



Rail Accident Investigation Branch

Rail Accident Report



**Fatal accident at Morden Hall Park footpath
crossing
13 September 2008**

Department for
Transport

Report 06/2009
March 2009

This investigation was carried out in accordance with:

- the Railway Safety Directive 2004/49/EC;
- the Railways and Transport Safety Act 2003; and
- the Railways (Accident Investigation and Reporting) Regulations 2005.

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Any enquiries about this publication should be sent to:

RAIB	Email: enquiries@raib.gov.uk
The Wharf	Telephone: 01332 253300
Stores Road	Fax: 01332 253301
Derby UK	Website: www.raib.gov.uk
DE21 4BA	

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Fatal accident at Morden Hall Park footpath crossing, 13 September 2008

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Introduction

Preface

- 1 The sole purpose of a Rail Accident Investigation Branch (RAIB) investigation is to prevent future accidents and incidents and improve railway safety.
- 2 The RAIB does not establish blame, liability or carry out prosecutions.

Key definitions

- 3 Throughout the report, 'left' and 'right' refer to the sides of the line as seen when looking in the direction of travel of the tram.
- 4 Appendices at the rear of this report contain the following glossaries:
 - acronyms and abbreviations are explained in Appendix A; and
 - technical terms (shown in *italics* the first time they appear in the report) are explained in Appendix B.

The Accident

Summary of the accident

- 5 At 14:37 hrs on Saturday 13 September 2008, a tram travelling from Wimbledon to New Addington on the London Tramlink system collided with a cyclist at Morden Hall Park footpath crossing, between Morden Road and Phipps Bridge tram stops (Figure 1).

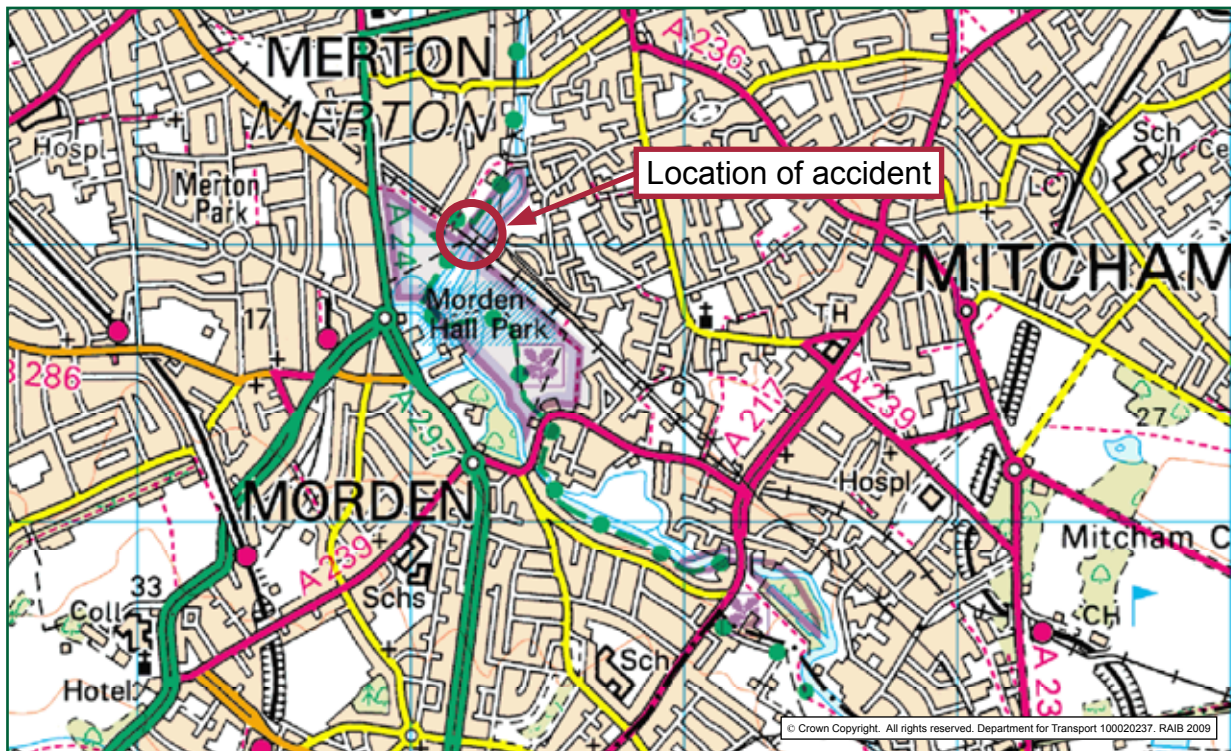


Figure 1: Extract from Ordnance Survey map showing location of accident

- 6 The tram was travelling at about 62 km/h (39 mph) at the moment that it struck the cyclist.
- 7 The cyclist crossed from right to left in front of the tram, and the nearside of the front of the tram struck the rear wheel of the bicycle. The cyclist was thrown to the ground and sustained injuries from which he later died.

The parties involved

- 8 The London Tramlink system, which opened in 2000, is owned and managed by Transport for London (TfL) through its subsidiary Tramtrack Croydon Limited (TCL), which trades as London Tramlink. TCL was previously an independent company which, since the opening of the tramway in 2000, had held a 99-year concession to run the Tramlink system. In the early part of 2008 TfL bought out the concession and replaced the management and most of the staff of TCL.

- 9 The system is operated under contract to London Tramlink by Tram Operations Ltd (TOL), a First Group company, which employs the tram drivers and controllers. The trams are maintained under contract to TOL by Bombardier Transportation Ltd.
- 10 Tram Operations Ltd, Bombardier Transportation and London Tramlink freely co-operated with the investigation.
- 11 The tram driver was an employee of TOL, who had been driving trams for one year since completing his training.
- 12 The cyclist, Mr Jeevan Sivalingam, was a 21 year-old man, who lived locally.

Location

- 13 Morden Hall Park crossing (also known as Deer Park Road crossing) is on the section of the London Tramlink system which runs along the route of the former British Rail line from Wimbledon to West Croydon, a distance of 9.5 km (Figure 1). Between the tram stops at Morden Road and Phipps Bridge the line is single and straight, running generally north-west to south-east. Morden Hall Park crossing is 405 m from Morden Road and 549 m from Phipps Bridge. The maximum permitted speed for trams on this section of line is 80 km/h (50 mph). The layout of the crossing is shown in Figure 2.

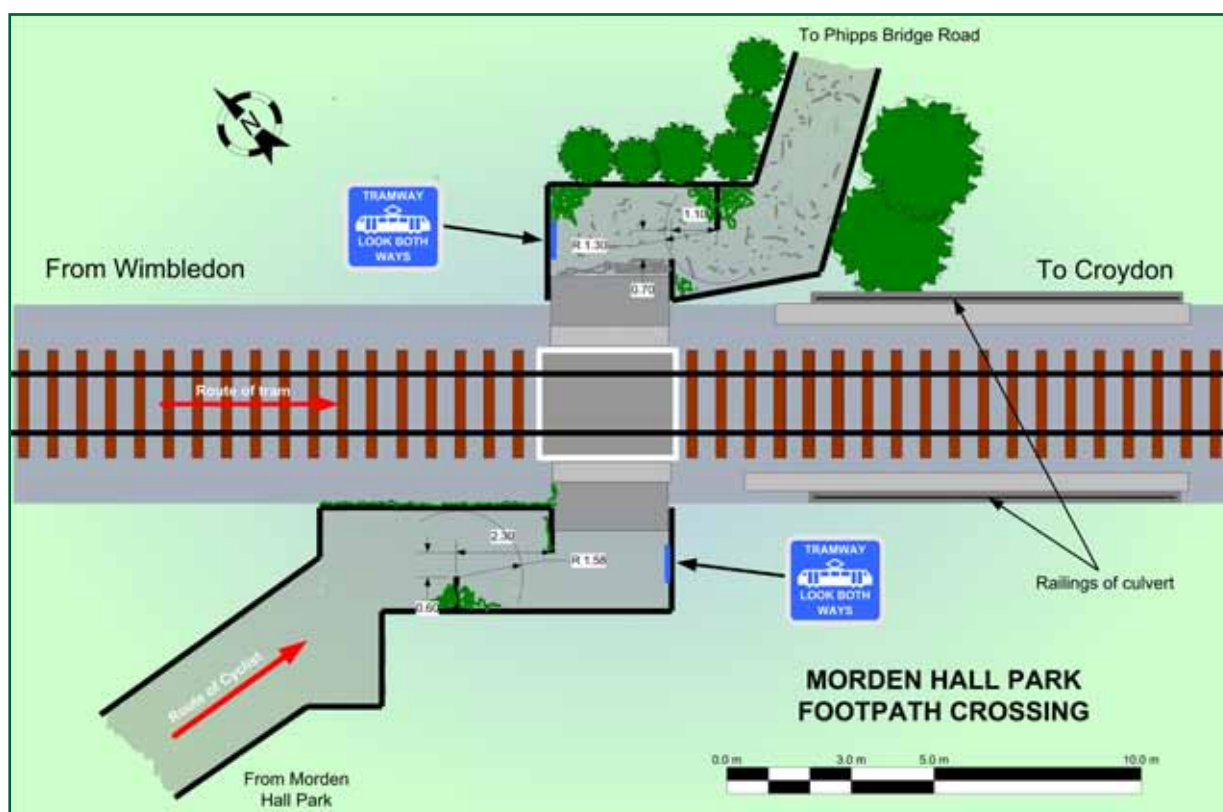


Figure 2: Layout of foot crossing

- 14 The foot crossing connects two areas of open land owned by the National Trust: Morden Hall Park on the south-west side of the line, and Bunces Meadow (containing Deen City Farm) to the north-east. It is part of the Wandle Trail, which since 2003 has been promoted by local authorities and other groups to provide a walking and cycling route along the banks of the river Wandle from Wandsworth to Waddon. In the area of this crossing the Trail is used by people visiting the park, by anglers going to and from the nearby river Wandle, and as a through route (particularly for cyclists) between Morden and Mitcham.
- 15 One of the channels of the river Wandle passes under the tramway in a culvert just to the south-east of the crossing. There are trees and bushes all around the crossing (Figures 2 and 6).
- 16 Before 1996, when work began to convert the railway into part of the Tramlink system (which opened in 2000), a footbridge existed at this point to carry the path over the line. As part of the conversion work, this bridge (along with four other footbridges between Merton Park and Mitcham) was removed, and replaced by a level crossing.
- 17 The crossing itself has a non-slip surface made of small stones embedded in resin. On each side of the crossing there is a 1.2 m wide strip of tactile paving. The approaches to the crossing are made of small stone and rubble, hard-packed and bound with fine chippings.
- 18 The crossing is approached through *chicanes* on both sides, constructed of wooden post and rail fencing about 1.25 m high. The chicanes on each side have quite different dimensions, but a common factor is that the barriers which form the chicanes do not overlap, but have a clear gap 0.6 m - 0.7 m wide between them, which gives a clear path width of at least 1.3 m through the chicane (Figure 2).
- 19 The approach to the crossing from the south-west is along a fenced, curving path 2.6 m wide (Figure 3). Before 2006, this approach was by a narrower path which ran directly towards the tramway at right angles to the track. In the winter of 2005/06 the layout of the approach paths was altered as part of a project to re-route the Wandle Trail around the edge of the wetlands which are an important feature of the park (Figure 4). The re-routed path curves round to approach the tramway at an angle of about 40°, and then bends sharply to enter the chicane, which is parallel to the tramway. Visibility along the tramway in both directions is unobstructed for several hundred metres in both directions from the point when a potential user reaches the centre of the chicanes (Figures 5 and 6).
- 20 There are blue signs 0.7 m square showing a pictogram of a tram and the wording '**TRAMWAY – LOOK BOTH WAYS**' (diagram 963.3 of the Traffic Signs Regulations and General Directions 2002), fixed to the fencing at waist level, facing users coming through the chicanes, on both sides of the crossing (Figures 2 and 6).
- 21 The crossing approaches are equipped with lamps on poles at both sides (one can be seen in Figure 6), but these were not lit at the time of the accident (which occurred during daylight), and, although this was not relevant to the accident, subsequent investigation found that they had not been maintained since installation and were no longer functional (paragraph 67).



Figure 3: Approach to crossing from south-west

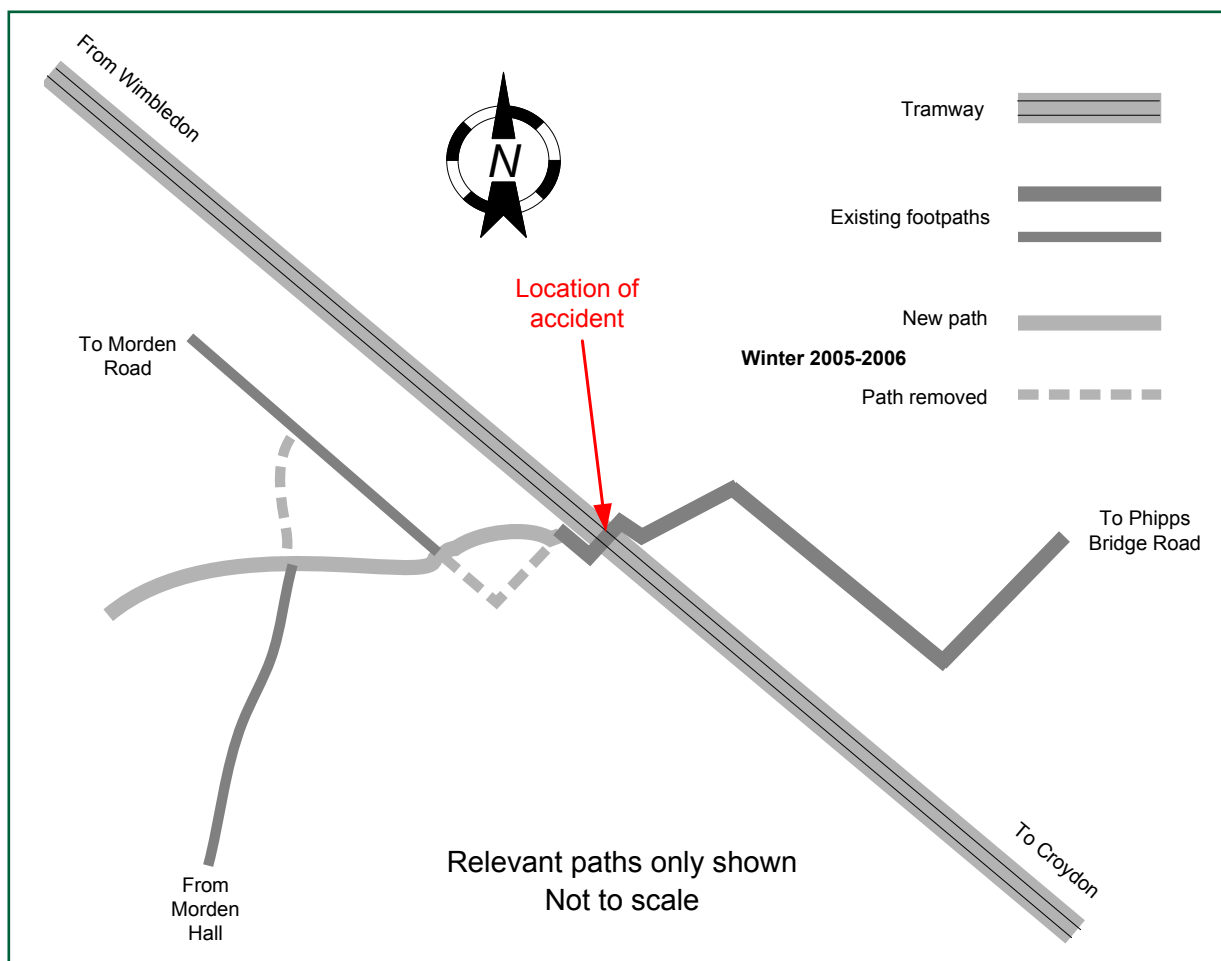


Figure 4: Footpaths near tramway crossing



Figure 5: View towards Morden Road, north-west from crossing



Figure 6: View towards Phipps Bridge, south-east from crossing

External circumstances

22 It was a bright, sunny afternoon and there was little wind. The path was dry.

The tram

- 23 The vehicle involved was tram 2530, one of the 24 units that make up the Tramlink fleet. It was built by Bombardier Transportation in Austria in 1998. Following the accident, and with the permission of the RAIB, it was examined on site by Bombardier staff and driven back to the depot the same evening. When it was later examined at the depot, no faults were found: in particular, the warning bell and horn were working normally.
- 24 The tram was equipped with forward facing closed circuit television (CCTV) and an *on-tram data recorder* (OTDR). The OTDR records a number of parameters including the vehicle speed, and the driver's operation of the power and brake controls and the warning bell and horn. Both the CCTV and OTDR systems were working correctly at the time of the accident, and data from them was taken by the RAIB for use in the investigation.

The accident

- 25 Tram 2530 left Wimbledon a few minutes behind schedule. The journey was uneventful until after leaving Morden Road tram stop. There were about 70 passengers on board.
- 26 The tram left Morden Road and accelerated normally, reaching 67 km/h. The driver saw a cyclist approaching from the right as the tram neared the footpath crossing at Morden Hall Park. The tram's OTDR shows that 7.4 seconds before reaching the crossing, the driver sounded the tram's warning bell and then the horn. Three seconds before reaching the crossing, the driver sounded the horn again, and 0.9 seconds before impact he applied the emergency brakes, including the *magnetic track brake*.
- 27 The forward facing CCTV fitted to the tram shows that the cyclist came into the camera's view nine seconds before the tram reached the crossing, when it was about 150 m away. He rode steadily towards the crossing and passed through the chicane without pausing. He rode onto the crossing, and did not appear to look towards the tram, which struck the rear wheel of his bicycle. At that point the tram was travelling at about 62 km/h, with the emergency brake applied. The tram came to a stop with its leading end 36 m past the foot crossing. Mr Sivalingam was thrown to the ground and landed between the tram and the railings of the culvert adjacent to the crossing.

Consequences of the accident

- 28 Mr Sivalingam sustained serious injuries from which he later died.
- 29 There was minor damage to the tram.

Events following the accident

- 30 The tram driver contacted the Tramlink control room by radio and told the controller that there had been an accident. The controller called the emergency services.
- 31 The Metropolitan Police, the London Ambulance Service and the British Transport Police attended the scene of the accident.
- 32 Mr Sivalingam was taken to hospital by air ambulance, but died from his injuries later the same day.
- 33 The passengers were evacuated from the tram and walked to Phipps Bridge, from where a tram was provided for them to continue their journey. Services on the Phipps Bridge – Wimbledon section were suspended until the tram involved in the accident had been taken to the Coomber Way depot. The tram service resumed at 16:22 hrs.

The Investigation

Investigation process and sources of evidence

- 34 The investigation covered the following elements:
- the sequence of events leading to the cyclist being struck by the tram;
 - the actions of the tram driver and the performance of the tram during the incident;
 - the risks associated with the use of the crossing by cyclists;
 - the assessment and management of risks at foot crossings on the London tramlink system; and
 - the history of the replacement of the footbridge at this location by a level crossing.
- 35 The RAIB obtained evidence from:
- the OTDR and CCTV equipment fitted to the tram;
 - discussions with staff;
 - surveys of the crossing and traffic using it; and
 - review of documents held by the infrastructure manager.

Key Information

Use of the crossing

- 36 The crossing is used extensively by pedestrians and cyclists. Following the accident, the RAIB and the Office of Rail Regulation (ORR) carried out surveys on successive days to gauge the extent of this usage.
- 37 On Friday 19 September, between 15:00 hrs and 16:00 hrs, the crossing was used by 51 pedestrians, 16 cyclists and one wheelchair user. Twelve trams passed in this period.
- 38 On Saturday 20 September, one week after the accident, between 14:00 hrs and 15:00 hrs, the crossing was used by 111 adult and 32 child pedestrians, 30 adult and 6 child cyclists, 19 pushchairs and one wheelchair user. During this period 18 trams passed.
- 39 On both these days the weather was fine and sunny. There were no special events taking place in the park.
- 40 At the time of the accident there were 16 to 18 trams per hour timetabled to pass the crossing on Monday – Saturday during the day, and eight trams per hour in the evenings and all day on Sundays.

Tram driving at crossings

- 41 From the start of operations on the Tramlink system in 2000, tram drivers have been given training in how to approach areas where pedestrians are likely to be encountered. These include road and footpath crossings, and street running areas in the town centre.
- 42 Although the tram has right of way at a crossing, TOL trains its tram drivers to look for and locate pedestrians and cyclists as they approach crossings. The tram driver should then attempt to establish whether the person has recognised the approach of the tram. This is often clear from the person's actions, or if the person makes eye contact with the tram driver. If there is no indication that the crossing user is aware of the approach of the tram, the driver may use the bell and/or horn to give warning of the tram's approach. If this still does not produce a reaction, and the person appears to be on a collision course with the tram, the driver should then stop as quickly and safely as possible.
- 43 There are no signs requiring tram drivers to sound audible warnings. TOL's operating philosophy is that tram drivers should use the bell and horn only when needed to warn an identified person of a tram's approach. This is intended to avoid the warnings becoming over-familiar and being disregarded, and also to reduce noise nuisance in the built-up areas through which the tramway runs.
- 44 The trams run with dipped headlights on at all times, but normally use the 'main beam' setting in the rural area of Morden Hall Park after dark.

Previous occurrences of a similar character

- 45 There had previously been three fatal accidents involving pedestrians being struck by trams since the Croydon Tramlink system opened in 2000. All of them occurred before the RAIB became operational. The first of these was at Fieldway tram stop on 7 September 2002, when an elderly person walked out in front of a tram approaching the stop. At Lloyd Park on 11 December 2002, a person walking from the park was struck by a tram at the foot crossing, and did not appear to have been aware of the approach of the tram. On 23 June 2003, a person crossing Addiscombe Road, west of the complex junction with Chepstow Road and Radcliffe Road, looked the wrong way and walked into the path of a tram.
- 46 The operator held an inquiry following each of these accidents, and in each case concluded that there were no identifiable deficiencies in the tram operation or infrastructure.
- 47 In each case, a subsequent coroner's inquest recorded a verdict of accidental death.

Analysis

Identification of the immediate cause¹

- 48 The CCTV from the tram shows that Mr Sivalingam rode through the chicane and onto the crossing without looking towards the approaching tram. This was the immediate cause of the accident.

Identification of causal² and contributory³ factors

- 49 The tram driver observed a cyclist approaching and sounded the warning bell and horn. The cyclist slowed down as he passed through the chicane. As soon as it became clear that the cyclist was not going to stop, the tram driver applied the emergency brake. At this point the tram was 0.91 seconds away from the crossing, and the speed of the tram was reduced from 67 km/h to 62 km/h at the point of impact. The tram stopped in 5.42 seconds from the application of the emergency brake, 36 m past the crossing. This represents an average retardation rate of 3.4 ms⁻².
- 50 This braking performance is in accordance with that specified in the Health & Safety Executive publication Railway Safety Principles and Guidance – part 2 section G (1997): Guidance on Tramways (RSPG Section 2G⁴) for tram emergency brakes (which should produce a retardation of about 3 ms⁻²). The actions of the tram driver and the braking performance of the tram were neither causal nor contributory to the accident.
- 51 After the accident, a pair of headphones was found close to the spot where Mr Sivalingam fell. Eyewitness evidence indicates that he was probably wearing them at the time of the collision, and a mobile phone and music player were among the property recovered at the scene. Distraction from what he was listening to, and impairment of his ability to hear the audible warnings from the tram, are possible causal factors in the accident.

¹ The condition, event or behaviour that directly resulted in the occurrence.

² Any condition, event or behaviour that was necessary for the occurrence. Avoiding or eliminating any one of these factors would have prevented it happening.

³ Any condition, event or behaviour that affected or sustained the occurrence, or exacerbated the outcome. Eliminating one or more of these factors would not have prevented the occurrence but their presence made it more likely, or changed the outcome.

⁴ RSPG Section 2G has now been replaced by the ORR document Railway Safety Publication – Guidance on Tramways (2006), which requires a tram to have a hazard brake with a retardation rate of at least 2.5 ms⁻² for a stop from the maximum permitted speed, and a maximum instantaneous retardation rate of between 3 and 4 ms⁻². The trams used on the London Tramlink system were approved for use (in 2000) with a specified retardation rate of 2.75 ms⁻².

Crossing design

- 52 Mr Sivalingam cycled towards the crossing with his back to the tram. The design of the chicane at the crossing made him slow down, but did not cause him to stop or dismount. After passing through the chicane, he turned left to cross over the track, but he did not complete the turn (so that he was at right angles to the track), until he reached the centre of the track. The design of the chicane and crossing permitted him to approach the tramway without turning to be at right angles to the track, and hence he remained with his back to the approaching tram. If he had turned and seen the tram before moving onto the crossing, he would probably have been able to stop clear of the track.
- 53 RSPG Part 2G provides guidance on the design of intersections between the tramway and roads and footpaths.
- 54 In particular, paragraph 56 of RSPG Section 2G said:
- ‘Fencing or pedestrian guard rails should be provided where necessary to guide pedestrians to face oncoming trams before they cross the track.’
- 55 The chicanes at Morden Hall Park crossing were not effective in this respect because the distance between the chicane barriers and their orientation at right angles to the track, combined with the very short final approach to the crossing, did not force users, both on foot and on bicycles, to turn fully towards the tramway when passing through the chicane and before turning onto the track. This was a causal factor in the accident.
- 56 RSPG Section 2G was superseded by the ORR publication ‘Guidance on Tramways’ in 2006. The guidance relating to the layout of foot crossings is the same in the new document.
- 57 The Department for Transport publication ‘Cycle Infrastructure Design’ (2008) (CID) gives guidance on the design of junctions between cycle tracks and other routes. There is no specific guidance on crossings with tramways, but at crossings of cycle tracks and roads, the guidance suggests (at paragraph 10.2.1) that ‘where it is not clear to cyclists approaching the crossing that they are about to meet a road, it may be worthwhile adding markings (and possibly signs) indicating that they ‘Give Way’. ‘Blister’ paving with a distinctively coloured surface, as used at Morden Hall Park, is suggested as appropriate to mark the crossing threshold in this situation. The design of the crossing at Morden Hall Park makes it clear to cyclists that they are about to cross a tramway, and no further markings or signs are necessary at this location to fulfil the intentions of the guidance.
- 58 The sign warning of the tramway was slightly obscured by graffiti (Figure 6). Mr Sivalingam was a local resident who is known to have been familiar with the crossing, and the condition of the sign and its position (paragraph 20) are not considered to have contributed to the accident.
- 59 At ‘open’ level crossings, where public roads and railways intersect with no signal control, ‘Give Way’ signs and markings on the carriageway are used to indicate to motorists that they must give way to trains, and such markings are also used, in some cases, at the end of cycle lanes and cycle tracks. It is possible that a double broken line and ‘Give Way’ markings on the path might reinforce the message of the tramway warning sign that cyclists must give way to approaching trams.

Changes to the path layout

- 60 The layout of the path on the south-west side of the crossing was altered over the winter of 2005-06 (paragraph 19 and Figure 4). As originally installed, the path approached the crossing at right angles, giving a user the opportunity to look both ways before turning right to pass through the chicane. The revised layout turns the user to the right gradually as they approach the crossing. This means that as they enter the chicane cyclists and pedestrians have their back to trams approaching from the Wimbledon direction, making it less likely that such people will become aware of trams unless they deliberately turn to look.
- 61 The section of path involved is entirely on land owned by the tramway. The work to alter the path layout in this area was planned by the South and West London Transport Conference (SWELTRAC), funded by Transport for London, and project managed by the National Trust, the owners of Morden Hall Park.
- 62 There was consultation between SWELTRAC, the National Trust and TCL before the work was done, but there is no evidence that the risk associated with the revised layout was identified by TCL. The change to the layout was a possible contributory factor in the accident.

Management of crossings on Tramlink

- 63 There are 18 foot crossings (outside the street running sections, and not associated with tram stops) on the London Tramlink system. All of these are 'passive' crossings, with signs but no active pedestrian controls or warning of approaching trams.
- 64 These crossings have greatly varying levels of usage. The busiest are those near the Ampere Way and Waddon Marsh tram stops, which are used by people going to and from the retail parks around the Purley Way. Others, such as the Addington Hills bridleway crossing, show little, if any, signs of use. However, in all cases the frequency of use of the crossing by pedestrians is such that it is unusual for a tram driver to encounter a crossing user, even at relatively busy crossings like Morden Hall Park.
- 65 The crossings were individually designed when the tramway was constructed. Seven of them use chicanes or other barrier arrangements to slow down and divert approaching pedestrians and cyclists. These are of varying designs, and only one is similar to Morden Hall Park. The other eleven crossings do not have such chicanes or barriers.

Maintenance

- 66 For most of the tramway's life, the infrastructure has been managed by the original concessionaire, TCL. As described in paragraph 8, the original TCL concession was bought out by Transport for London (TfL) in early 2008, and the managing organisation is now known as London Tramlink.
- 67 During the period that the independent TCL was managing the infrastructure, no contractual arrangements were in place for inspection and maintenance of the crossing signs and fences. As a result of this, many of the fences, including some chicanes, became broken down. London Tramlink has now put maintenance arrangements in place, although there is still a backlog of remedial work.

Risk assessment

- 68 After taking responsibility for the tramway infrastructure, and before the accident took place, London Tramlink had been concerned about the state of the crossings on the system. It had been unable to locate any record of assessment of risks at foot crossings since the opening of the tramway. London Tramlink had therefore, in the first half of 2008, commissioned a consultant to carry out an assessment of the safety issues relating to 'non-vehicular access and walkways' on the system. The results of this, which was completed in September 2008, a short time after the accident, provided a record of the current state of the foot crossings (and crossings at tram stops), and made some recommendations for repairs, additional signs and other minor changes.
- 69 The study did not assess the way in which users passed through the crossings, or identify the risk of users, facing away from the direction of approaching trams, failing to react to them. In relation to Morden Hall Park crossing, the study recommended only that the graffiti should be cleaned off the warning signs at the crossing.

Modifications to crossings

- 70 An accident occurred at Arena tram stop on 23 August 2007 in which a pedestrian was struck by a tram. The pedestrian had run towards the tram stop along a path almost parallel to the tramway, and was concentrating on a westbound tram which he could see approaching and which he wished to catch. He did not notice an eastbound tram which was approaching from behind him, crossed the line just in front of it, and was struck and became trapped under the tram, but suffered only minor injuries.
- 71 Following this accident, additional fences were installed to form a chicane in the approach path at Arena (Figure 7). The design of these forces pedestrians and cyclists approaching along the path, who wish to cross the line, to turn to the right as they move onto the crossing. This makes it more likely that they will notice a tram coming from their right.



Figure 7: Chicane installed at Arena tram stop

- 72 If the risks at other crossings on the network (including Morden Hall Park) had been considered at the time the chicane was introduced at Arena, and appropriate action taken, the risk of an accident might have been reduced. However, given the absence of any previous accidents at this location, it is possible that an assessment of this crossing would not have given a high priority to changes to the design of the chicane. The absence of an adequate risk assessment for the use of footpath crossings was a contributory factor in the accident.
- 73 CID gives guidance on the use of chicane barriers on cycle routes, and emphasises that the arrangement should be designed to slow cyclists down rather than force them to dismount⁵. In considering modifications to the chicane to encourage cyclists to slow down and look for approaching trams, it is also necessary to consider the needs of wheelchair users and others, such as people with pushchairs, who use the crossing. The Department for Transport publication 'Inclusive Mobility: a guide to best practice on/access to pedestrian and transport infrastructure' (2005) gives guidance on the design of footways and staggered barriers. It recommends (paragraph 3.5) a minimum distance (offset) of 1200 mm between the barriers, and (paragraph 3.1) an absolute minimum width of 1000 mm at any point on the path. The 2008 CID guidance recommends that, to accommodate tandem cycles, tricycles and cycles with trailers there should be at least 2000 mm between barriers.
- 74 These considerations mean that chicane barriers with the dimensions of those at Arena are unlikely to be suitable for use on the designated cycle track at Morden Hall Park. However, a design along similar lines, which would have the effect of turning a cyclist to face towards Wimbledon during their approach, might reduce the risk at this crossing.

Identification of underlying factor⁶

Replacement of footbridges by crossings

- 75 The crossing is at a location where, before the railway from Wimbledon to West Croydon was converted to a tramway, the track was crossed by a footbridge. As part of the conversion, all the footbridges over the sections of railway which were used as part of the new tramway were removed and replaced by level crossings.
- 76 The footbridges had, in the main, been provided after the railway was electrified on the 750 V DC *conductor rail* system in 1930. The hazard created by the 750 V DC conductor rails was recognised and by the 1980s footpath crossings had been eliminated from all of the British Rail and London Transport DC electrified lines within Greater London.
- 77 The conversion of the railway to form part of the Croydon tramway system, powered by electricity from overhead wires, removed the hazard of the conductor rails, and was seen as an opportunity to remove obstacles to the use of footpaths by all sections of the community, and to enable the creation of cycle routes which avoid busy roads.

⁵ Cycle Infrastructure Design, DfT, 2008, paragraph 8.15.5

⁶ Any factors associated with the overall management systems, organisational arrangements or the regulatory structure.

- 78 Replacement of the footbridges by level crossings improved the accessibility of the footpaths. However, it created a risk of collision between pedestrians and cyclists and trams.

Control of risk at crossings

- 79 There is no reference in RSPG Section 2G, or in any other relevant guidance, to the conversion of railways into tramways, and the philosophy of the Croydon project was to start afresh in designing each section of the tramway, regardless of the previous use of the land over which it ran.
- 80 In the design philosophy of the tramway, as with most sections of tramway in the UK, the trams are envisaged as operating on 'line of sight', able to stop short of any obstruction that they encounter. In an emergency, a tram driver can use the magnetic track brake to achieve much more rapid deceleration than would be possible for a train.
- 81 Paragraph 63 of RSPG Section 2G said:
'Tram drivers should be warned that they are approaching a pedestrian footpath crossing.'
- 82 No signs are provided on the Croydon system to indicate the location of crossings: they are clearly visible to tram drivers (after dark, the crossings are either illuminated, or the crossing equipment, painted white, is picked out by the tram headlights). The tram driver sounded audible warnings at an appropriate point, and there is no evidence that the lack of signage contributed to the accident.
- 83 When the tramway was designed, the residual risk, of collision between a tram and a person who comes into its path at the last moment, was intended by the designers to be controlled by measures including the provision and maintenance of adequate sightlines for crossings (for both tram drivers and crossing users), and design features of the tram to prevent people from becoming trapped underneath. The signs and 'blister' paving (which is primarily intended to assist blind or partially sighted people) provided at Morden Hall Park appear to fulfil the intentions of the current guidance on the design of cycle tracks.
- 84 There were clear benefits to both pedestrians and cyclists using the paths, and improvements in accessibility, produced by the removal of the footbridges. Two of the five locations where this was done were places where tram stops were provided, and consequently where tram speeds are low. However, there are greater risks associated with a foot crossing at a location remote from tram stops, such as Morden Hall Park, where the trams pass at a speed similar to that of the trains which previously used the crossing. The RAIB has not been able to locate any documented design risk assessments covering this change.
- 85 The conversion of the footbridge to a level crossing and consequent exposure of path users to conflict with trams, is an underlying factor in the accident.

Conclusions

Immediate cause

86 The immediate cause of the accident was that the cyclist rode through the chicane and onto the crossing without looking at the approaching tram (paragraph 48).

Causal factors

87 Causal factors were:

- a. The cyclist may have been wearing headphones which prevented him hearing the audible warnings sounded by the tram driver (paragraph 51).
- b. The layout of the path and the design of the chicane permitted users to approach the track while facing away from eastbound trams (paragraph 52, Recommendation 1).

Contributory factors

88 The following factors were considered to be contributory:

- a. The planning of changes to the layout of the path on the south-west side of the crossing did not take into account the hazard that this might have created for cyclists approaching from that direction (paragraph 61).
- b. The risks created by the way in which Morden Hall Park and other foot crossings on the Croydon Tramlink system were being used had not been assessed by the infrastructure manager since the tramway opened (paragraph 72, Recommendation 1).

Underlying factor

89 An underlying factor in the accident was that the conversion of the railway line between Wimbledon and West Croydon into the tramway created a conflict between path users and trams at the locations where footbridges were replaced by level crossings (paragraph 85).

Actions reported as already taken or in progress relevant to this report

- 90 The ORR issued an Improvement Notice to TCL (trading as London Tramlink) on 15 October 2008, requiring it to assess the risk to users at footpath crossings and identify further action, if any, required to reduce risk, by 14 January 2009.
- 91 The ORR reported that TCL complied with this notice by 14 January 2009, by doing the following:
- It assessed the risks to users at crossings by looking at the locations and layouts of crossings, the groups of people using them, the track alignment and line speed, the degree of visibility and any previous history of incidents.
 - It identified existing control measures (ie those in force before TfL took over the running of the network).
 - It ranked crossings into broad categories of risk in order to prioritise remedial work.
 - It looked at what improvements could be made at the crossings, and has drawn up a programme of works, that includes further assessment of visibility at some crossings.

The ORR continues to monitor this programme of work.

Recommendations

92 The following safety recommendation is made⁷:

Recommendation to address causal and contributory factors

- 1 Tramtrack Croydon Ltd (trading as London Tramlink) should, following its assessment of the risks at footpath crossings on its system, and where it is appropriate and practicable to do so, modify the crossings so that users are influenced to look both ways before crossing, and cyclists are encouraged to slow down sufficiently (by means such as the provision of barriers, signs and/or markings), to give them time to become aware of approaching trams (paragraphs 87b, 88b).

⁷ Those identified in the recommendation, have a general and ongoing obligation to comply with health and safety legislation and need to take these recommendations into account in ensuring the safety of their employees and others.

Additionally, for the purposes of regulation 12(1) of the Railways (Accident Investigation and Reporting) Regulations 2005, these recommendations are addressed to the Office of Rail Regulation to enable it to carry out its duties under regulation 12(2) to:

- (a) ensure that recommendations are duly considered and where appropriate acted upon; and
- (b) report back to RAIB details of any implementation measures, or the reasons why no implementation measures are being taken.

Copies of both the regulations and the accompanying guidance notes (paragraphs 167 to 171) can be found on RAIB's web site at www.raib.gov.uk.

Appendices

Appendix A - Glossary of abbreviations and acronyms

CCTV	Closed Circuit Television
CID	Cycle Infrastructure Design
DC	Direct Current
ORR	Office of Rail Regulation
OTDR	On-tram Data Recorder
RSPG	Railway Safety Principles and Guidance
SWELTRAC	South and West London Transport Conference
TCL	Tramtrack Croydon Ltd
TfL	Transport for London
TOL	Tram Operations Ltd

Appendix B - Glossary of terms

All definitions marked with an asterisk, thus (*), have been taken from Ellis' British Railway Engineering Encyclopaedia © Iain Ellis. www.iainellis.com.

Chicane	A narrow or tortuous section of a road or path, intended to cause traffic passing along it to reduce speed.
Conductor rail	An additional rail, used to convey and enable collection of electrical traction current at track level.*
Magnetic track brake	A braking system which acts directly on the rail rather than the wheels, consisting of an electromagnetic friction brake applied directly to the rail head as an emergency brake.*
On-tram data recorder	A data recorder fitted to trams collecting information about the performance of the tram, including speed, power controller and brake control positions, and activations of horn, bell, etc.



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Any enquiries about this publication should be sent to:

RAIB	Telephone: 01332 253300
The Wharf	Fax: 01332 253301
Stores Road	Email: enquiries@raib.gov.uk
Derby UK	Website: www.raib.gov.uk
DE21 4BA	