser start to cross the track as the train approached. However, a second male trespasser pulled the other off the track. Passing the Dry Creek North yard the driver conducted a 'running brake' test in accordance with Pacific National procedures. The train proceeded with all track signals passed at green.

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[4] The two drivers were equally qualified and alternated their time at the driving controls. For convenience the report refers to 'the driver' as the person in the left hand seat at the driver controls and the 'co-driver' as the person in the right hand seat acting as observer and handling communications.

At about 15:16 the Train Controller passed information of the opposing trains and the passing loops at which they would cross. The co-driver wrote down the details.

Just before 1529 the TransAdelaide 15:28 'up' train departed Salisbury Station for Adelaide Station with the level crossing boom gate barriers horizontal. When the rear of the train cleared the crossing on Park Terrace the barriers lifted and were fully vertical at 15:29:01. Vehicular traffic on Park Terrace resumed its east/west flow.

Serco bus 927039 (VYV 786) left from platform 'C' of the Salisbury interchange as service 401 on route to Virginia at about 15:30, some four minutes behind schedule. The 401 bus was immediately in behind the 400 service. Both vehicles waited at the interchange traffic lights to enter Park Terrace and cross over the railway lines. On a green traffic signal the 400 service turned right out of the Interchange and crossed the eastbound lane of Park Terrace. The 401 service closely followed the 400 service through the traffic signal. Both buses entered the outside westbound lane of Park Terrace, joining a queue of west-bound traffic. The buses crossed the TransAdelaide tracks in close formation. Both buses then stopped in the queue of traffic. The 401 service stopped about one metre behind the 400 service at a slight angle with the left side of the bus partially in the left lane and with the rear of the bus overhanging the standard gauge track.

The westbound traffic on Park Terrace was halted due to red signals at the traffic lights controlling the Salisbury Highway intersection. Traffic on the road between the intersection and the railway level crossing was backed-up over the level crossing. There were a number of cars alongside the bus. A red Holden car was alongside towards the rear of the bus, with a white Holden Nova behind the red car. The Holden Nova was stationary across the outside rail of the standard track. A blue Commodore and a red Ford Fairlane came to a stop behind the bus and Holden Nova, respectively.

The sky was mostly overcast and the conditions were dry.

About 17.8 km from Keswick, the track rises in a 'light' grade of 1:152 for about 3.6 km to Salisbury Station. On this grade the driver of train 5AL8 was using the maximum power setting 'notch 8' giving a speed of 81 km/h. At 15:31:00 the train approached the Kings Road crossing and at 15:31:09 the driver used the train air horn for five seconds to give warning of the train's approach. Both drivers could see a large number of school students on the platform and adjacent road and walkways.

At 15:32:26[5] the warning lights at the Park Terrace level crossing barrier started flashing and the warning bells started to sound. At 15:32:34 the boom gate barriers started to drop and were in the horizontal position at 15:32:42. At this time train 5AL8 was 445 m from the Park Terrace crossing.

The train was making a steady speed of 81 km/h on a slight uphill curve towards the Salisbury Station. The curve and trees on the left hand side of the track restricted the sighting distance of the left (western) side of the track to about 250 m ahead.

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5 Note. There is an approximate time difference between the GPS train time and TransAdelaide of 3 seconds

FIGURE 3:
Rail approach to Park Terrace

At about 15:32:45, about 330 m from the crossing, the train drivers saw Salisbury Station and the traffic waiting at the right side (eastern) approaches to the crossing at the boom barrier. In the next seconds, as the locomotive continued to round the curve, it appeared to the driver that there might be two cars between the broad gauge and standard gauge tracks.

As the driver of train 5AL8 reached for the warning horn, the left side of the crossing came into view at about 250 m and he saw a white car and a bus apparently parked overlapping the outer running rail. With the warning horn sounding at 15:32:49, the driver simultaneously gave an exclamation. One second later, at 15:32:50, he applied full emergency braking and also put the independent brake to full application. At 15:32:51 the throttle was put from 'notch 8' (maximum power) to idle. The second driver said words to the effect 'I hope this traffic is going to move!'

At the crossing the cars behind the bus reversed clear of the tracks.

It was apparent to the two drivers in the cab of NR34 that a collision with the Holden Nova and the bus was inevitable. The second driver left his seat to take refuge in the train vestibule at the rear of the driving cab. The driver maintained maximum horn warning for nine seconds until four seconds or about 72 m prior to the collision, before also taking refuge in the vestibule.

The occupant of the white Holden Nova on the inside lane was stopped straddling the outside rail of the standard gauge track. The car was unable to move forward or backwards due to the traffic backed-up over the level crossing. Upon seeing the approaching train and hearing its horn the driver opened the door and ran clear.

On the 401 bus service, students from Salisbury High School occupied most of the seats at the rear of the bus. The students told the investigation that stopping over the rail track happened often and they were not overly concerned until they heard the train horn and saw it approaching rapidly. They shouted at the driver who, some

recalled, moved the bus forward as much as one metre. Some students remembered that the bus operating the 400 bus service was directly in front, also stuck in the traffic queue, preventing the 401 bus service from clearing the track. The students started to move to the centre of the bus where some tried to force the centre doors open.

Transport SA bus doors are fitted with interlocks to the braking system. If an attempt is made to open a door while the doors are shut, the brakes will be applied automatically. This is a safety measure to ensure that a bus will not move off while a passenger is attempting to board. This is an example of a safety device, effective in one set of circumstances, becoming a potential safety deficiency in another.

At 15:33:01 locomotive NR 34 entered the crossing at 65 km/h. It hit the white Holden Nova sedan under the left side of the cowcatcher, forcing it into the side of the Serco bus operating the 401 service. The train also made contact with the rear of the bus. The bus was struck about 800 mm from the rear and was spun through 180 degrees and propelled into the inside lane of the eastern lane of Park Terrace. It demolished the crossing gate, a light pole and fencing on the pedestrian island in the centre of the road. The front of the bus (now facing towards the interchange) was hit by the second rail vehicle in the consist, a rail motor wagon, damaging the coachwork in the area of the driver's position.

The train came to a halt at 15:33:32, 183 m north of the crossing. Neither the locomotive, nor any of the rail vehicles were derailed.

The co-driver made an emergency call to the ARTC rail control centre. The area around the Park Terrace rail crossing and the Salisbury interchange was busy and a number of '000' calls were made to the emergency services.

FIGURE 4:
The bus

Figure 5:
The Train and Holden car

1.3.2 The release of train 5AL8

After the majority of the injured had been taken to hospital and with the Police in control of the accident site, technical staff from Pacific National and GSR assessed whether 5AL8 was fit to continue its scheduled journey.

After providing details to the Police, the two drivers returned to the Pacific National depot. They underwent routine drug and alcohol tests administered by an Occupational Health specialist (see 1.11). Two relief drivers assumed driving duties.

A Pacific National manager and an engineer from United Goninan inspected locomotive NR 34. At 17:48 it was determined that NR34 was disabled. Arrangements were made for an engine from the Two Wells yard to proceed to Salisbury and tow the train to the Bolivar yard, where NR34 could be detached and another locomotive coupled to power the train.

The Train Service Technician from the GSR train crew, together with a representative from United Goninan inspected the Great Southern Railway carriages. The brake rigging gear, brake piston travel and brake hoses were checked, and the consist examined for possible damage.

At 19:10:00 the locomotive from Two Wells arrived at Salisbury and was coupled to NR34. At 19:32:00 train 5AL8 departed the accident site.

ARTC staff assisted by Rail Infrastructure Services engineers tested and demonstrated that the track circuitry was working correctly. This included ensuring that the relays from the ARTC relay box, which detects the train approaching Park Terrace and transmits the information to the TransAdelaide relay box, which in turn operates the crossing signals and boom gate barriers, were intact and operating correctly. In addition the 'directional sticks', which detect the direction in which a train is moving and operate the relays to open the crossing when a train is clear, were 'proved'. Signals 23, controlling down access to the Dry Creek Bolivar block section, and signal 4 at Bolivar, controlling up access were also 'proved'.

The combination of these tests showed that the signalling and level crossing protection equipment were, at the time of the accident, working as designed.

Park Terrace was opened to road traffic at 00:16:00 on 25 October 2002. Two 'down' (northbound) freight trains passed through Salisbury, at slow speed while the site was under the direction of the Emergency Services. After the Park Terrace was reopened to road traffic, trains operated at 40 km/h until the light mast on the traffic island was repaired on Friday morning, 25 October.

1.4 Injuries

Four people, the bus driver and three passengers on the bus (one a student) were killed as a result of the collision. A further twenty-six people received injuries of varying severity that required them to be admitted to hospital.

Two passengers on 5AL8 received minor injuries, which were treated by train staff. One train staff member also received minor injuries.

1.5 Damage

1.5.1 The train

The damage to NR 34 was relatively minor. The damage was centred on the cable side of the locomotive from the driver's cab to the No.1 bogie. Visual examination of the bogie suggested little if any damage to the bogie other than a missing damper. The greatest damage was to the cable side of the end plate, wing plates and the cowcatcher. Vertical and horizontal external handrails below the driver's window were also distorted.

The motor rail wagon AMRZ 269 immediately behind the locomotive also came into contact with the bus during the collision. The left leading corner post was marked by yellow paint, evidently from the bus. Pieces of fibreglass bodywork, also from the bus, were found in the leading area of the decks. The motor rail wagon sustained some superficial damage. The corner post was distorted inwards by about 75 mm, the 'end of train' marker light bracket was damaged and minor damage was sustained to the bracket and spindle of the manual brake.

No other damage was sustained by train 5AL8.

1.5.2 Damage to infrastructure

No damage was sustained by the standard gauge line. On the western side of the crossing one level crossing flashing light on the median island, together with the light mast, was demolished, the boom barrier arm was snapped and the pedestrian walkway fencing on the north side of the crossing was also demolished.

1.6 Train crew details

	Driver at controls	*Co-Driver*
Gender	Male	Male
Date Certified in NR Class Locomotive	11 November 1996	16 November 1996
Certified on route Keswick-Tarcoola	December 1994	31 January 2000
Medical Status	Current	Current
Medical restrictions	None	None
Last Certification Check	9 June 2002	20 December 2001
Time on duty	Two hours	Two Hours

The passenger service staff consisted of a Train Manager of some 30 years rail experience, two assistant managers, a train service technician and 16 other staff. All staff were qualified in senior first aid and senior staff were qualified in advanced resuscitation techniques.

1.7 Vehicle information

1.7.1 Train information

The train consisted of locomotive No. NR 34, a motor rail car and 24 rail vehicles. NR 34 is a model Cv40-9i locomotive, built by A Goninan & Company of Cardiff NSW and General Electric in June 1996. It had a net mass of 132 tonnes and generates 3,000 kW. The locomotive was 22 m in length (coupling centres) and had a width of 2.938 m. It has serial number 7250-06/97-236.

NR 34 completed a scheduled service on 1 October 2002. It re-entered service with no outstanding deficiencies. On 3 October a number of defects were reported and parts replaced. On 16 October the locomotive was subject to a routine inspection.

There is no evidence that locomotive NR34 was anything other than operationally fit for service on 24 October 2002.

The remainder of the train vehicles were owned or operated by GSR. Maintenance records show that all vehicles were subject to regular inspections and maintenance (a table showing the date of the most recent maintenance is at attachment 1). The post accident test and inspection, together with the distance within which the train came to a halt, indicate that the brakes on all the vehicles in the consist were in good working order.

The investigation concludes that the consist was in a proper operational condition and there was no deficiency in the locomotive or rolling stock that contributed to the accident.

1.7.2 Road vehicle

The car destroyed was a white Holden Nova registration number WOJ 601.

The bus involved was part of the Serco Bus fleet, number 246, registration number VYV 786, model number NL202D, MAN with an overall length of 11.7 m and a width of 2.445 m. The damage was such that the bus was not repaired.

1.8 Track and other infrastructure

1.8.1 Track utilisation

In a typical week 77 trains pass through Salisbury station on the standard gauge track,[6] or an average of 11 trains per day.

On 24 October four southbound and two northbound trains had passed through Salisbury on the standard gauge track before the accident, the last at about 1410.

On the broad gauge track 106 TransAdelaide trains, four express trains and two goods trains pass through Salisbury in any weekday. In addition, on some days tourist trains operate a return service to and from the Barossa valley.

In total 123 trains pass through Park Terrace in a typical week day.

1.8.2 Track infrastructure

The standard gauge track through the Salisbury is 1435 mm on concrete sleepers secured by Pandrol fasteners.

The track was not damaged by the collision.

1.8.3 Signalling infrastructure

Trains are controlled and monitored by track circuitry, low voltage in both rails. A section will be shown as occupied if the track circuit is effectively shorted out by the continuity between the train wheels.

For northbound trains entry to the 15.92 km block section between Dry Creek and Bolivar is permitted by signal 23 at the north end of Dry Creek. For trains to proceed the signal must be set by the Train Controller. As the locomotive passes the signal the locomotive provides continuity between the two rails and the signal reverts to stop, preventing any following train entering the section until the leading train is clear. The Train Control centre controls the occupancy of any given section.

After the accident the Safety and Technical Investigations Manager of ARTC assisted by engineers from Rail Infrastructure Corporation tested signal 23 and it was shown to be operating correctly.

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6 The figure is based on trains on the standard gauge for the week ending 12 October 2002. The number of trains, however, can be affected by seasonal and environmental influences on the grain harvest.

Since 1991 Park Terrace crossing warning lights, bells and gates have been the subject of 18 incidents resulting in repair or non-scheduled maintenance. All these repairs related to the warning signals and boom gate barriers and were addressed by TransAdelaide.

Witnesses attested to the gate closing before the train came into view. Following the accident ARTC and their technical consultants Rail Infrastructure Corporation tested and proved the interface between the ARTC and TransAdelaide circuits. Readings from TransAdelaide central signal data logger showed that the timing and sequence of the gate closure was according to the normal standard.

Testing was also conducted to ensure that the sensor circuitry detecting the direction in which the train is moving ('directional sticks') were working properly. When the rear of a train clears a crossing, these sensor circuits activate the circuit to open the gates, providing there is no TransAdelaide train approaching the crossing.

The tests by ARTC, by engineers from the Rail Infrastructure Corporation and tests by TransAdelaide showed that on the day of the accident the rail systems, including the automatic boom barriers, all operated as designed.

1.9 Train Control

ARTC controls movements of trains on its track network from the Adelaide Control Centre. Train 5AL8 was under the direction of the controller operating the Western CTC from Adelaide to Port Augusta and the North Train Order Board covering the track from Port Augusta to Alice Springs.

The Western CTC train board shows the track sections, signals and the status of some level crossings. Kings Road crossing is shown on the train board and Heaslip Road, but not Park Terrace.

Once 5AL8 had passed Islington Yards the controller set the signals to clear for 5AL8 as far as Long Plains. 5AL8 was to pass a freight train waiting in the Two Wells yard some 45 km north of the Keswick terminal.

The first the controller knew of the accident was at about 15:34 when he received the emergency message transmitted by the co-driver of 5AL8.

1.10. Environmental factors

The accident occurred in full daylight, in good visibility on a dry crossing. The air temperature was about 19° C, the relative humidity 51 per cent, with a westerly wind at about 18 km/h and a 7/8 cloud cover.

1.11 Medical and toxicology

Both drivers were tested for alcohol and drugs at 1849 on 24 October. The results in both cases were negative, with no evidence of alcohol or drug usage.

2 ORGANISATIONAL CONTEXT

2.1 Introduction

Safe driving and proper observance of the road rules by drivers is integral to rail safety, the safety of train drivers, road vehicle drivers and passengers, as well as pedestrians at level crossings. The road rules, together with the design of level crossings and associated road works, signalling, warning systems and physical barriers form the defences that prevent the road, rail and pedestrian systems coming into conflict.

The principles covering the design of level crossings, the associated road network and road traffic signals are contained in various Australian Standards. The design of boom barriers in Australia, as adopted by state rail authorities conform to specifications drawn up by the American Rail Engineering and Maintenance-of-Way Association in the Signal Manual of Recommended Practice.

2.2 Traffic warnings and signal design

Traffic flow through the interchange area between Paternoster Row and Gawler Street together with access to and from the feeder roadways, bus interchange and pedestrian crossing control, is managed by a complex set of 27 vehicle lanterns and 12 pedestrian lanterns. These lights are positioned on 23 traffic light poles over a distance of about 115 m. The traffic engineering is further complicated by the 30 m[7] wide rail crossing.

The focus of the three sets of traffic signals along Park Terrace is to maintain maximum traffic flow while ensuring a safe separation between road and rail traffic. The rail system has its own system of half boom gate barriers with the associated lights and audible (bell) warning signals.

Eight hundred and forty five metres (about 30 seconds) before arriving at the crossing all approaching down trains activate a track circuit connected to the crossing boom gate barriers and the interchange area traffic lights at Park Terrace (Gawler Street, North Lane and the rail crossing)[8]. After detection the boom gates start a closure sequence of 18 seconds, involving the ringing of the warning bells and the flashing of warning lights for eight seconds before the boom gate barriers start to move from the vertical to a fully horizontal position. The lights for through traffic turn to red and the pedestrian crossing lights turn to green.

Australian Standard 1742.14, Manual of uniform traffic controls – Traffic Signals makes specific provision for signals adjacent to a railway level crossing at sections 7.2 and 8.

> 7.2. If a traffic signal installation is located close to a railway level crossing, special provision shall be made to ensure that queues generated by the traffic signals will not extend across the railway tracks. This may be achieved by treatments such as warning signs, escape routes, additional road widening and queue detectors.

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7 This width is measured from the west bound lane 'Stop' line to the limit of the pedestrian crossing on the west side of the rail corridor. The distance across the tracks is about 17.5 m.

8 Up trains on the standard gauge activate a circuit 782 m north of Park Terrace crossing

Consideration should be given to providing a queue clearance phase or any other special phase that would avoid queue formation across the crossing before the arrival of the train. This will require traffic signal linking with the railway level crossing to enable a special phase to be initiated at a predetermined time before the train is due to arrive at the crossing. Once the queue-clearing phase has terminated, no phases or turning movements which would have traffic cross the railway line can be introduced until the train has cleared the crossing. It may be necessary to provide for additional storage of these vehicles while the railway level crossing is closed.

In some situations, it may be possible to include the railway level crossing within the vehicular conflict area. In this case, the train movement may be treated as a priority phase.

8. PROXIMITY TO OTHER TRAFFIC CONTROL DEVICES

The following should be considered before installing traffic control devices in the vicinity of a railway level crossing –

(a) the effect that the device may have upon the operation of the railway level crossing, e.g. vehicles queuing over the crossing; and

(b) the effect that the normal operation of the railway level crossing may have upon the effectiveness of the traffic control devices, e.g. vehicles at the railway crossing queuing through an intersection, thus affecting the flow of traffic not using the crossing.

The busy intersection of Salisbury Highway, Waterloo Corner Road and Park Terrace is just such a situation. And the problem of traffic backing up on Park Terrace and fouling the level crossing was recognised in the design of the system. Waterloo Corner Road and Park Terrace is controlled by a set of traffic lights dynamically operated, which detects the density of traffic on the various roads as measured by remote sensors.

For west-bound traffic, sensors connected to the Salisbury Highway traffic signals are located in the pavement 50 m from the rail crossing and are used to detect a vehicle that has been stationary for at least five seconds. The traffic lights at the Park Terrace / Bus-Rail Interchange are linked to the Salisbury Highway traffic lights via Telstra line through the Adelaide Computer Traffic Signals system.

When a train is detected approaching the crossing (when the level crossing warning lights start to flash and the bells sound) and a stationary car is detected over the queue sensor the traffic light system is designed to switch to the westbound traffic phases. The westbound traffic phases should start to clear the westbound traffic queues on Park Terrace.

Information from Transport SA is that on 24 October 2002, and for some time before – possibly some years - the parameters controlling the links between the Salisbury Highway junction, the level crossing signals and the pavement sensors lights was disconnected.

2.3 Road vehicle driver responsibility

The Australian Road Rules were made as part of a national scheme for uniform road laws throughout Australia. In South Australia the rules are given force by s. 80 of the Road Traffic Act 1961 (as amended).

The Australian Road Rules, rule 123 provides that:

> A driver must not enter a level crossing if the driver cannot drive through the crossing because the crossing or road beyond the crossing, is blocked.

The Australian Road Rules, Rule 175 (1) provides:

> A driver must not stop on a level crossing, or on a road within 20 metres before the nearest rail or track to the driver approaching the crossing and 20 meters after the nearest rail or track to the driver leaving the crossing, unless the driver stops at a place on a length of road, or in an area, to which a parking control sign applies and the driver is permitted to stop at that place under the Australian Road Rules.

These requirements are summarised in the SA Road Traffic Handbook.

> You must not enter the crossing:
>
> - If there is a danger of a collision with a train or tram;
> - If any train or tram is on, entering or approaching the crossing;
> - When flashing or rotating red lights, or warning bells, are operating;
> - When the crossing is closed by gates or booms.
>
> Take particular care where there are multiple tracks. There may be trains or trams in both directions. Do not attempt to cross the line(s) unless there is a clear passage through the crossing and you can drive completely clear of the crossing.

Under the Road Traffic Regulations 1996 (SA) the driver of any vehicle parked or standing on a road in such a position or condition as to cause or be likely to cause danger to other traffic or persons using the road is liable of a fine of $51. This seems to be the only penalty applicable to entering a level crossing without the ability to exit it. Given the potential hazard such vehicles can cause the issue arises of whether or not a greater penalty, coupled with an enhanced enforcement regime, would deter drivers from breaching this requirement of the Road Traffic Regulations.

Approaching Park Terrace rail crossing from either direction, road vehicles should not attempt to cross the tracks unless there is room for the vehicle clear of the tracks on the far side. All vehicles are required to stop at the boom gate barriers when the warnings are activated by the presence of a train. There are clear road stop lines adjacent to the boom gate barriers and no standing (except as controlled by traffic signals) is permitted at any time.

At the time of the accident, other than pavement markings providing a general prohibition on parking between the crossing and Salisbury Highway, there were no road markings on the crossing itself delineating a 'no stopping', or 'do not enter unless clear' area. The only markings there were on the westbound lane were the broken lines marking the pedestrian crossing.

2.4 Accreditation and audit of rail industry

Pacific National, Great Southern Railways, ARTC and TransAdelaide are all accredited rail operators, meeting the requirements of Australian Standard AS 4292. The National Rail Accreditation Scheme operates under a national scheme of mutual recognition. Accreditation in one State/Territory leads to other States and the Northern Territory granting accreditation.

Under the scheme each company is subject, as a minimum, to an annual compliance audit and, where necessary, inspections of various functions of the rail operation.

Audits are also subject to mutual recognition, but where a safety issue specific to a particular authority arises that authority will audit those particular issues. Also, under the Rail Safety Act 1996 (SA) each company is required to furnish an annual safety report.

Great Southern Railway had been audited on 30-31 October 2001 and submitted its Safety Report on 29 January 2002. The 2002 annual audit had started on 24 October, the morning of the accident. ARTC had completed its audit on 12-13 March 2002 and submitted its annual Safety Report on 5 April 2002. TransAdelaide underwent an audit between 29 July and 5 August 2002 and lodged its annual Safety Report for 2000-2001 on 16 April 2002.

Pacific National was formed on 1 July 2002, from the reorganised National Rail Corporation (NRC) as a consequence of the combined sale of NRC and the New South Wales Government owned rail operator FreightCorp. NRC underwent an annual audit in July 2001, which noted the company's high standard of safety management. In July 2002 the New South Wales rail authority directed that as the company had been reorganised Pacific National should make a new application for accreditation. Interim arrangements covered Pacific National's ongoing operation.

At the time of the accident, the four rail organisations were all properly accredited and operating in accordance with Australian Standard AS 4292. No deficiency recorded in any of the four audits had any bearing to the Salisbury accident.

2.5 Track issues – level crossing sightings

For 'down' trains approaching Park Terrace from the south on the standard gauge, the sighting distance of the western side of the level crossing is about 250 m. The sighting distance could be extended if foliage from trees on the inside of the curve were lopped and cut back to the line of the fence. At a distance of 200 m or more a locomotive driver could probably see if a vehicle is stopped on the track or over a rail. However if a vehicle were not overhanging a rail, but close to the line, a locomotive driver would have difficulty in determining if a car was foul (within gauge) of the line of the train.

In discussing this issue with the owners of the tracks, it was pointed out by the track owners that strong opposition was experienced on environmental and aesthetic grounds from the property owners, and others, to lopping trees. There must be sufficient sighting distance of rail signals to allow a train driver to react appropriately. Train signalling operates on a 'pre-warning' basis. Sequential signals are programmed so that a driver proceeding on a green signal will either meet another green or a yellow cautionary signal at the next mast. The yellow cautionary signal requires the driver to reduce to a predetermined speed that will allow the train to be halted before the next signal, should it be at red. There was no such imperative for sighting distances at level crossings. Trains have priority and given the crossing controls and warnings, and the road rules, vehicles and pedestrians should not normally be on the track.

2.6 Train drivers' rosters

Pacific National utilise a crew rostering tool to manage crew fatigue. The Fatigue Audit InterDyne (FAID) fatigue modelling program, was developed by Interdynamics in collaborative partnership with the Centre for Sleep Research at the University of South Australia. The FAID program quantifies an individual's level of fatigue based on hours of work for the previous seven days. Train drivers duty hours, including travel, are entered into the computer program which returns a 'fatigue index score' for each

driver at any given time. Pacific National has designed their driver rosters so that at the completion of any given rostered day the fatigue index does not exceed 80.

Both drivers of train 5AL8 were rostered in accordance with the FAID program.

2.7 The rail crossing identified as a danger

Various public statements made after 24 October suggested that the collision was an accident waiting to happen and that warnings had been made of just such an occurrence.

There is little doubt that the interchange area is a traffic bottleneck, particularly at peak traffic times, and the pre-exiting rail crossing is a complicating factor in a road system that has become more intensively used and complex over time.

According to records held by Transport SA, the accident of 24 October was the first accident between a train and road vehicle at Park Terrace level crossing.

Between 1 January 1997 and 23 October 2002 there have been 9 reported level crossing incidents at Park Terrace involving TransAdelaide trains, seven involving pedestrians and two involving road vehicles. The two near collisions with vehicles involved a truck caught under a closing boom barrier and one fire truck that 'ran' the closed booms. Both these latter incidents occurred in 2002. In addition, one pedestrian was killed (a suspected suicide) about 200 m south of the crossing.

The investigation found only one record of an accident involving the standard gauge track, that being a fatality to a pedestrian that was crossing from the Salisbury Highway side, in 1996.

Searches for correspondence that pre-dated 24 October 2002 in Transport SA files relating to specific complaints/warnings of Park Terrace Crossing revealed no specific issue with the crossing itself. Most of the correspondence dealt with traffic or lighting issues at the Salisbury Highway intersection or the Gawler Street intersection.

There are some features of the Salisbury area that may contribute to a belief that the area is one that experiences transport accidents and 'near misses'. The area north of Salisbury Station has a reputation with train drivers on both the standard and broad gauge tracks as an area favoured by suicides. Also the area is one where there seems to be a large number of road accidents. According to data from Transport SA the road junctions at Wiltshire Street, Gawler Street and Salisbury Highway, together with the immediate area of the rail crossing since 1 January 1997 there has been in the order of 365 reported road accidents in the area. This equates to one road accident every six days. Seventy eight per cent of these have been rear end collisions (68 per cent where the car ahead had been stopped). And the great majority of these, 71 per cent, have occurred at the Salisbury Highway junction.

Advice from road engineers in Transport SA is that the frequency of road accidents in this area is no greater than would be expected at such an intersection. The frequency of accidents at the four areas in a small geographical area, however, may have created a perception that the area, with the rail crossing, was more dangerous than other similar areas.

Despite the absence of direct complaints or clear statistical information, there were other warnings. Information from the students on the bus operating the 401 service and anecdotal evidence was that it was not uncommon for road vehicles to queue back across the railway tracks. These observations were supported by on site observation on

in late October and early November, after the accident. On three occasions investigators saw car drivers entering the crossing when the opposite side was not clear and queuing over the rail track.

A collision between a train and road vehicles queued on the track was foreseeable. Given the apparent frequency of road vehicles queuing over the rail tracks, particularly the standard gauge, the risk of such an accident was not remote.

2.8 'Near hit' reporting

The reporting of near misses or 'close events' within the rail industry, better referred to as 'near hits', is sketchy and ad hoc. Also such systems are company specific and rely heavily on an effective safety culture.

It should be realised that an effective 'near hit' rail reporting system is extremely difficult to construct. 'Nearness' is highly subjective and depends upon the incident and the personality or mood of the observer. There is also an issue that the incident may reflect upon the observer and there is a natural reluctance to admit to possible personal shortcomings. Also there may be a reflection on the company's working procedures, or the procedures being seen as too time consuming, both of which may be a disincentive to 'near hit' reporting.

Talking to locomotive drivers, level crossings are always a general concern, particularly road vehicles approaching passive crossings and persons standing within a meter or so of the rails at pedestrian crossings. Even if clear of the train a pedestrian is in danger of being struck by any loose lashings or equipment that may vibrate loose and marginally overhang the train.

Although 'near miss' reporting systems are not easy to implement, they are worth pursuing. Such schemes provide a means by which hazards or potential accidents may be identified before people are hurt. Overtime, given a standard terminology and approach to accident reporting, such schemes also may help in developing a common safety culture within a company or industry. In the case of the rail industry the statistics, and hence the outcomes, would benefit from as wide a collection as possible, ideally a national system.

In commenting on the draft report the South Australian Police Transit Service Branch expressed the view that the police could play a useful role in intelligence gathering if a system of reporting of incidents and near misses included the Transit Service Branch as an addressee.

2.9 'Ownership' and oversight of level crossings

Railway crossings are the grade interface between the rail and road networks. In South Australia the maintenance of the railway track and the surface of the road 600 mm from the outside rail, together with the warning signals and any barrier device is the responsibility of the rail infrastructure provider. The infrastructure provider is also responsible for the pedestrian crossing of the railway lines and any associated control device, such as a maze.

In South Australia, beyond 600 mm from the outside rail, responsibility for the road surface, signage and traffic control measures is that of the road provider. This includes pedestrian crossings of the roadway. The road owner may be the Road Traffic Authority or, if owned locally, the local council.

At the time of the accident on 24 October 2002, there was no current body of focused mechanism within SA that coordinated the various transport interests in reviewing level crossing safety.

In each State of Australia level crossing safety has been managed through a State Level Crossing Committee. In SA the Level Crossing Committee last met in June 1999. The minutes of the 1999 meeting noted that the future of the Committee was under review at ministerial level. No meeting of the level crossing committee or any other alternative forum has been created to allow SA road and rail interests to review level crossing safety.

Whether or not the Park Terrace level crossing would have been of particular concern to any oversight body cannot be known. Although the traffic volume was higher than forecast, there had been no consolidated reports of hazards at the crossing. It was protected by lights and boom gate barriers that afforded a level of protection for a rail/road interface.

3 EMERGENCY RESPONSE BY RAIL OPERATORS

3.1 Overview

The collision occurred in a built up area close to emergency service facilities. The emergency services were first notified of the accident at 15:34. A large number of calls were made and it took some of the callers dialling '000' some minutes to reach an operator. It is safe to say that there was no delay in notification reaching the emergency services. Of the emergency services the Salisbury Police cycle patrol was first on scene followed by the ambulance service. Arriving from the eastern side the initial responders had to cross the track under the train. The emergency service vehicles were then directed to approach from the west.

This brief review of the emergency response is confined to the response by the rail interests involved:

- ARTC
- Great Southern Railway
- Pacific National
- TransAdelaide

3.2 ARTC

The first notification of the accident was received at 15:34 by the Western CTC board controller at the ARTC Train Control Centre. The controller immediately notified the Train Transit Manager, who had direct operational overall responsibility for Train Control, and also rang '000'. He found that the line was busy but eventually was connected.

The Train Transit Manager initiated the ARTC standard operating procedure following a major incident. The Safety and Technical Investigation Manager left for Salisbury at 15:35, the CEO and senior managers were notified as were Pacific National, Great Southern Railway and Transport SA and other relevant State authorities.

At 17:00 the Western Area CTC controller was relieved to allow him to compile a report and complete a standard form relating to level crossings accident.

At the site the Safety and Technical Investigation Manager met with the ARTC Safety Compliance Manager and representatives of Transfield (ARTC's civil maintenance provider) and Rail Infrastructure Corporation (ARTC's signal maintenance provider).

3.3 Great Southern Railway

The train came to a complete stop 31 seconds after the impact with the vehicles. The Train Manager and six of his staff immediately put on safety vests and left the train to render assistance. Three passengers with medical qualifications (two doctors and a nurse) also left the train to render assistance. The Train Manager rang '000' but the lines were already busy with other calls.

The train staff supplied towels and first aid kits in the immediate aftermath of the accident and also provided comfort to some of the distressed people at the scene.

Meanwhile the level crossing signal bells continued to ring. The Train Manager was unable to contact the drivers of 5AL8 by radio and made his way to the locomotive to check that they were not hurt. At this time he could hear the emergency services approaching. By the time he had walked the 180 m back to the crossing the first ambulance had arrived. The on train staff progressively withdrew to the train as the emergency services took over. The three passengers also returned to the train.

On board the train two passengers and one staff member received minor injuries. These were treated by staff on the train and all continued on to Alice Springs.

As the response to the accident developed, the Train Manager created an access way for the emergency services by opening the doors at the end of one carriage. Access to the carriage was controlled by GSR train staff.

ARTC had alerted Great Southern Railways to the accident at 15:37:00 and the General Manager (Safety) and other staff made their way to the scene to assist the on train staff and assess the damage.

3.4 Pacific National

After the impact, and as the train slowed to walking pace, the two drivers of train 5AL8 returned to the driving positions of the locomotive from the vestibule. The co-driver immediately made an emergency call to ARTC Train Control centre, while the driver contacted the Pacific National control room at Dulwich and the Transit Police. They ensured that the train was stable and then the co-driver climbed down onto the track to check the car and to see if there were any occupants. Despite the damage the car ignition was still on and the radio was playing. He called to the driver to hand down a fire extinguisher.

The train had come to a halt immediately level with the northern end of TransAdelaide rail platform 1. They were aware of what seemed a large number of people jumping from the platform and gaining access to the front of the engine through holes in the fence. Others came through a hole in the fence on the western side of the track. None were of assistance but were at hazard should the car have caught fire. The first Police arrived at the locomotive after about five minutes. The Police progressively exercised control over the critical areas of the crash site.

The State Manager and other Pacific National staff arrived about 40 minutes after the collision. Their priority was the health and welfare of the two drivers, to control the site and assess the damage to the locomotive.

3.5 TransAdelaide

The Salisbury station attendant notified the TransAdelaide Train Control centre of the accident almost immediately after the impact. The Train Controller then noticed that the warning light for Salisbury Park Terrace level was not showing on the 'overview panel', indicating that the electrical circuits at Park Terrace had been damaged.

The next TransAdelaide train due at Salisbury Station was the 15:10:00 down train to Gawler arriving at Salisbury at 15:39:00. The Train Controller contacted the driver by radio and informed him of the accident and to proceed with caution. A similar caution was provided to the driver of the 15:21:00 up train from Gawler, which was due at Salisbury at 15:44.

The drivers of these first two trains reported that people were milling about the accident scene and some people were accessing the site from the eastern side of the track, across the TransAdelaide lines. The drivers also stated that the accident had not fouled the TransAdelaide track and the accident site was well clear of their tracks. be The 15:44 up train departed Salisbury at 15:52.

TransAdelaide Staff were directed to the accident scene. As they arrived they assisted in securing the area by stopping people accessing the track and directing arriving passengers safely away from the area. Also technicians arrived and disconnected the crossing alarm bells.

At about 15:45:00 the Train Control Supervisor was contacted by a Police officer phoning from the scene. The officer asked whether TransAdelaide intended suspending its services. The supervisor said that they would prefer not to, bearing in mind the disruption this would create to commuters from the city. The Police officer said he would consult his senior officer, however, the Police did not contact the supervisor again.

The supervisor cancelled the signal on both approaches to Salisbury on both tracks and instructed that all trains should be crossed to the 'up' line through Park Terrace, using No. 1 platform. Thus using the track furthest from the accident site until south of the level crossing. Each driver approaching the area was issued with a 'verbal caution order' to proceed with caution, that the boom gate barriers were not operating, that there had been an accident and that they were not to proceed if they considered it unsafe.

TransAdelaide maintained the Adelaide Gawler Service throughout the afternoon and evening, albeit with delays. No driver reported any unsafe condition at Salisbury. Some reports of potential near misses were reported as diverted traffic built up at Kings Road and Nurlutta (Commercial Road).

4 ANALYSIS

4.1 Introduction

A potentially unsafe act only becomes dangerous in the presence of a hazard. The anecdotal history from train drivers, and others, is that it is not unusual to see road vehicles foul of rail level crossings, however this is only hazardous if the train is on the same track or a train is expected on that track.

The railway infrastructure, railway working procedures, the design of the active level crossing, road traffic signals and signage and the road rules and enforcement provide defences that, if effective, prevent catastrophic conflict between road vehicles and trains. The key defences that failed relate to human behaviour, violation[9] of the traffic rules and the perception of the danger inherent in level crossings.

4.2 Train 5AL8 and infrastructure

The locomotive, and the rail vehicles making up the consist of 5AL8 were in good operational condition and operated within design parameters. There were no defects in the consist that contributed to the accident.

The rail infrastructure including the track condition, signals, track circuitry, level crossing warning lights, warning bells and boom gate barriers all operated within design parameters.

4.3 Train speeds and stopping distances

There is no uniform stopping distance for trains. The stopping distance will depend on the mass of the train and its speed.

The following table is indicative of emergency braking applications for trains on a 1:150 rising gradient travelling at 80 km/h.

Train	*Trailing load*	*Stopping distance*
Freight 1800 m	4860 tonnes	667 m
Freight 1200	3760	521 m

Train 5AL8, with a mass weight of 1335.8 tonnes came to a halt in 460 m over a period of 44 seconds.

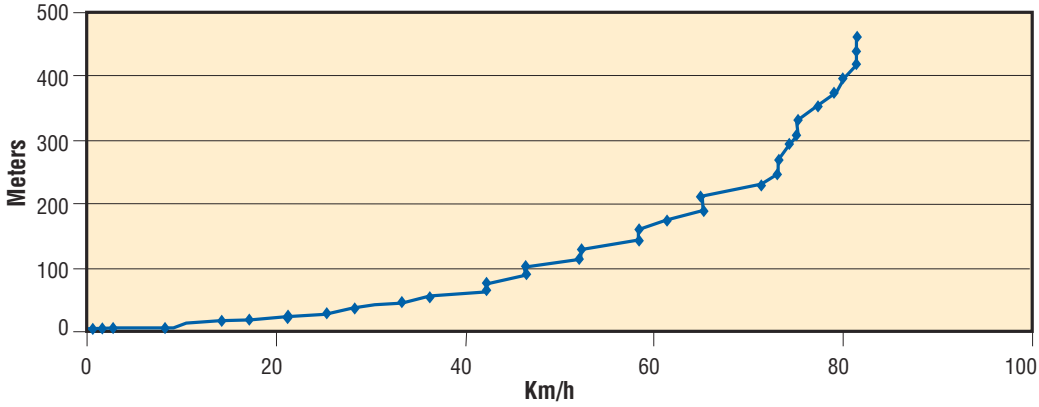
The idea of trains limiting their speed to the sighting distance to level crossings is predicated on the train driver detecting that a crossing is fouled and being able to bring the train to a halt before a collision. To base this on a uniform speed would be difficult as factors such as gradient and variations in mass introduce significant variations.

9 Violation in this context is used in terms of the Generic Error Modelling System, see Reason, J. 1990, Human Error.

Drivers of trains are used to seeing a vehicle crossing the tracks ahead of the train. At active crossings there is the minimum 25 second period between a train initiating the rail circuit and entering the crossing. If such a circuit is predicated on a 70 km/h train the locomotive would be about 490 m from the crossing when the boom barrier closing sequence starts. At passive crossings vehicles may cross at closer distances. Anecdotal evidence from train drivers is that it is not unknown for vehicles to 'race' trains to crossings. When first sighting a vehicle stopped on or near a track, a driver would not know whether the vehicle was stalled, or otherwise trapped, or about to move off the track. The first reaction of both drivers of train 5AL8, when initially applying the brakes was 'I hope they move in time'.

Given the sighting distance of about 250 m the chances of train 5AL8 or a train of greater mass having sufficient time to come to a halt before Park Terrace crossing is problematic. Allowing for assessment and reaction time by a driver, a driver would have at best 200 m in which to bring a train to a halt. The braking characteristics of a train will vary, but is largely a function of mass, speed and the gradient. The difference between the 600 m passenger train and an 1800 m freight train is significant. Train 5AL8 would have stopped just short of the crossing had its initial speed been 70 km/h. However a 1800 m freight train pulling 5860 tonnes could only travel at 40 km/h to achieve a stopping distance of 250 m.

FIGURE 6:
Braking distance 5AL8 24 October



4.4 Slowing trains to reduce risk

Given the defences in place at crossings and the road rules that drivers are required to follow, trains have priority at level crossings. Road vehicles stop for trains and not the other way round. Following the collision of 24 October the line speed was reduced from 115 km/h to 50 km/h. This was not based on any analysis but to allay public concern in relation to the risk of road vehicles and pedestrians being struck by a train on Park Terrace Level crossing. Although a train of similar mass to 5AL8 could stop within the sighting distance, freight trains would need to travel at a much lower speed to stop within the same distance. Freight usage of the standard gauge track through Salisbury is much greater than passenger train usage.

At active level crossings with automatic barriers, the Australian Standard requires that trains on the standard gauge line initiate the warning sequence and closing of the boom barriers at least 25 seconds before entering the crossing. Cars stopped at the road stop line when the sequence is initiated will have at least 25 seconds wait before the train arrives.

The track circuitry that activates the Park Terrace level crossing sequence is 845 m from the crossing. Train 5AL8, under normal circumstances would have created a delay at the boom barrier of about 70 seconds (allowing time for the barrier to rise). A car travelling at 60 km/h travels 1100 m in this time.

There are costs that are incurred in such a measure to reduce the risk of fatalities or injury. These costs include the delay to road users on Park Terrace, the increased use of fuel and individual time. There is also a cost in braking the train and the fuel required to accelerate a train.

Intrinsically, there is also a road user 'frustration factor' that is introduced in any delay. A freight train of 1800m in length, travelling at 30 km/h would delay traffic for 3 minutes 25 seconds. Such a delay could encourage a certain percentage of road vehicle drivers and pedestrians to disregard the road rules. This could lead to certain road vehicle drivers entering the crossing when the road on the other side is not clear, or attempting to cross when the warning signals are activated or when the boom gates are coming down.

The real effect of limiting the train speed to 50 km/h is that a road vehicle or pedestrian has more time to clear the line than if a train is travelling at 80 km/h. A sighting distance of 250 m provides an extra seven seconds for road vehicles and pedestrians to clear the tracks. This time would be greater if the approaching train applied full emergency braking.

FIGURE 7:
Park Terrace at about 250 m

To limit trains to a speed that allows them to come to a halt in a sighting distance of Park Terrace and, to be logically consistent, has a cost and probable behavioural consequences. Reduction in rail vehicle speed increases the delays to road traffic and increases any propensity for drivers and pedestrians to disobey the law. If the speed is above that which allows a train to stop within the sighting distance, given the mass of the train, any collision can be expected to have serious outcomes.

4.5 Railway personnel

There were no deficiencies in the Train Control procedures that contributed to the accident.

The driver and co driver were properly qualified. There was no impairment in the driver's performance or reaction. Both drivers were at the beginning of their shift. The driver at the controls at the time of the collision had completed his last driving assignment on Sunday 20 October. Tuesday 22 October and Wednesday 23 October were rostered days off. His FAID score at 1330 on Thursday 24 October was 37.2. The co-driver did not drive on Monday 21st October. He worked an eight hour shifts on 22 and 23 October respectively and had a FAID score of 52.9.

The driver did everything possible to warn those on Park Terrace level crossing of the train's approach. The driver acted promptly in applying emergency braking and returning the throttle to zero to bring the train to a halt as soon as was possible. The driver could not have avoided the collision.

The GSR on train staff acted promptly in going to the aid of the injured.

4.6 Train control

Both ARTC Train Control Centre and TransAdelaide Operations Control Centre were made aware of the collision almost immediately after the event.

ARTC was informed by the train driver. The ARTC controller informed various stakeholders of the accident, including TransAdelaide Operations Control. The TransAdelaide Train Controller was informed of the accident by the Salisbury Station staff member on duty.

The accident had not fouled TransAdelaide tracks and there was an imperative to keep the TransAdelaide passenger services operating. But the initial access to the accident site was from the east side of Park Terrace, across the TransAdelaide tracks. Although the TransAdelaide supervisor immediately introduced a safe working procedure to maintain services, there was some concern and confusion on the part of some at the accident site that the broad gauge continued to work. This was compounded by the number of onlookers who gathered at the site.

Although there was communication between the TransAdelaide and ARTC train control centres, there was limited contact between the control centres and the accident site. The TransAdelaide Operations Manager introduced an effective, but ad hoc plan to maintain services. There was, however, a lack of effective contingency planning between ARTC and TransAdelaide to cover situations such as the Salisbury accident.

The track providers emergency response plans lacked effective communications between the rail corridor users and a structured process for maintaining services.

4.7 Site control

The first concern was to reach the accident site and any injured personnel. The first emergency personnel crossed the track beneath a 'live' train. Such acts were impulsive, understandable, but extremely dangerous. There were not sufficient rail staff or Police to initiate immediate or subsequent site control.

Within half an hour the Police had the area adjacent to the crossing was tightly controlled. However, there were reports of people wandering over the extent of the train. Some of these were train passengers or others going to or from the car park, others were spectators. Site control over a long train is difficult, but there was a real

risk to those persons from the TransAdelaide services and from any movement from train 5AL8. There are no easy answers to the problem, but with this experience as a basis, accident procedures should be reviewed with the aim of improving site security.

4.8 Road traffic signals and road design.

From 15:29:01, when the south bound TransAdelaide up train cleared Park Terrace level crossing, the road traffic was able to cross from the east side of the rail crossing until the boom barriers started to drop to the horizontal at 15:32:34, 30 seconds before the collision. Sometime before 15:32, traffic on Park Terrace travelling west was stopped by the traffic signals at the Salisbury Highway junction. When the boom barriers at the level crossing started to drop, westbound traffic was already queued across the track.

The traffic signal sets on Park Terrace at the Salisbury Street junction and Gawler Street/Interchange operated as designed. The Gawler Street/Interchange traffic lights sequence is linked with the rail crossing and their operation is consistent with the Australian Standard.

The Salisbury Highway/Park Terrace intersection traffic lights did not operate as designed. The design of the lights, consistent with the Australian Standard, included a link to the rail level crossing to give vehicles in Park Terrace priority if there was a sufficient build up of traffic when a train was approaching. This should have initiated a signal to the Adelaide Computer Traffic Signal System. That link to the Adelaide Computer Traffic Signal System was not operational and had not been for a significant period, possibly five years.

Even if the system was working as designed it is doubtful whether it would have operated in time to clear traffic from the level crossing. For safety reasons, any pedestrian sequence cannot be interrupted. Such a sequence runs for 25 seconds at the Salisbury Highway/Park Terrace intersection. If the pedestrian crossing is activated immediately before the sensor detects a stationary vehicle, the 25 second pedestrian cycle governs the system. Also, there is a time lag associated with terminating conflicting traffic movements before the lights set to clear the road. Road planners work on the average car occupying about 6 m of road. Given this the queue of traffic extended approximately 150 m between Salisbury Highway and the eastern rail tracks, it would take as best case 55 to 60 seconds for a vehicle on the crossing to move. At a worst-case, in the case of a pedestrian crossing priority, it would take 80 to 85 seconds before vehicles actually on the level crossing could move.

The link between Salisbury/Park Terrace traffic light system was disconnected and did not operate as designed is a failed defence. The designed timing sequence, and the length of time that it could take for cars to move off the level crossing suggests that the missing defence was not a significant factor in the collision of 24 October. Regardless of any effect on the traffic flow created by the sequence of the traffic lights, there was the potential for westbound traffic to be blocked by other vehicles, particularly those attempting to cross or change lanes in the short, 142 m length of road. There was the potential for:

- southbound traffic on Salisbury Highway to block traffic in the left turn lane;
- vehicles leaving the railway car park and attempting to enter the outside ahead lane or the right turn lane;
- drivers changing lanes after clearing the tracks;
- vehicles using or crossing to, the right hand turn into or out of the Eureka Tavern.

FIGURE 8:
Park Terrace crossing

The Park Terrace crossing, from the eastern stop line to clear the pedestrian crossing on the west side, is 30 m (about 22.5 m from the boom barrier to one metre clear of the track). A car travelling at minimum speed, say 5 km/h, should travel some 40 m. By 15:32:40 the traffic had come to a complete stop so that vehicles were queued back with two vehicles foul of the standard gauge track and a further two behind them.

Prima facie at least four road vehicles did not observe the Australian Road Rules. There may be a number of factors, which it would be reasonable to assume prompted drivers to take such a risk, none of which are mutually exclusive:

- The drivers anticipated that the traffic would clear;
- The drivers perception of the space available for their vehicle was overestimated;
- Habitual or 'routine' violation of the crossing rules at Park Terrace;
- Assumption that the gates were closing for a TransAdelaide train on the broad gauge track.

4.9 Road vehicle drivers

The evidence shows that the driver of the 401 service followed close behind the 400 service. The driver of the 401 service did not stop at the stop line and allow service 400 to clear the tracks before assessing whether there was sufficient space to allow his bus to cross and clear the rail tracks as required by the Road Traffic Rules.

The evidence as to the actions of the Holden Nova driver is not clear. The fact is that the driver did not have sufficient clear space to clear the rail tracks. The two vehicles behind the bus and the Holden Nova must have entered the crossing at a time at which it was not possible to clear the tracks in accordance with the Road Rules.

Salisbury is one of seven crossings on the northern rail corridor involving a three-track crossing. The three tracks are shown on the crossing warning sign, as required by AS 1742-7. Drivers of road vehicles are required to judge, from a distance of 30 m plus their own vehicle length, whether their vehicle will fit into the available space. The lower the driver's seated position, the harder it would be for such judgements to be made.

There were no clear road markings on the crossing delineating the area of danger, marking the extent of road that should not be entered unless the vehicle can drive through. Any judgement of distance would be made more difficult by the lack of such markings. The yellow box road markings painted on the road after the collision is an aid to help drivers assess clear space beyond the markings and a prompt to remind them not to enter unless the space is clear. Where drivers proceed in closely behind another vehicle the box markings will not provide a perspective of clear space.

While perception of distance may be a factor, the clear evidence is that drivers do not appreciate the dangers posed by rail crossings. A percentage of drivers are either not aware that they 'must not enter a level crossing if the driver cannot drive through the crossing because the crossing or road beyond is blocked' or the road rule does not enter their consciousness.

4.10 Salisbury level crossings as an identified risk

The accident on 24 October 2002 was said by some to be an 'accident waiting to happen'.

There are no statistics on which to conclude that the Park Terrace level crossing is any more prone to accidents than any other rail level crossing in Adelaide with similar traffic levels. There are limited reports of 'near miss' events from either drivers or road users (vehicle drivers or pedestrians) at the Park Terrace level crossing. However as outlined in 2.7, people using the crossing had experience of vehicles queuing over the lines.

In discussion with train drivers, there is clearly a problem in defining a 'near miss'. Pedestrians standing too close to the track, but not attempting to cross ahead of the train may be considered to be dangerous, but whether such a situation constitutes a 'near miss' is a matter for subjective judgement. With level crossings controlled by booms or gates, vehicles are prevented from crossing ahead of the train. Such crossings become dangerous only when traffic is backed up at an adjacent intersection or vehicle drivers wilfully drive around the physical barriers. Again there is anecdotal evidence of vehicles being driven around horizontal barriers, but only one recorded instance, that of an emergency service vehicle responding to a call.

Since 1996 the road system in and adjacent to the Salisbury civic and shopping centre has been subject to changes in design. The volume of traffic using Park Terrace increased beyond that anticipated. Such a change in traffic usage is a change to the degree of risk for vehicles using Park Terrace.

The Safety Management Plan submitted by Pacific National and ARTC as part of the rail accreditation process make specific provision for the risk of level crossing accidents.

In the case of Pacific National, where the risk involves the locomotive, rail vehicles and the drivers, the 'treatment actions' are centred on proper warning devices (horns and headlights) safety awareness training for the train crew and ongoing liaison with

infrastructure owners to provide adequate level crossing protection. As part of an action plan, Pacific National developed a ranking system for high-risk level crossings based on prior incidents and near miss events. The Salisbury Park Terrace crossing had no reports of a Pacific National incident and no reports of near misses.

ARTC also include level crossings in a prioritised generic hazard analysis. A number of issues including vandalism, power failure and equipment failure are considered high risk factors. Inadequate signage and approaches to the level crossing are classed as significant factors.

TransAdelaide's Business Risk plan looks in more general terms at the risk of train collisions, derailments and other significant accidents.

From the point of view of the rail industry:

- trains have priority at level crossings;
- legislation requires road vehicle drivers to observe road rules that should prevent road vehicles coming into conflict with trains;
- all crossings must be marked in a standard way with appropriate warning signs;
- active crossings have clear warning signals; and
- in metropolitan Adelaide all road crossings have boom barriers to prevent road vehicles from crossing the tracks when a train is approaching.

The Australian Standard AS 1742, Manual of Uniform Traffic Control Devices, provides standards for railway crossings in Part 7 (AS 1724.7). The standards specify the approach signs, the warning signals and road markings for the approaches to the crossing. The issue of exiting a rail level crossing, providing exit markings to provide points of reference or cues for road vehicle drivers, is not considered. Reliance is placed on the observance of the road traffic rules in that drivers must not enter a crossing unless the other side of the crossing has clear space.

Public safety at level crossings is a matter of ongoing concern for governments and the rail industry. Accordingly Transport Ministers have included in the Australian Transport Council's National Road Safety Plan for 2003 and 2004 a directive to develop and implement a coordinated approach to improving public awareness of level crossing safety issues[10]. In addition, the issue of level crossing safety is a major item on the agenda of the inter-governmental Rail Group, which meets under the auspices of the Australian Transport Council and its Standing Committee on Transport (SCOT).

In South Australia, however, there is, no forum that represents the interests of all level crossing users that has an identifiable and clear mandate to maintain a safety overview. The demise or failure of the Level Crossing Committee to meet, since 1999 removed what overview there was and the committee's responsibilities in terms of ongoing risk assessment of level crossings was not clear.

[10] The Australian Transport Council (ATC) is a Ministerial forum for Commonwealth, State and Territory consultations and advice to governments on the coordination and integration of all transport and road policy issues at a national level.

5 KEY CONCLUSIONS

1. The immediate cause of the collision between train 5AL8, the white Nova Holden WOJ 601 and Serco bus number 246 (VYV 786) was that the drivers of the road vehicles entered the level crossing, in contravention of the Australian Road Rules, at a time when they were unable to drive through the crossing and were blocked by other vehicles.
2. The driver and co-driver of locomotive NR 34, reacted promptly in sounding a warning of train 5AL8, applying emergency brakes and returning the throttle to idle. Neither the driver nor the co-driver could have taken any action that would have prevented the collision with the white Holden Nova or Serco bus number 246 (VYV 786) operating the 401 service.
3. Locomotive NR 34 and the 25 vehicles of the consist comprising train 5AL8 were in working order, were properly maintained and were fit for purpose. There were no deficiencies in the consist that contributed to the collision.
4. The railway infrastructure (track circuitry, signals, level crossing warning signals and the boom barrier) worked as designed within standard time limits.
5. Following the collision, the on train staff servicing the passenger vehicles of train 5AL8 acted promptly to assist the injured at the scene of the accident until they were able to relinquish care to the emergency services.
6. The response of the emergency services was timely.
7. The road traffic lights at the junction of Park Terrace, Gawler Street, North Lane and the Bus Interchange and the link with the level crossing warning signals worked as designed.
8. The road traffic signals at the Salisbury Highway/Park terrace intersection did not work as designed or as recommended by Australian Standard AS1742.14, in that the link with the railway crossing had been broken at some time and the special queue-clearing phase was not operational. There was no effective maintenance or checking system in place to monitor the continuing operation of the queuing phase of the lights and the links with the Traffic Control Centre. The non-operation of the special queuing phase was probably not a significant factor in the collision of 24 October.
9. The road traffic on the western side of the level crossing for traffic crossing Salisbury Highway or turning onto Salisbury Highway was halted at the traffic signals causing traffic to back-up over the level crossing.

10. The backing up of westbound traffic across some part of the level crossing was not unusual and had become an accepted factor of driving in Park Terrace.

11. The complexity of the Park Terrace road system over a distance of 175 m from the bus interchange turning just east of the level crossing to the stop line at Salisbury Highway, increased the probability of road vehicles backing up to the level crossing in that:

    - Road vehicles exiting or entering the Station car park and crossing or from the outside westbound lane, right turn lane, or attempting to enter the eastbound lane potentially restrict traffic flow.
    - Road vehicles exiting or entering the Eureka Tavern car park across the traffic.
    - Heavy traffic southbound on the Salisbury Highway restricts the opportunity for traffic in the left turn lane to join the Salisbury Highway.

12. Based on observed behaviour of road vehicle drivers, a collision between traffic queued at Park Terrace and a train was foreseeable. However, the absence of any specific reports of near miss incidents or accidents between trains and vehicles at Park Terrace had led to a belief that there was no significant risk.

13. The lack of initial site control following the collision and during the immediate emergency phase increased the risk of pedestrian onlookers being struck by trains, either through any possible movement of train 5AL8 or the TransAdelaide services.

6 SAFETY ACTIONS INITIATED AND FURTHER RECOMMENDED SAFETY ACTIONS

6.1 Safety Actions already initiated

Recommendations made in the 'Graham' report are endorsed by this investigation. A number of immediate safety actions were initiated to improve the safety of the crossing together with actions recommended by Mr Vince Graham.

- A train speed limit of 50 km/h was introduced for trains approaching Salisbury.
- Yellow hatched road markings were painted on the road to clearly delineate the area of the level crossing.
- Additional 'Do not enter' signage was placed adjacent to the boom barriers
- Buses to and from the Salisbury interchange to the west of the railway corridor have been routed by way of the underpass on the Salisbury Highway.
- A review of level crossings and an assessment of the practicability of grade separation.

The investigation particularly endorses the Graham recommendations relating to:

- an oversight group to maintain a system of continuous risk assessment of level crossings in SA. Such a group should have clear terms of reference and a report, together with any recommendations or initiatives should be published.
- Implement training for bus and truck drivers in South Australia on the dangers of level crossing, together with safety advertising and a general education program on level crossing safety.

6.2 Recommended Safety Actions

In addition the investigation makes the following safety recommendations:

RR20030001 Road traffic signals adjacent to level crossings be regularly monitored to ensure that all links and functions within the system are operational

RR20030002 Traffic flows through Park Terrace should be measured to assess the practicality of extending the timing on a link to force westbound traffic from Park Terrace to take account of the worst case timing scenario, while maintaining the existing timing of the boom barrier closing.

RR20003003 Train speed restrictions introduced as a safety measure in the vicinity of level crossings should be objectively reviewed taking into account:

- new traffic arrangements and safety measures
- the different types and characteristics of trains on the standard and broad gauge tracks.

RR20030004 The rail industry should attempt to devise a confidential hazard reporting system that embraces the whole industry in the one system.

RR20030005 ARTC and TransAdelaide review their notification and communication procedures when responding to accidents on the shared rail corridor, particularly between the train control centres and the accident site.

RR20030006 The rail companies and emergency services examine ways in which early effective site control and control of public access might be further improved.

RR.20030007 Standards Australia develop a standard for the marking of a 'do not enter unless clear' area across level crossings, with a view to providing appropriate cues to help road vehicle drivers assess the space available on the other side of the crossing.

RR20030008 Transport SA should review the provisions of the Road Traffic Regulations 1996 to determine whether or not any existing penalty covering the drivers of vehicles that stop or park within the boundary of rail level crossings is appropriate.

RR20030009 Transport SA, the rail industry and the Transit Services Branch of the South Australian Police should explore the desireability of any 'near hit' reporting system including SAPOL as an addressee.

7 DIRECTLY INTERESTED PARTY PROCESS

7.1 Distribution of the draft final report

The draft final report was distributed for comment on 3 February, to:

- Australian Rail Track Corporation Ltd
- Pacific National
- Great Southern Railway
- TransAdelaide
- The Department of Transport, Urban Planning and the Arts
- Serco Adelaide Buses
- South Australian Police
- City of Salisbury Council
- The Principal, Salisbury High School
- Mr Vince Graham.

The directly interested parties were invited to review the draft report and to make submissions on in respect of the report, to correct matters of fact and comment on the views expressed by close of business on 21 February. Comments were received from:

- Australian Rail Track Corporation Ltd
- Great Southern Railway
- Serco Adelaide Buses
- TransAdelaide

Where appropriate the text was amended to reflect the comments received. Otherwise the comments are contained in section 7.2.

7.2 Comments

ARTC commented:

> Conclusion 13. This conclusion is factually correct. However, it could be taken to imply that people initially on the site should make it their priority to keep bystanders away. Their priority, in fact, would be to attend to injured persons, and ensure that there is no other life threatening circumstances, such as fire or explosion. The Police took charge of the trespassers when they arrived, and had that situation under control within 30 minutes. The train crew and train controllers would ensure that the train did not move in the immediate aftermath of the incident. This conclusion, in its current form, may result in inappropriate revision of priorities.

Serco Adelaide Buses commented:

> The paragraph (at section 1.2) page 12 does not represent the actual Salisbury Highway intersection as currently exists. The left filter to Salisbury Highway has been changed to impede the traffic flow. The Island has been reduced.

TransAdelaide commented:

Clause 4.7 & Conclusion 13

It was considered that this area was principally under the control of the Police; however in the first few minutes of the incident until cordoned off this aspect is difficult to control. Suggestions would be welcomed!

TransAdelaide concurs with the recommendations made in the ''Graham' recommendations. . . . A number of his immediate actions have already been implemented to improve the safety of this and other crossings.

Clause 6.2 Recommended Safety Actions

RR20030001	Trans Adelaide agree that appropriate procedures need to be drawn up between TransAdelaide, ARTC and Transport SA to meet this requirement.
RR20030002	(This recommended safety action is) is being implemented as part of the 'Graham' recommendations. Designs and installation of signalling interface to improve traffic controller response progressing. Inputs from TransAdelaide, ARTC and Transport SA complete. System to be commissioned 14 February 2003 with a trial period of 6 weeks to follow.
RR20030004	(This recommended safety action is) being addressed as part of the 'Graham' report.
RR20030005	A procedure is currently in place. TransAdelaide formally contacts ARTC and vice versa whenever an incident occurs within 2m of their respective tracks. This is part of a standing procedure implemented by train control staff. There is also a direct line of communications between the two organisations.
RR2003006	Accident scenes such as this are principally under the control of the Police; however in the first few minutes of the incident until cordoned off this aspect is difficult to control.

In his report 'Graham' proposes that Transport SA consolidate and maintain a Technical Standards Manual for level crossings in South Australia. It is considered (by TransAdelaide) that this may be a better approach than endeavouring to develop an Australian Standard, an invariably their development is a lengthy and time consuming process.

The Transit Services Branch of the South Australian Police commented:

The control rooms of all accredited rail operators in South Australia provide the SA Rail Authority and SAPOL (Transit Services Branch) information on notifiable incidents under the Rail Safety Act. This process would enhance the intelligence gathering recording and dissemination process relative to 2.7 'Rail crossing identified as a danger', 2.8 'Near hit reporting', 4.10 'Salisbury level crossing as an identified risk' and 6.2.4 'Hazard reporting and notification procedures'.

Site Control is always a concern at such an extensive incident. SAPOL personnel are trained annually in incident management and Operational Safety Training. Response to this type of incident is part of that training.

Attachment 1

5AL8 - GSR service record vehicle

Train 5AL8 Individual Car data – 24 October 2002

Car Id	A Service	B Service	C Service	D Service	E Service	F Service
AMRZ269	23.10.02	31.07.02	25.05.02	12.09.02	12.03.02	17.09.02
HGM297	23.10.02	26.06.02	02.05.02	26.08.02	26.02.02	02.11.02
BRJ302	16.10.02	23.10.02	16.08.02	10.04.02	01.07.02	24.11.00
HM318	23.10.02	04.07.02	09.05.02	10.09.02	21.03.02	30.09.99
BG368	23.10.02	17.10.02	15.08.02	10.12.01	06.06.02	21.12.02
BG370	23.10.02	05.09.02	26.10.02	29.10.02	02.05.02	26.11.01
BG371	23.10.02	27.06.02	09.05.02	30.08.02	07.03.02	05.09.01
AFC936	23.10.02	17.09.02	14.03.02	12.07.02	17.01.02	15.09.02
CDF928	23.10.02	12.09.02	27.06.02	16.11.01	06.05.02	29.10.99
BRJ270	23.10.02	21.06.02	29.08.02	11.04.02	31.10.02	08.04.00
ARJ242	23.10.02	30.05.02	01.08.02	15.03.02	03.10.02	20.03.01
ARM288	23.10.02	09.05.02	19.09.02	26.07.02	30.01.02	25.02.99
DF232	23.10.02	22.08.02	21.02.02	10.06.02	10.12.01	30.11.98
AFC307	24.10.02	18.07.02	02.09.02	13.06.02	13.12.01	16.05.02
ARL921	24.10.02	N.A.	N.A.	N.A.	N.A.	15.09.02
ARL309	24.10.02	05.04.02	06.06.02	04.02.02	22.08.02	03.03.01
ARL324	24.10.02	31.01.02	31.07.02	16.11.00	03.10.02	12.12.01
ARL246	24.10.02	03.07.02	04.09.02	04.05.01	04.11.01	15.05.02
DF934	24.10.02	03.10.02	08.03.02	09.07.02	27.01.02	28.07.99
AFC301	24.10.02	26.09.02	08.03.02	15.07.02	08.05.02	05.08.99
ARL250	24.10.02	28.03.02	26.09.02	14.01.02	29.07.02	08.01.99
ARL248	24.10.02	04.04.02	30.05.02	14.01.02	08.08.02	01.03.00
SSA260	24.10.02	25.07.02	14.05.02	09.09.02	15.03.02	01.04.97
ER207	24.10.02	28.03.02	19.09.02	16.01.02	18.07.02	29.01.01
HGM317	24.10.02	08.08.02	03.10.02	03.06.02	03.12.01	01.06.02

Attachment 2

Draft final report – Salisbury Investigation

30 December 2002

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SECTION ONE: BACKGROUND AND TERMS OF REFERENCE

On Thursday 24 October 2002 passenger train 5AL8 collided with a bus and a car on the rail level crossing at Salisbury. Four people died as a result of the collision.

The level crossing at Salisbury was protected by boom gates, warning lights and bells and all appear to have been operating normally at the time of the accident. Heavy peak period road traffic on Park Terrace created a queue back of traffic from the Salisbury Highway/Park Terrace intersection onto the rail level crossing causing the level crossing to be obstructed.

Passenger train 5AL8, weighing approximately 1200 tonne, was travelling north on the standard gauge ARTC track at 81 kph around a left hand curve. The sighting distance to the level crossing available to the train crew was approximately 200 metres. The distance required to stop passenger train 5AL8 under emergency braking was over 400m. Evidence available suggests the braking system on train 5AL8 was operating normally and the train driver sighted the obstructed level crossing at the earliest opportunity and applied the train's emergency braking system.

In response to this accident the South Australian Minister for Transport appointed the Australian Transport Safety Bureau to undertake an investigation into the accident and the South Australian Police are preparing a report for the coroner.

In addition to the above the Minister commissioned a wider investigation with the following terms of reference –

1. adequacy or otherwise of all vehicular and passenger transport related infrastructure in the area including the road/rail traffic management systems;
2. effectiveness of current risk management strategies, management structures and processes in relation to road/rail level crossing in South Australia;
3. management decisions which may have affected the risk of such a crash;
4. development of appropriate short, medium and long term remedial strategies; and
5. any related matters.

This report responds to the above terms of reference and provides recommendations to the Minister on each term of reference.

SECTION TWO: SALISBURY AREA TRANSPORT

INFRASTRUCTURE

The road network in the vicinity of the Park Terrace rail level crossing is complex and congested during peak periods. Traffic volumes on Park Terrace are estimated at 22,000 vehicles per day and Salisbury Highway traffic volumes are estimated at 34,000 vehicles per day.

The section of Park Terrace from Wiltshire Street to the Salisbury Highway (approx. 325m) incorporates multiple intersections, access points, a bus interchange and the level crossing adjacent to the Salisbury railway station. There are three rail tracks across the level crossing. Two tracks service TransAdelaide's suburban train services and intrastate rail freight services for the Australian Railroad Group. A third

bi-directional track is owned and maintained by the Australian Rail Track Corporation and services interstate freight and passenger services for multiple above rail operators. There are approximately 130 timetabled train movements across the level crossing on any weekday and approximately ten movements per hour during the afternoon peak hour period on Monday to Friday.

Industrial and residential development in the Salisbury area has seen traffic volumes increase and this trend is expected to continue.

An underpass to take Salisbury Highway under the rail tracks north of Salisbury station was constructed more than ten years ago. Since that time modifications have been made to the local traffic arrangements on Park Terrace that have added to the complexity and congestion of the traffic network between the Salisbury Highway and Wiltshire Street.

The extent of peak hour traffic congestion in the vicinity of the Park Terrace level crossing was understood by both state and local authorities. There was, however, no evidence available to road or rail authorities that the level crossing was a potential 'black spot'. Accident and incident records from TransAdelaide and ARTC do not suggest this level crossing was a high risk location.

Post accident police enforcement has resulted in many motorists being fined for queuing on the Park Terrace level crossing. This strongly suggests that, pre accident, road traffic queuing onto the Park Terrace level crossing was a frequent occurrence. Therefore the significant risk factor that led to the accident on 24 October 2002 had pre-existed, undetected, for some time.

The road transport infrastructure in the vicinity of the Salisbury level crossing continues to pose risks of further level crossing collisions. Interim actions to reduce train speeds, remove buses from the level crossing, pavement marking and increase police enforcement have helped reduce the risk and severity of a further collision but that risk still exists.

The infrastructure options I have considered to reduce the continuing risk at the Salisbury level crossing are –

- Grade separation
- Closure of the level crossing
- Traffic management initiatives to control the length of queue forming on Park Terrace from the Salisbury Highway/Park Terrace intersection.

These options have been subject to discussions with both Transport SA and Salisbury Council.

Grade separation of the Park Terrace level crossing by either an underpass or overpass

poses severe practical problems. The 'scar' created by either an overpass or underpass on property either side of Park Terrace would severely impact the Salisbury Town Centre. There already exists a grade separated crossing of the rail tracks at Salisbury highway a short distance north of the Park Terrace level crossing.

Closure of the level crossing and resulting changes to local traffic arrangements, while less severe than grade separation options, may impact businesses in the Salisbury Town Centre.

Transport SA has developed a series of traffic management initiatives to attempt to control the queue length between Salisbury Highway and the level crossing on Park Terrace.

These initiatives fall into three categories –

1. Initiating a phase change in the Salisbury Highway/Park Terrace traffic signals to give priority to westbound Park Terrace traffic when a train is detected to be approaching the level crossing.
2. Controlling the maximum queue length of vehicles between Salisbury Highway and the level crossing by stopping westbound Park Terrace traffic east of the level crossing at Gawler Street/Park Terrace traffic lights. Additional queue detectors embedded in the road surface west of the level crossing would initiate a red signal at the Gawler Street lights.
3. Reducing the number of access points for traffic to enter Park Terrace between Wiltshire Street and the Salisbury Highway and providing emergency escape lanes east and west of the level crossing.

Initiatives 1 and 2 described above are relatively low cost and could be commissioned within a few months. Some aspects of initiative 3 above could be achieved by temporary traffic barriers.

It is my conclusion that a two stage approach should be taken to future risk management of the Salisbury level crossing.

In the first stage the short term and low cost initiatives developed by Transport SA should be implemented and assessed for effectiveness in controlling traffic queuing back onto the level crossing from the Salisbury Highway intersection.

Interim train speeds of 50 kph should continue to apply for this period. If these initiatives are, in the judgement of Transport SA, effective in controlling vehicles queuing onto the level crossing then normal train speeds should be resumed following a local awareness campaign.

Assuming the level crossing is to remain open all long vehicles (truck and bus) should be restricted from using the Park Terrace level crossing and no further access points onto Park Terrace should be approved by either Salisbury Council or Transport SA between Wiltshire Street and the Salisbury Highway.

If the stage one measure does not prove effective in controlling the vehicles queuing onto the level crossing then the level crossing should be closed following the development and construction of a local traffic management plan. Following closure of the level crossing normal train speeds should be resumed.

RECOMMENDATIONS FOR SALISBURY AREA ROAD/RAIL TRAFFIC MANAGEMENT SYSTEMS (Term of Reference No. 1)

Recommendation 1

All bus and long road freight vehicles should be permanently restricted from using the Park Terrace level crossing.

Recommendation 2

Traffic management initiatives proposed by Transport SA to control vehicle entry and vehicles queuing between Salisbury Highway and the level crossing on Park Terrace should be implemented for a trial period. The trial should be assessed by Transport SA utilising recordable closed circuit television. Interim train speeds in the vicinity of the Park Terrace level crossing should continue for the period of the trial.

Recommendation 3

If the results of the trial proposed in Recommendation 2 are considered successful by Transport SA then, following a local awareness campaign, normal train speeds should be resumed.

Recommendation 4

If the results of the trial proposed in Recommendation are considered by Transport SA to be inconclusive or unsuccessful then a local traffic management plan to close the Park Terrace level crossing to vehicular traffic must be implemented. Interim train speeds in the vicinity of the level crossing would continue until the closure of the level crossing. Following closure of the level crossing and a local awareness campaign for pedestrian traffic normal train speeds could be resumed.

SECTION THREE: LEVEL CROSSING MANAGEMENT IN SOUTH AUSTRALIA

According to the Australian Transport Safety Bureau level crossing fatal accidents in Australia account for less than one percent of the national road toll. (ATSB Monograph 10).

When these accidents do occur they often involve multiple fatalities and reawaken the community to the continuing danger posed by level crossings in Australia. In recent years New South Wales has experienced a tragic accident at a level crossing at Wagga in southern New South Wales killing five young men. At Benalla in Victoria three people were killed recently when a steam train collided with a truck on a level crossing.

While level crossing safety is clearly of national concern it is a state government responsibility. Historically each state has managed level crossing safety through a Level Crossing Committee generally involving road, rail, police and local government representatives. Up until 1999 South Australia managed level crossing safety matters through the State Level Crossing Safety Forum.

This forum last met in June 1999. The precise reasons for the discontinuation of the Level Crossing Safety Forum in SA appear to be –

- the committee had no authority or direct funding
- the increasing complexity of the rail industry following privatisations
- a lack of agreement between parties on level crossing funding
- a ministerial review.

There were two reviews of the state level crossing governance arrangements undertaken by Transport SA in late 1998 and again in early 2000. Both of these reviews led to recommendations or suggestions being forwarded for Ministerial consideration. Transport SA has not been able to provide me with any written response following Ministerial review of the proposals.

It is not possible to conclude that had the level crossing governance arrangements proposed by Transport SA in 1998 or 2000 been implemented that the risk exposure now evident at Salisbury or other level crossings would have been identified and corrected. Those risk exposures will only be dealt with by moving to a proactive risk assessment system.

South Australia does not have co-ordinated and effective governance structures for level crossing safety.

Level Crossing Committees in other states have been reformed and have adopted risk assessment and management processes that maintain a stronger focus on improving the risk profile of all level crossings. It should be noted, however, that the impetus for the reform of the Level Crossing Safety regime in New South Wales was the multiple fatalities at the Wagga level crossing accident.

A best practice approach to level crossing safety management in South Australia requires a commitment to the following objectives –

• The adoption of a statewide level crossing risk assessment programme to identify risk and prioritise risk mitigation strategies.

• The development and adoption of level crossing design standards, including signage and pavement marking and the consistent implementation and maintenance of these standards.

• The development of design capability for the interconnection of railway and road traffic signalling to control level crossing risks particularly in the Adelaide metropolitan area.

• Defined funding to enable the progressive implementation of risk mitigation programmes. The amount of funding should be considered against other priorities in the state's road safety programme and an amount allocated for a 3-5 year programme.

• A focus on level crossing closures. Adelaide's metropolitan road network has a high density of rail level crossings and a concerted effort is required to close as many level crossings as possible to protect human life. Some crossings in residential areas involve low volumes of road traffic but high risk situations with alternative access reasonably available. The Wattlebury Road level crossing at Mitcham is an example.

• A planning decision to prevent any further level crossings to be constructed on the TransAdelaide network.

The implementation of these objectives can be achieved by South Australia adopting best practice already in operation in other states. Queensland has developed a risk factors assessment model for level crossings that is available to South Australia and has already been adopted by both New South Wales and Victoria. New South Wales has implemented a governance model for level crossings that has centralised control and established a small group of resources on a full-time basis to achieve a rapid implementation of risk factors assessment, prioritised action within available funding and a closure strategy for selected level crossings in New South Wales. Western Australia has developed some detailed engineering standards to control queue back risks onto level crossings

RECOMMENDATIONS FOR FUTURE LEVEL CROSSING MANAGEMENT IN SOUTH AUSTRALIA (Term of Reference No. 2).

Recommendation 5

The following level crossing governance arrangements should be introduced to manage road/rail level crossings throughout South Australia.

5.1 A Level Crossing Strategy Advisory Committee be established, chaired by Transport SA and include senior representatives of rail track owners, police and local government

5.2 A small full time Level Crossing unit be established within Transport SA to undertake –

(i) initial and ongoing risk assessment of all level crossings in South Australia

(ii) prioritisation and implementation of level crossing risk mitigation strategies

(iii) an ongoing review to ensure consistent and effective implementation and maintenance of level crossing signage, pavement marking and road/rail sighting distances for all level crossings

(iv) a programme to achieve closure of level crossings wherever possible particularly where 'short stacking' situations create a queue back of road traffic onto a level crossing

5.3 Transport SA consolidate and maintain a Technical Standards Manual for the design, signage and markings and maintenance of level crossings in South Australia. These technical standards should include design standards for the interconnection of road and rail signalling systems to manage road traffic queuing in 'short stacking' environments of level crossings.

5.4 The Level Crossing Unit proposed in Recommendation 5.2 should immediately adopt the Queensland model for the risk factor assessment of all level crossings.

5.5 The Department of Urban Planning and all Adelaide metropolitan area councils should adopt a planning policy to prevent the development of any further level crossings on the TransAdelaide rail network.

5.6 Photo enforcement of breaches of level crossing road laws should be adopted on level crossings recommended by the Level Crossing Advisory Committee on the advice of the Level Crossing Unit.

SECTION FOUR: MANAGEMENT DECISIONS AFFECTING RISK OF A LEVEL CROSSING ACCIDENT

Level crossings, like road intersections, are locations where there is a higher risk of accidents. The risk of level crossing accidents is substantially reduced by good signage, installation of active level crossing protection and law abiding drivers.

The decision to install boom gates, lights and bells on all TransAdelaide track level crossings more then ten years ago was a very positive decision to control risk and has contributed to a substantial reduction in level crossing safety incidents since installation. The installation of boom gates, lights and warning bells protects motorists moving forward onto a level crossing when a train is approaching. It does not protect motorists who intentionally or unintentionally 'queue back' onto the level crossing because of traffic flow obstruction on the downstream side of the level crossing.

Western Australia Main Roads Department recognises the risk (short departure stacking) and includes on their website (www.mrwa.wa.gov.au) guidelines and possible treatments (chapter 10 Railway Crossing Protection in WA).

I can find no evidence that road or rail authorities in South Australia have identified or acted on the potential risks associated with short departure stacking in the vicinity of level crossings. There is potential for this condition to be a latent problem at other South Australian level crossings and my recommendation (No. 5) on both risk factor assessment and future level crossing governance in South Australia are designed to remedy this problem.

The design of the traffic lights system at the Salisbury Highway/Park Terrace intersection originally included a connection from the rail signalling system. This connection, as designed, enabled the approach of a train to the Park Terrace level crossing to be signalled to Salisbury Highway/Park Terrace intersection traffic lights to give priority to westbound traffic, queued on Park Terrace.

This system did not, however, enable a vehicle, queued back onto the level crossing to move forward prior to the train reaching the level crossing. The rail signal was provided approximately 30 seconds before a train reached the level crossing. A road vehicle queued back to the Park Terrace level crossing was estimated by Transport SA to take 60 seconds or more to begin moving once the Salisbury Highway/Park Terrace traffic lights cleared to green.

This interconnection of the road/rail signalling system was disconnected as a result of road works three or more years ago and was not operational at the time of the accident on 24 October 2002.

I am satisfied that the disconnection of the rail signal feed to the Salisbury Highway traffic light system did not contribute to the accident on 24 October 2002.

Had the queue back risks inherent at this location been identified and acted upon a suitably designed interconnected road/rail signalling system may have reduced but not eliminated the risk of a level crossing collision at this location. Recommendation 5.3 deals with this issue.

At the time of the accident there was no yellow pavement marking on the roadway of the Park Terrace level crossing. After the accident yellow marking was undertaken and additional signage provided. From my investigations of other level crossing locations in the Adelaide area yellow pavement marking and signage were inconsistently applied. Clear standards need to be adopted and applied by Transport SA with regard to both signage and pavement marking at level crossings in South Australia. Recommendation 5.2 (iii) deals with this issue.

SECTION FIVE: RELATED MATTERS

As a result of my investigation there are three matters that warrant comment and further consideration by transport authorities in South Australia. The first matter relates to pedestrian safety on level crossings including wheelchair access. The second relates to community education on the dangers associated with rail level crossings. The third involves establishing a national safety alert procedure to allow transport authorities to learn lessons from accidents in other states and territories.

Pedestrian and Disabled Safety

In 1996 TransAdelaide engaged TMG International to undertake a study on the effectiveness of pedestrian crossings on the TransAdelaide system. That comprehensive study found that existing level crossing protection was adequate and in a tolerable range of risk for critically exposed groups namely teenagers/school children, the aged and infirmed and adults.

There are aspects of pedestrian level crossing safety which, I believe, require further consideration following the TMG report.

The most likely scenario for a pedestrian fatality is school children crossing tracks behind a stationary train and walking into the path of an express train on an adjacent track. Experienced train drivers often take precautionary measures, if possible, in these circumstances and slow their train and sound the train horn.

In recent years, particularly in Victoria, the issue of the safety of wheelchair access on pedestrian level crossings has become a safety concern. The management teams of both TransAdelaide and the Public Transport Board raised this issue. The particular issue is the condition of the level crossing surface and the potential for potholes and gaps near rails to create a hazard for wheelchairs and other personal motorised vehicles.

These issues need to be subject to comprehensive risk assessment by TransAdelaide and infrastructure plans and, if necessary, operational rules established to reduce risk to pedestrian and the disabled on level crossings.

Public education on the dangers of rail level crossings

The most significant contributing factor to rail level crossing fatalities is the intentional or unintentional breach of road rules by motorists. In regional areas motorists fail to look for infrequent trains. In city areas motorists choose to queue across level crossings assuming the queue ahead of them will clear before a train arrives at the crossing.

Many motorists believe trains can stop quickly to avoid a collision. Trains CANNOT stop quickly as the following table demonstrates.

Approximate distance to stop (metres)

Train speed	*TransAdelaide Passenger train(kph) (3000 class)*	*Heavy freight train (5000 tonne)*
100	n/a	1,800
90	300	1,500
80	220	1,300
50	100	600
20	20	200

A typical heavy freight train (approximately 5000 tonne) operating between Adelaide and Perth, travelling at 100 kph would take approximately 1800m to stop under emergency braking conditions.

The groups most as risk at vehicular and pedestrian level crossings in South Australia are –

(i regional motorists – infrequent train services and passive level crossing protection

(ii heavy vehicle drivers (truck and bus) – long and slow over level crossings

(iii school children and disabled – risks at pedestrian level crossings.

There is an opportunity to target an education campaign on the dangers of rail level crossings to each of these exposed groups. TransAdelaide already have a school education unit that is in constant demand by schools in the Adelaide metropolitan area.

The Public Transport Board and Transport SA have the opportunity to develop a level crossing education module for bus and truck drivers to be used in all state accreditation programmes.

More broadly based community education programmes utilising television and radio media are expensive. Understandably road safety authorities will spend available advertising funds to target speed, alcohol and fatigue as causes of road fatalities. Because of the low incidence of level crossing fatalities nationally it is unlikely that level crossing safety would ever justify broadly based community advertising.

Targeted advertising programmes, particularly in regional areas, are being undertaken in New South Wales and Queensland and should be assessed for effectiveness by Transport SA.

A public education programme called 'Operation Lifesaver' has been implemented in most states of America over the last decade. More than four hundred people are killed each year on American level crossings compared to less than ten per year in Australia.

'Operation Lifesaver' should be reviewed as a national initiative to establish both its effectiveness and application to the Australian environment. South Australia should pursue this national review through their membership of the

Standing Committee on Transport (SCOT) and the Australian Transport Council (ATC).

National 'Safety Alert' Programme

The international aviation industry has developed a system of warning airlines worldwide of safety concerns with aircraft or operational procedures. The regulation of road and rail safety and the responsibility for road and rail accident investigations are a state responsibility in Australia.

The risk factors that lead to a fatal accident in one state may be undetected in other states. There is, however, no formal established mechanism to collect and disseminate this safety information to all Australian state road and rail safety authorities.

The Salisbury accident occurred because of a particular set of circumstances. Other states would benefit from understanding the underlying cause of this accident to enable them to take any corrective actions in their own jurisdictions.

The Australian Transport Safety Bureau is potentially a suitable organisation to undertake the role of issuing national 'Safety Alerts'. This role would require the co-operative effort of all states and territories. Safety Alerts are most effective when issued shortly after an incident and are less effective when issued one or two years following the incident.

The initiative of establishing a national 'Safety Alert' programme should be taken up through the SCOT and ATC forums by South Australian representatives.

RECOMMENDATIONS ON RELATED MATTERS (Term of Reference No. 5)

Recommendation 6

6.1 That TransAdelaide undertake risk assessment and risk mitigation on all pedestrian level crossings on their network to minimise the risk of injury to people using wheelchairs and other personal motorised vehicles.

6.2 That TransAdelaide undertake risk assessment and risk mitigation on all pedestrian level crossings to minimise the risk of pedestrians (particularly School children) walking behind a stationary train and into the path of an express train. Risk mitigation strategies evaluated should include changes to train driving practices and warning signage at pedestrian level crossings.

Recommendation 7

7.1 That Transport SA and the Public Transport Board develop and implement a training module for all accredited bus and truck drivers in South Australia on the dangers of rail level crossings.

7.2 That Transport SA review the effectiveness of regional advertising programmes concerning level crossing safety undertaken in New South Wales and Queensland to establish their effectiveness for South Australia.

7.2 That South Australia propose a national review of 'Operation Lifesaver' through state representatives on SCOT and the ATC.

Recommendation 8

That South Australia through membership of SCOT and ATC, propose the establishment of a national land transport 'Safety Alert' programme to be developed and implemented by the Australian Transport Safety Bureau.

SECTION SIX: SUMMARY OF RECOMMENDATIONS

Recommendation 1

All bus and long road freight vehicles should be permanently restricted from using the Park Terrace level crossing.

Recommendation 2

Traffic management initiatives proposed by Transport SA to control vehicle entry and vehicles queuing between Salisbury Highway and the level crossing on Park Terrace should be implemented for a trial period. The trial should be assessed by Transport SA utilising recordable closed circuit television. Interim train speeds in the vicinity of the Park Terrace level crossing should continue for the period of the trial.

Recommendation 3

If the results of the trial proposed in Recommendation 2 are considered successful by Transport SA then, following a local awareness campaign, normal train speeds should be resumed.

Recommendation 4

If the results of the trial proposed in Recommendation 2 are considered by Transport SA to be inconclusive or unsuccessful then a local traffic management plan to close the Park Terrace level crossing to vehicular traffic must be implemented. Interim train speeds in the vicinity of the level crossing would continue until the closure of the level crossing. Following closure of the level crossing and a local awareness campaign for pedestrian traffic normal train speeds could be resumed.

Recommendation 5

The following level crossing governance arrangements should be introduced to manage road/rail level crossings throughout South Australia.

5.1 A Level Crossing Strategy Advisory Committee be established, chaired by Transport SA and include senior representatives of rail track owners, police and local government.

5.2 A small full time Level Crossing Unit be established within Transport SA to undertake –

(i initial and ongoing risk assessment of all level crossings in South Australia

(ii prioritisation and implementation of level crossing risk mitigation strategies

(iii an ongoing review to ensure consistent and effective implementation and maintenance of level crossing signage, pavement marking and sighting distances for all level crossings.

(iv a programme to achieve closure of level crossings wherever possible particularly where 'short stacking' situations create risk of collisions.

5.3 Transport SA consolidate and maintain a Technical Standard Manual for the design, signage and markings and maintenance of level crossings in South Australia. These technical standards should include design standards for the interconnection of road and rail signalling systems to manage road traffic queuing in 'short stacking' environments of level crossings.

5.4 The Level Crossing Unit proposed in Recommendation 5.2 should immediately adopt the Queensland model for the risk factor assessment of all level crossings.

5.5 The Department of Urban Planning and all Adelaide metropolitan area councils should adopt a planning policy to prevent the development of any further level crossings on the TransAdelaide rail network.

5.6 Photo enforcement of breaches of level crossing road laws should be adopted on level crossings recommended by the Level Crossing Advisory Committee on the advice of the Level Crossing Unit..

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6.2 That TransAdelaide undertake risk assessment and risk mitigation on all pedestrian level crossings to minimise the risk of pedestrians (particularly school children) walking behind a stationary train and into the path of an express train. Risk mitigation strategies evaluated should include changes to train driving practices and warning signage at pedestrian level crossings.

Recommendation 7

7.1 That Transport SA and the Public Transport Board develop and implement a training module for all accredited bus and truck drivers in South Australia on the dangers of rail level crossings.

7.2 That Transport SA review the effectiveness of Regional advertising programmes concerning level crossing safety undertaken in New South Wales and Queensland to establish their effectiveness for South Australia.

7.3 That South Australia propose a national review of 'Operational Lifesaver' through state representatives on SCOT and ATC.

Recommendation 8

That South Australia, through membership of SCOT and ATC, propose the establishment of a national land transport 'Safety Alert' programme to be developed by the Australian Transport Safety Bureau.

APPENDIX A – INTERIM REPORTS

November 2002
The Hon. Michael Wright MP
Minister for Transpor
12th Floor, Roma Mitchell House
136 North Terrace
ADELAIDE SA 5000

Dear Minister

Consistent with my Terms of Reference for the investigation of matters relating to the Salisbury level crossing I have attached for your information an interim report containing six recommendations.

While I do expect to make further recommendations against the Terms of Reference in my final report, including options for the future of the Salisbury level crossing and risk management issues, these interim recommendations can be actioned well ahead of my final report.

I would reinforce to you that while these interim recommendations do not eliminate the risk factors that may have contributed to the level crossing accident at Salisbury they are important short term actions that will reduce risks at that location.

Yours sincerely

Vince Graham

APPENDIX A - Interim report to the Minister for Transport on the Salisbury level crossing

Background to recommendations

On Thursday 24 October 2002 heavy westbound traffic on Park Terrace, probably blocked by red lights at the Salisbury Highway/Park Terrace, queued back toward the Park Terrace Road rail level crossing. A vehicle or vehicles appear to have queued back onto the level crossing obstructing the ARTC rail track.

The passenger train 5AL8, weighing approximately 1200 tonne, travelling north on the ARTC track at 81kph around a left hand curve had a sighting distance to the level crossing of approximately 200m and a braking distance to stop of over 400m. Train 5AL8 collided with the vehicles on the level crossing. Permitted train speed on this section of track for 5AL8 was 115 kph.

While human factors may have played a role in the queuing of vehicles on the rail level crossing, it appears that traffic congestion in a complex traffic area and the distance required for a heavy freight or passenger train to stop are factors that created the environment for the accident on Thursday 24 October 2002.

The evidence currently available to me suggests that the road and rail signalling systems in the vicinity of the level crossing and the braking system on train 5AL8 were operating normally. Based on the evidence available from the data logger on the locomotive hauling train 5AL8 the train driver sighted the level crossing obstruction at the earliest opportunity and applied the train's emergency braking system.

While there are a number of factors requiring further evaluation I am recommending the following interim courses of action to reduce (but not eliminate) the risks of a similar accident occurring at the Salisbury level crossing or other level crossing locations.

Interim recommendations

1. Buses and other long vehicles can be subject to greater risks in this traffic environment than cars because of their length, number of passengers and the possibility of their clear space past the level crossing being taken by a vehicle changing lanes or entering from side roads.

   As an interim arrangement I recommend all buses departing the TransAdelaide's Salisbury interchange do NOT use the Salisbury level crossing and depart via Gawler Road and the Salisbury Highway.

2. There is currently in place a 50 kph interim speed restriction on the ARTC track in the vicinity of the level crossing. There have been no interim speed restrictions applied to the Trans Adelaide tracks because almost all TA passenger trains stop at the level crossing. This means that TransAdelaide trains are generally going through the level crossing at slow speed.

   A freight train utilizes the TransAdelaide track on a daily basis (ASR's Penrice train) and a limited number of passenger trains do not stop at the

station and may therefore operate through this level crossing at higher speeds.

To allow further consideration of future options for this level crossing I am recommending the current ARTC track speed of 50kph be continued until the end of November 2002 to allow all industry participants to meet with me to discuss longer term arrangements.

I am also making an interim recommendation that track speed on the Trans Adelaide tracks be limited to 50kph for a distance of 500m on the approach sides of the level crossing.

I note that permanently reduced track speeds may be counter productive causing traffic boom gates to block road traffic for considerable periods adding to both traffic congestion and driver frustration.

3. The risk factors that led to the Salisbury level crossing accident included traffic congestion, the potential for road traffic to queue back onto a rail level crossing and the braking distance required for heavy freight and passenger rail services. These same risk factors may exist at other rail level crossing locations. The assessment of that risk and actions to reduce assessed risk requires the knowledge, competency and judgement of several organisations including TSA, TA, ARTC and SA police.

I am recommending that the SA Road Level Crossing Safety Committee be immediately reconvened under the chairmanship of the TSA and involving TA, ARTC and SA Police and a local government representative to undertake the following -

3.1 Initiate a comprehensive short term risk assessment of level crossing locations where traffic networks, systems and congestion may cause a queuing back of traffic onto rail level crossings.

3.2 Develop and implement risk management strategies including the potential for level crossing closures, standard traffic signage and pavement marking at all identified risk locations and put in place processes for the ongoing maintenance of this signage and markings.

3.3 The Torrens Road level crossing at Ovingham, currently subjected to road works, should be immediately subject to a risk assessment and a risk action plan.

3.4 Develop a comprehensive data base of all level crossings within South Australia including road and rail factors, risk assessment and risk mitigation actions.

3.5 Develop and implement enforcement strategies to influence driver behaviour on SA level crossings.

3.6 Assess the technical viability of photo enforcement for road traffic queuing on rail level crossings and make recommendations to government as a priority.

I will consider further organisational recommendations for the management of level crossing safety in South Australia in my final report.

4. There is opportunity for the interconnection of road and rail signalling systems to reduce the potential traffic risks on rail level crossings. The potential of this technology to reduce risks requires both rail signalling engineers and road traffic engineers to have a common understanding of current domestic and international standards and best practice.

   In response to serious level crossing accidents in the United States a comprehensive programme called 'Operation Lifesaver' has been developed and implemented nationally by rail and road authorities.

   I am recommending that a small group consisting of a road traffic signalling engineer, a rail signalling engineer and a safety specialist visit appropriate interstate, USA and Canadian organisations to –

   (a) establish current design standards and design considerations for road rail level crossings.

   (b) understand current technology and applications available for the interconnection of road rail signalling systems and circumstances in which they are applied.

   (c) review the 'Operation Lifesaver' project with road and rail authorities to establish both the content and the effectiveness of the programme.

   (d) report back to the South Australian Minister for Transport on the application of observed best practice in (a), (b) and (c) above to the South Australian environment.

5. A consistent observation in the wake of level crossing accidents nationally is the lack of public understanding of the distance required to stop a train, particularly a heavy passenger or freight train. Over the past decade more powerful locomotives have enabled the operation of longer and heavier freight trains. Today, trains up to1800m long weighing up to 5,000 tonne operate on the interstate network. The distance required to stop these trains operating at a track speed of 110 kph on level track can be over 2 km.

   Any state-wide or national public education campaign on level crossing safety should await the report back from the study group evaluating 'Operation Lifesaver' proposed in recommendation 4 above.

   There may, however, be an immediate benefit in educating accredited bus drivers and heavy vehicle drivers in South Australia on the risks associated with queuing across level crossings.

   I recommend that Transport SA require all accredited bus operators and heavy vehicle operators to incorporate a training module on

level crossing safety into driver training courses and all currently accredited drivers be presented with this training module by the end of February 2003.

Transport SA should institute a compliance review of this recommendation.

6. The above interim recommendations will reduce, but not eliminate, the risk of a further accident on the Salisbury level crossing. Further work will be undertaken over the next four weeks on future options for this level crossing, including grade separation, traffic management schemes to close the level crossing and other options to reduce traffic congestion and reduce risk if the level crossing were to remain open.

   The continuing exposure, particularly to drivers queuing back onto the level crossing, does require both ongoing police enforcement and maximum sighting distances for trains approaching the level crossing.

   I recommend that

   - The South Australian Police continue with an appropriate level of enforcement for drivers queuing across the Salisbury level crossing, particularly during known periods of traffic congestion.
   - That TransAdelaide and ARTC action all reasonable measures that can be taken to improve rail sighting distances on approach to the Salisbury level crossing particularly shrub trimming or shrub removal if necessary.

Vince Graham

Investigator
8 November 2002
28 November 2002

Hon. Michael Wright MP
Minister for Transport
12th Floor, Roma Mitchell House
136 North Terrace
ADELAIDE SA 5000

Dear Minister

In my Salisbury interim report to you dated 8 November 2002 I recommended speed restrictions on both TransAdelaide and ARTC tracks at Salisbury be applied until the end of November 2002 to allow me time to meet with industry participants to discuss longer term arrangements.

I have met with rail operators and track owners and also undertaken further discussions with Transport SA on infrastructure and traffic management options for Salisbury.

The rail industry is concerned at the market and cost impact of speed restrictions at Salisbury. The more fundamental concern for the industry, however, is the potential for general and permanent train speed reductions to be applied as a means of controlling accident risk at level crossings.

I believe Transport SA has identified a range of short term and relatively low cost traffic management initiatives at Salisbury to reduce the potential for road vehicles to queue back onto the Salisbury level crossing. These initiatives should be put in place by the end of March 2003 and, if effective, could allow the removal of the interim train speed restrictions.

If these interim traffic management initiatives do not prove effective in controlling traffic queuing back onto the level crossing then consideration will need to be given to a local traffic management plan at Salisbury to close the level crossing to all vehicular traffic. Following closure normal train speeds could be resumed.

This staged approach will be subject to further recommendations to you in my final report and has been discussed with Salisbury Council.

I would emphasise that the current and proposed speed restrictions do not control the current risks at the Salisbury level crossing but do reduce the risk. A heavy freight train travelling at the restricted speed of 50 kph cannot stop within the sighting distance available at Salisbury if the level crossing is obstructed. Further reductions in freight train speeds would effectively close the level crossing for extended periods.

Track speed restrictions cannot adequately control the accident risks at level crossings.

I therefore recommend to you that the current interim 50 kph track speed on the ARTC track at Salisbury continue until an effective traffic management plan is implemented at Salisbury.

The current 50 kph track speed on both TransAdelaide tracks should also be continued and should apply for a distance of approx. 250 metres on the approach side of the level crossing for rail car traffic and for an effective distance determined by TransAdelaide for other trains. The final locations of all train speed advisory signs should be determined by TransAdelaide.

Yours sincerely

Vince Graham

c.c. David Marchant ARTC
Roy Arnold TransAdelaide

Collision between the passenger train 5AL8 and vehicles at the Salisbury Interchange level crossing, Salisbury, South Australia

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