

Jacob Gemma

From: Collis Jill
Sent: 16 January 2017 16:29
To: Clarke Andrea (Exc); Carter Howard; Powell Gareth; Evers Mark; Daniels Leon; Fox Jonathan; Kilonback Simon; O'Neill Rory (Trams); Lyons Greg; Behan Catherine; Mason Paul; Brown Andy; Gasson Sarah; Bevins Richard; Morris Jonathan; Griffiths Nathan; Curry Justine; Gourley Jennifer; Seeley Louise; Everitt Vernon; Dimond Helen
Subject: Confidential & Privileged - Tfl Restricted - Croydon - RAIB Sandilands interim report

Dear all,

Please see below FYI

Jill

Jill Collis | Director of Health Safety Environment
Everyone Home Safe and Healthy Everyday

Tel. [REDACTED]
email [REDACTED] [tube.tfl.gov.uk](mailto:[REDACTED]@tube.tfl.gov.uk)

From: Chris Ford [[mailto:\[REDACTED\]@dft.gsi.gov.uk](mailto:[REDACTED]@dft.gsi.gov.uk)]
Sent: 16 January 2017 12:20
To: Collis Jill
Subject: RAIB Sandilands interim report

Jill

The RAIB will be issuing a second Sandilands interim report next month and have started to advise affected parties of our intention to do so.
The report content will be subject to consultation with key parties, including TfL, before publication. The consultation copies will probably be issued next week.

Regards

Chris Ford

Principal Inspector
Rail Accident Investigation Branch
Cullen House
Berkshire Copse Road
Aldershot
Hampshire
GU11 2HP
Set SatNav to GU11 2HH
Tel: [REDACTED]
Mob: [REDACTED]

Email: [REDACTED] [raib.gov.uk](mailto:[REDACTED]@raib.gov.uk)
Website: www.RAIB.gov.uk

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Jacob Gemma

From: Collis Jill
Sent: 01 December 2017 09:16
To: Brown Mike (Commissioner); Carter Howard; Daniels Leon; Powell Gareth; Fox Jonathan; O'Neill Rory (Trams); Brown Matt; Everitt Vernon
Subject: Confirmed Date - FW: Publication of the RAIB report into the accident at Sandilands junction

Dear all,

Please see below RAIB publication date/time 13:00 on 7th December and the request our report is not published the same day.

Regards

Jill

From: Simon French [mailto: [REDACTED]@dft.gsi.gov.uk]
Sent: 01 December 2017 09:08
To: Collis Jill
Cc: Chris Ford
Subject: Publication of the RAIB report into the accident at Sandilands junction

Jill,

I am now able to confirm that we will be publishing at about 13:00 hrs on Thursday 7 December. Publication will be preceded by an off-camera press briefing at TMRW (75-77, High Street, Croydon, CR0 1QE), followed by recorded interviews with broadcasters.

I would advise against you publishing your report on the same day. Although our reports are unlikely to differ greatly in facts, publication on the same day creates the risk of comment on any differences, so diluting the safety learning that we both want to disseminate. It also creates the risk that families become concerned about which is the official account of the event, and may comment adversely. For this reason, I suggest that you wait a day or two after we have published our report before publishing your own.

Regards

Simon

Simon French
Chief Inspector of Railway Accidents
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GU11 2HP
e-mail: [REDACTED]@dft.gsi.gov.uk

Tele: [REDACTED]

From: Collis Jill [[mailto: \[REDACTED\]@tube.tfl.gov.uk](mailto: [REDACTED]@tube.tfl.gov.uk)]
Sent: 08 November 2017 15:41
To: Simon French <[\[REDACTED\]@dft.gsi.gov.uk](mailto: [REDACTED]@dft.gsi.gov.uk)>
Cc: Chris Ford <[\[REDACTED\]@dft.gsi.gov.uk](mailto: [REDACTED]@dft.gsi.gov.uk)>
Subject: RE: meeting with the Mayor

Thank you for the update and heads up on publication date(s).

We are liaising with the BTP family liaison coordinator to communicate the findings from our investigation with the families and will aim to publish our report either the same day as yours but after yours or shortly after depending if you have a preference.

Regards

Jill

Jill Collis | Director of Health Safety Environment
Everyone Home Safe and Healthy Everyday

Tel. [REDACTED]
email [\[REDACTED\]@tube.tfl.gov.uk](mailto: [REDACTED]@tube.tfl.gov.uk)

From: Simon French [[mailto: \[REDACTED\]@dft.gsi.gov.uk](mailto: [REDACTED]@dft.gsi.gov.uk)]
Sent: 08 November 2017 12:33
To: Collis Jill
Cc: Chris Ford
Subject: RE: meeting with the Mayor

Jill,

The meeting went very well. The mayor was accompanied by Val Shawcross and an official.

Having agreed the need for confidentiality, I presented the an outline of our role, the investigation and a high level review of key findings and recommendations.

The questions that followed were generally very strategic. I was asked about the levels of cooperation with TfL and TOL. I replied that these had been very good. I explained our strategy leading to publication as follows:

- briefing of families from 08 Nov onwards (including face to face for those that request it)
- planned publication in early December, accompanied by RAIB press briefing and interviews

The mayor and his team seemed very comfortable with all that they heard and stated that they had confidence in our organisation and the work that we had carried out.

I hope that this is a helpful, if brief, summary.

For your information, we are currently targeting 07 December for publication (with 12 December as a contingency date).

Regards

Simon

Simon French
Chief Inspector of Railway Accidents
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Tele: [REDACTED]

From: Collis Jill [[mailto:\[REDACTED\]@tube.tfl.gov.uk](mailto:[REDACTED]@tube.tfl.gov.uk)]
Sent: 08 November 2017 11:14
To: Simon French <[\[REDACTED\]@dft.gsi.gov.uk](mailto:[REDACTED]@dft.gsi.gov.uk)>
Subject: meeting with the Mayor

Good morning Simon,

I hope your meeting with the Mayor went well. Is there any feedback from the meeting from your point of view we need to be aware of?

Regards

Jill

Jill Collis | Director of Health Safety Environment
Everyone Home Safe and Healthy Everyday

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Jacob Gemma

From: Collis Jill
Sent: 09 February 2017 16:56
To: Carter Howard; Everitt Vernon; Brown Mike (Commissioner); Powell Gareth; Daniels Leon; Fox Jonathan; O'Neill Rory (Trams); Breen Tom; Kilonback Simon
Cc: Clarke Andrea (Exc); Morris Jonathan; Behan Catherine; Tagg Ella (ST); Quinn Amy; Gourley Jennifer; Eleodore-Williams Jennifer; Colli Aneta; Thomson Kizzy; Hawley Anthea; Gasson Sarah
Subject: FW: RESTRICTED - RAIB interim report for consultation - Sandilands Junction - TfL Restricted - Confidential and Legally Privileged
Attachments: 070217 JC.RH.pdf

Dear all,

A copy of the final reply to RAIB for your information. (approved by Mike)

Once RAIB let me know the publication date I will let you know.

Regards

Jill

From: Collis Jill
Sent: 09 February 2017 16:49
To: [REDACTED]@dft.gsi.gov.uk'; 'RAIBreportconsultation@raib.gov.uk'
Subject: RESTRICTED - RAIB interim report for consultation - Sandilands Junction - TfL Restricted - Confidential and Legally Privileged

Dear Richard

Thank you for the opportunity to comment on RAIB's draft second interim report into the tragic derailment at Sandilands Junction. Transport for London representations are in the attached.

Should you require any further clarification of the representations made please do not hesitate to contact me.

Regards

Jill Collis

Jill Collis | Director of Health Safety Environment
Everyone Home Safe and Healthy Everyday

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email [REDACTED][tfl.gov.uk](mailto:[REDACTED]@tfl.gov.uk)

Jacob Gemma

From: Collis Jill
Sent: 12 October 2017 11:17
To: Fox Jonathan; O'Neill Rory (Trams); Brown Matt; Everitt Vernon; Carter Howard; Daniels Leon; Brown Mike (Commissioner)
Subject: FW: Sandilands - family liaison issues - TfL Investigation Report & RAIB's suggestion - TfL Restricted/Legally Privileged and Confidential

Dear all,

Please see the email below – I suggest this forms part of Tuesday's meeting unless you wish to reply earlier.

I will also put a briefing note together for Tuesday's meeting covering RAIB/ORR/BPT investigations

Best wishes

Jill

From: Simon French [mailto: [REDACTED]@dft.gsi.gov.uk]
Sent: 12 October 2017 11:09
To: Collis Jill
Cc: Chris Ford; Andy Lewis; AndrewR Hall
Subject: Sandilands - family liaison issues

Jill,

Thank you for the call concerning the TfL report into the Sandilands tram accident and your intention to provide copies of this to the bereaved prior to placing it in the public domain. It's good that we are both agreed on the need to protect the bereaved families from unnecessary distress and to avoid overwhelming them with 'competing' information.

A number of bereaved families have expressly asked that the publication of the RAIB's report, and the associated face to face briefings, be delayed until a reasonable time after the anniversary. This will mean that many of our family briefings will not start until 1 or 2 weeks after the anniversary and may continue until late November, hence our plan to publish in early December (clearly, we also wish to avoid publication too close to Christmas). I believe that the publication of your report during this 'family liaison' period, and in the weeks immediately before publication, could well cause distress to these families and would be highly disruptive to our task of ensuring that everybody feels well informed. It could also cause families to feel that they are being asked to choose between two different accounts of the same event. These concerns would be exacerbated by the fact that your report is narrower in scope and based on only the evidence available to your investigators.

Given the above, I would like to propose the following family liaison strategy:

Proposed family liaison strategy associated with the release of TfL's report into the Sandilands accident

- a) TfL will contact BTP to provide details of when the TfL report will be available and to ask that FLOs be involved in disseminating it to the families (if necessary, the RAIB can help to put you into contact with the FLOs)*
- b) during mid-late November the RAIB inspectors will be meeting with the families who are bereaved and some of the seriously injured. During these meetings we will explain that TfL has also prepared a report which will be available to them shortly after publication of the RAIB's final report*
- c) police FLOs will ask the families if they wish to receive a copy of the TfL report and how they wish to receive it (eg post or personal delivery)*

- d) after publication of the RAIB's report, TfL will provide a copy of its report to those families that have stated a wish to receive a copy – we suggest this is best done via the police FLOs*
- e) once these families have received their copy of the TfL report it could be placed in the public domain*

I am unsure of the extent to which TfL intend giving pre-publication information to the injured and other passengers on the tram. The RAIB is dealing with a small number of the injured people in the same way as the bereaved and, if they are to be included in the TfL process, we would tell them about the TfL report as noted in (b) above. Please let me know what your thoughts are about the seriously injured (and other passengers).

I hope that this suggested approach is helpful to you. However, as always, I am happy to discuss.

Regards

Simon

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Jacob Gemma

From: Collis Jill
Sent: 16 November 2016 10:11
To: Carter Howard; Brown Mike (Commissioner); Daniels Leon; Everitt Vernon; Powell Gareth; Fox Jonathan; Brown Matt; O'Neill Rory (Trams); Breen Tom; Kilonback Simon; Behan Catherine
Subject: FW: CONFIDENTIAL and URGENT – Interim Report into derailment at Sandilands Jn, Croydon TfL Restricted - confidential and legally privileged
Attachments: 161116_L_883_Sandilands Jn_IR final_09_Jill Collis.doc; 883-Sandilands_interim_report_TfL_comments.doc; IR012016_161116_Sandilands_Jn_embargoed.pdf

Dear all,

Please find attached in RAIB's interim report.

Note it will be published on their website at 14:00 and is embargoed until 14:00 and RAIB request we limit circulation to those for who it is essential to have a copy.

Regards

Jill

Jill Collis | Director of Health Safety Environment
Everyone Home Safe and Healthy Everyday

Tel. [REDACTED]
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From: Mat Reaney [[mailto:\[REDACTED\]@raib.gov.uk](mailto:[REDACTED]@raib.gov.uk)]
Sent: 16 November 2016 10:02
To: Collis Jill
Subject: CONFIDENTIAL and URGENT – Interim Report into derailment at Sandilands Jn, Croydon

Dear Ms Collis

Please find attached RAIB Interim report 01/2016 and associated correspondence relating to the fatal accident involving the derailment of a tram at Sandilands Junction, Croydon on 9 November 2016. This will be published on our website at 1400 hrs on 16 November 2016 (today).

The report is embargoed until 1400 hrs and we request that, at this stage, you limit the circulation of the report to those for whom it is essential to have a copy.

We would be grateful if you could acknowledge receipt of this by return of email.

Kind Regards

Mat Reaney
RAIB

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Rail Accident Investigation Branch

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www.raib.gov.uk

our ref: 883 – Sandilands Junction
– 2016-11-09

date: 16 November 2016

Jill Collis

 [tfl.gov.uk](mailto:jill.collis@tfl.gov.uk)

IN CONFIDENCE

Dear Jill

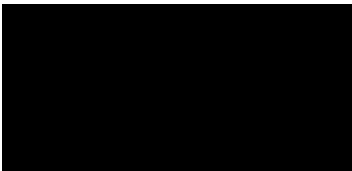
Derailment of a tram at Sandilands Junction, Croydon, 9 November 2016

The Interim Report into the above accident is now complete and I enclose a copy of the final document, which will be published at 14.00 hrs on **16 November 2016**.

Please note the contents of the Interim report are to be treated as confidential until it is published after which it will be freely available on the RAIB web site.

I would also like to thank you for the comments you provided on the draft report, which have been considered and addressed in the attached document.

Yours sincerely



Simon French
Chief Inspector



Rail Accident Investigation Branch

Rail Accident Investigation: Interim Report

**Fatal accident involving the derailment of a tram
at Sandilands Junction, Croydon
9 November 2016**

Embargoed until 1400 hrs 16/11/16

Report IR1/2016
November 2016

Note: This interim report contains information obtained from the Rail Accident Investigation Branch's (RAIB) initial examination of the available evidence. Some of the information contained in this report may be refined or changed as the investigation progresses.

The purpose of a RAIB investigation is to improve safety by preventing future railway and tramway accidents or by mitigating their consequences. It is not the purpose of such an investigation to establish blame or liability. Accordingly, it is inappropriate that RAIB reports should be used to assign fault or blame, or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

Fatal accident involving the derailment of a tram at Sandilands Junction, Croydon

9 November 2016



Summary

- 1 At about 06:07 hrs on Wednesday 9 November 2016, a tram running between New Addington and Wimbledon derailed and overturned on a curve as it approached Sandilands Junction, in Croydon (figure 1). The tram travelled for a short distance on its side before stopping in the vicinity of the junction.
- 2 Seven people suffered fatal injuries in the accident. A further 51 people were taken to hospital, with eight of them suffering injuries described by the London Ambulance Service as “serious or life-threatening”.
- 3 The Rail Accident Investigation Branch’s (RAIB) initial review of the on-tram data recorder (OTDR) shows that the tram was travelling at a speed of approximately 70 km/h (43.5 mph) as it entered the curve, which had a maximum permitted speed of 20 km/h (12.5 mph).



Figure 1: Google image showing area where accident occurred

The RAIB's role and the context of this interim report

- 4 The RAIB is responsible for conducting independent investigations into railway and tramway accidents in the UK. The purpose of its investigations is to improve safety by establishing the causes of accidents and making recommendations to reduce the likelihood of similar occurrences in the future or to mitigate their consequences.
- 5 The RAIB is not a prosecuting body; its investigations are focused solely on safety improvement and do not apportion blame or liability. The police and the Office of Rail and Road deal with contraventions of the law. None of their statutory duties are changed by the RAIB investigation.
- 6 The RAIB's investigation is running independently of those of the British Transport Police, the Office of Rail and Road, and the industry. However, all investigating agencies, and the industry, are co-operating fully with each other.
- 7 This interim report provides some key information including the RAIB's findings from its initial investigation. It builds upon the information already provided on the RAIB's website¹. A final report will be published on completion of the investigation. All RAIB investigation reports are available on the RAIB website.
- 8 At any stage in its investigations the RAIB may also issue urgent safety advice (see paragraph 32) and make recommendations to such persons as appropriate in the circumstances.

¹ www.gov.uk/raib

Background information

People

- 9 The driver was the only member of staff on the tram. The exact number of passengers is still being established, but is believed to be around 60.

Parties involved

- 10 The tramway infrastructure is owned and managed by Transport for London through its London Trams subsidiary.
- 11 Tram Operations Ltd, a subsidiary of First Group, operates the trams.

Key features of the route and accident location

- 12 The accident occurred at Sandilands Junction on the London Tramlink network in Croydon; the point at which the two easterly legs of the network from Beckenham Junction/Elmers End and New Addington converge (see figure 2).
- 13 The tram involved in the accident was running between Lloyd Park and Sandilands tram stops on the route from New Addington. After the Lloyd Park tram stop, the route runs in the open for about 900 metres, and then passes through Sandilands tunnels (comprised of three closely spaced tunnels with a total length of 512 metres), before emerging into a cutting approximately 100 metres before the left-hand curve on which the accident occurred. The curve has a radius of approximately 30 metres.
- 14 The tramway runs in its own dedicated corridor in this location (it does not change to street running until after Sandilands tram stop). The alignment through the tunnels on the approach to the curve is straight, and the track is on a gently falling gradient from the tunnel portal to the curve, before rising again through the junction.

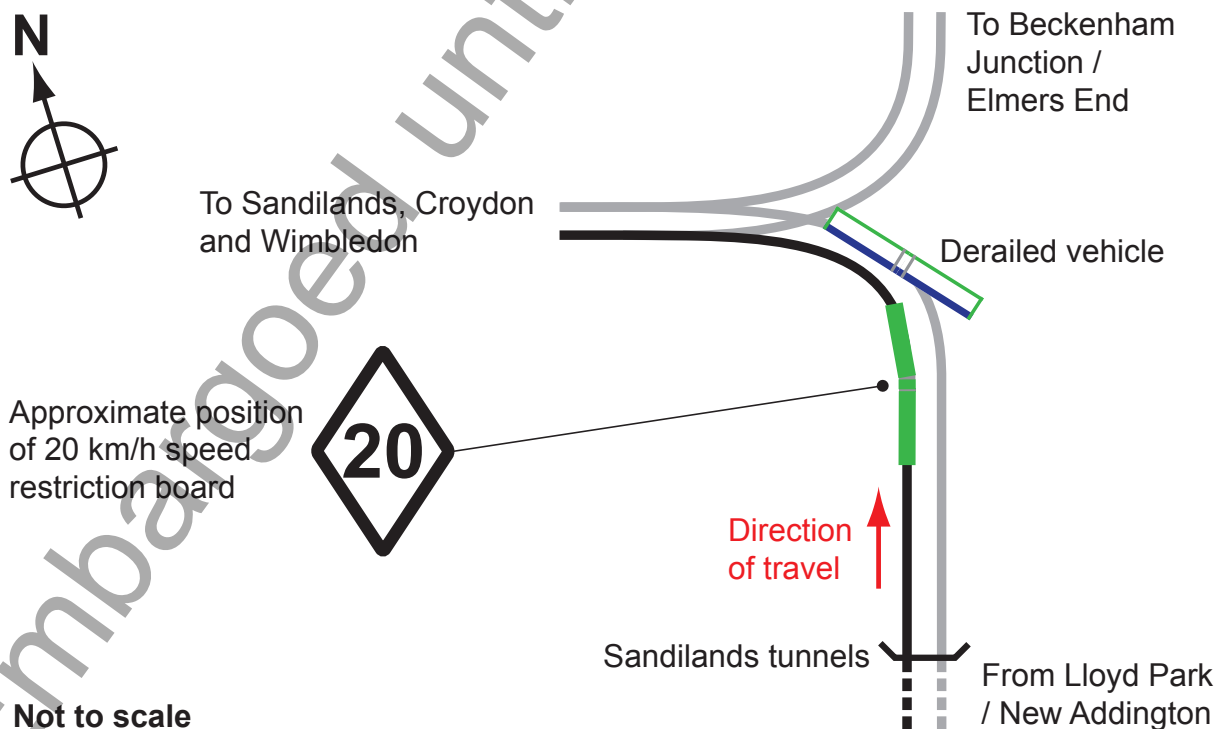


Figure 2: Diagram of accident location

- 15 The maximum permitted speeds for trams approaching the area from Lloyd Park are 80 km/h (50 mph) until the curve near to Sandilands Junction, at which point it drops to 20 km/h (12.5 mph). A reflective board denotes the commencement of the 20 km/h speed restriction; it is located approximately 30 metres before the point where the derailment occurred.
- 16 Trams, including those in Croydon, generally operate on 'line-of-sight' principles, with drivers being required to check that the route ahead is clear. Indicators are provided at locations where conflict can occur, such as junctions and road crossings. There is no requirement for advance warning of speed restrictions (neither is there a requirement for speed control systems to be fitted to trams).

External circumstances

- 17 At the time of the accident it was dark and raining heavily.

The tram

- 18 The vehicle involved was tram 2551, one of 24 units (comprising three bogies and two cars joined by an articulation unit) that made up the initial Croydon fleet. It was built by Bombardier Transportation in Austria in 1998.
- 19 The tram was equipped with forward facing and internal closed circuit television (CCTV) cameras and an OTDR. The OTDR records key parameters such as the vehicle speed and the driver's operation of power and brake controls.
- 20 The OTDR was functioning at the time of the accident, and the evidence obtained is being used in the RAIB's investigation. However, an initial examination of the tram's CCTV equipment suggests that it was not working at the time of the accident.

The accident

- 21 Tram 2551 departed from New Addington at 05:55 hrs, calling at six stops including Lloyd Park. After leaving Lloyd Park it travelled at up to 80 km/h (in accordance with prevailing speed restrictions), as it ran towards its next stop at Sandilands.
- 22 The tram entered the curve on the approach to Sandilands Junction at a speed of approximately 70 km/h (43.5 mph). As it encountered the curve, it derailed and turned over onto its right side, travelling for approximately 25 metres before it stopped.

Consequences

- 23 Seven people lost their lives in the accident and 51 were taken to hospital, eight of them suffering from serious injuries.
- 24 The right side of the tram, which made contact with the ground, was severely damaged.
- 25 There was some damage to the track and lineside equipment in the vicinity of the accident.

The investigation

- 26 The RAIB was notified via its telephone incident line at 06:42 hrs, and deployed five inspectors and two support staff to the site of the accident. The first three inspectors arrived on site at 10:02 hrs. The RAIB completed work on site at 09:20 hrs on 12 November 2016.
- 27 The RAIB has:
- secured relevant physical evidence including the tram;
 - moved the tram to a secure location;
 - obtained details from the tram's OTDR;
 - carried out a detailed survey of the track and other infrastructure in the area of the accident;
 - started gathering evidence from the tram operator;
 - started gathering evidence from witnesses; and
 - launched an appeal for other witnesses to come forward (www.gov.uk/government/news/raib-witness-appeal).

Initial findings

Track

- 28 The RAIB has undertaken a survey of the track in the vicinity of the derailment and will be reviewing the findings from the survey in due course. At this stage, no evidence has been found of any track defects, or obstructions on the track, that could have contributed to the derailment.

The tram and its operation

- 29 Detailed examination of the tram has not yet been possible. However, the RAIB's initial investigation has not indicated any malfunction of the tram's braking system.
- 30 A tram approaching the Sandilands Junction area from Lloyd Park at 80 km/h (50 mph) would need to brake at its full service rate of 1.3 m/s² approximately 180 metres before the speed restriction board in order to be travelling at 20 km/h (12.5 mph) when the board was reached.
- 31 Initial analysis of the tram's OTDR indicates that some braking was applied in the 180 metres before the 20 km/h speed restriction board, but this was only sufficient to reduce the tram's speed from 80 km/h (50 mph) to approximately 70 km/h (43.5 mph) by the time the tram passed the board and entered the curve on which the accident occurred.

Urgent Safety Advice

- 32 In the light of this accident, the RAIB has issued the following urgent safety advice to Tram Operations Ltd and London Trams:

'The factors that led to the over-speeding are still under investigation. Until these factors are better understood, and before the junction re-opens to passenger operation, the RAIB advises London Trams and Tram Operations Ltd to jointly take measures to reduce the risk of trams approaching Sandilands Junction from the direction of New Addington at an excessive speed. Options for consideration should include the imposition of a further speed restriction before the start of the existing 20 km/h speed restriction around the curve and/or additional operational signs.'

RAIB's future action in the investigation

- 33 During its investigation the RAIB will work in conjunction with other agencies to contact the families of those who lost their lives and those who were injured in the accident. The RAIB will also be contacting any passengers who were on-board the tram when the accident occurred, but who were not injured.
- 34 The RAIB's ongoing investigation will include consideration of:
- the sequence of events before and during the accident;
 - events following the accident, including the emergency response and how passengers evacuated from the tram;
 - the way in which the tram was being driven and any influencing factors;
 - the design, configuration and condition of the infrastructure on this section of the route, including signage;
 - the tram's behaviour during the derailment and how people sustained their injuries;
 - any previous over-speeding incidents at Sandilands Junction; and
 - any relevant underlying management factors.
- 35 The RAIB's investigation report will include recommendations to reduce the likelihood and/or consequence of similar events occurring in the future.

Rail Accident Investigation Branch

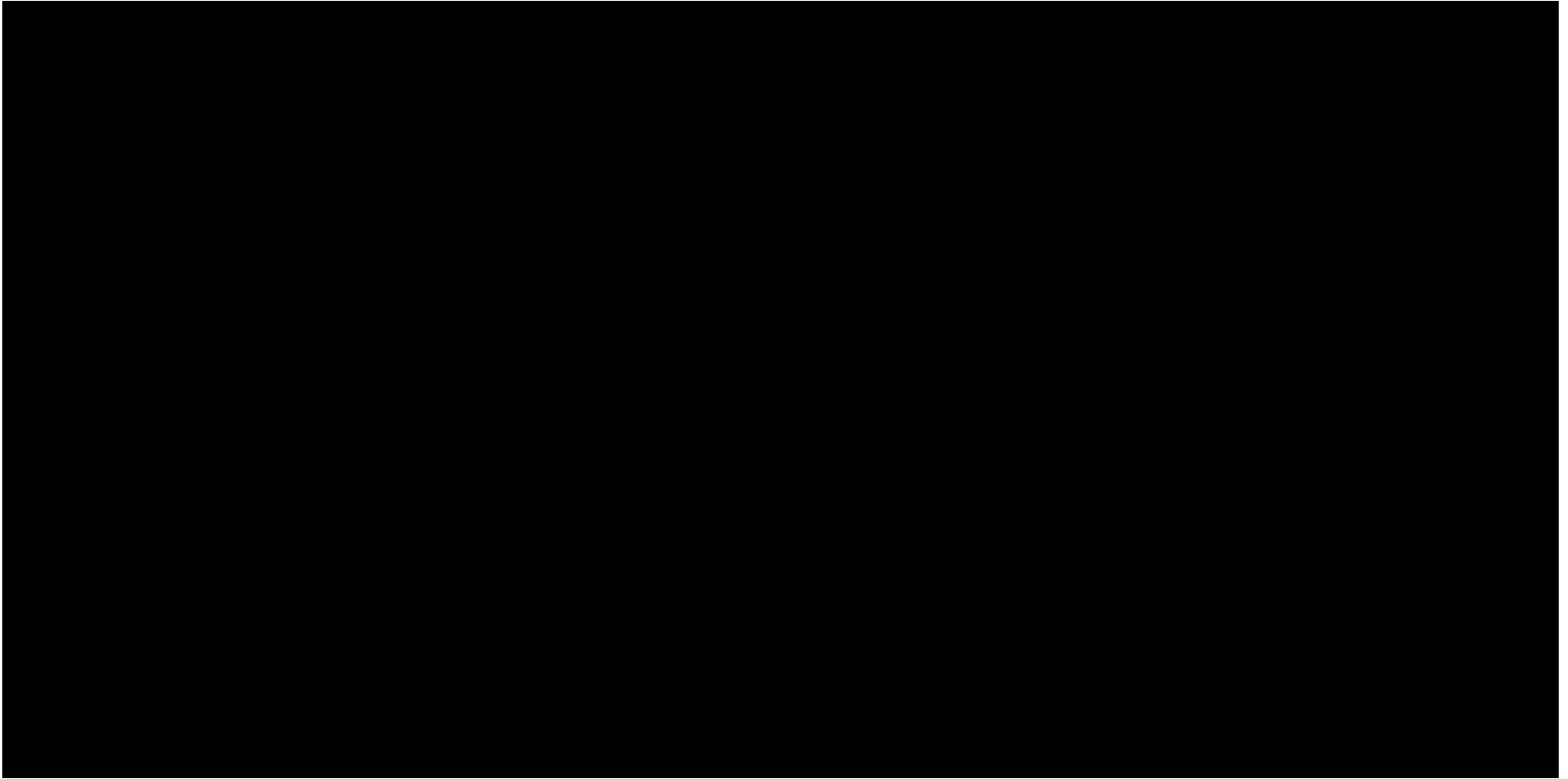
Date: 16 November 2016

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Any enquiries about this publication should be sent to:

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Derby UK	Website: www.gov.uk/raib
DE21 4BA	



Jacob Gemma

From: Collis Jill
Sent: 14 November 2016 19:35
To: Carter Howard; Brown Mike (Commissioner); Daniels Leon; Everitt Vernon; Powell Gareth; Fox Jonathan; O'Neill Rory (Trams); Breen Tom; Behan Catherine; Kilonback Simon; Capps William; Collett Martin
Cc: Clarke Andrea (Exc); Morris Jonathan; Branks Kirsten; Tagg Ella (ST); Gourley Jennifer
Subject: FW: Sandilands Junction - RAIB Urgent Safety Advice
Attachments: 1611140-A-883 Sandilands Junction Urgent Safety Advice Issued-RAIB.pdf

Dear all,

Please find attached the Urgent Safety Advice.

Regards

Jill Collis | Director of Health Safety Environment
Everyone Home Safe and Healthy Everyday

Tel. [REDACTED]
email [REDACTED] [tfl.gov.uk](mailto:[REDACTED]@tfl.gov.uk)

From: John Cope [[mailto:\[REDACTED\]@dft.gsi.gov.uk](mailto:[REDACTED]@dft.gsi.gov.uk)]
Sent: 14 November 2016 18:38
To: John Cope
Cc: Andrew Herrod; Mat Reaney; Simon French; AndrewR Hall
Subject: Sandilands Junction - RAIB Urgent Safety Advice

Thank you for your comments on the draft Urgent Safety Advice prepared by the RAIB in connection with the investigation into the derailment and overturning of a tram at Sandilands Junction on 9 November 2016.

The final version of the USA is attached, and is now issued.

Please disseminate the Advice within your organisation as you consider appropriate.

I would be grateful if you would confirm receipt of this email and attachment.

Regards,

John

John Cope
Principal Inspector (Branch Support Services)
Rail Accident Investigation Branch
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Hampshire
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URGENT SAFETY ADVICE

1. INCIDENT DESCRIPTION			
LEAD / INSPECTOR	John Cope	CONTACT TEL. No.	01932 440011
INCIDENT REPORT NO	883	DATE OF INCIDENT	09/11/16
INCIDENT NAME	Sandilands Junction		
TYPE OF INCIDENT	Derailment/overturning		
INCIDENT DESCRIPTION	At around 06:07 hrs on Wednesday 9 November, a tram travelling from New Addington to Wimbledon derailed and overturned on the 30 metre radius, left hand curve on the approach to Sandilands Junction. Seven passengers were killed and many others injured, some seriously. Evidence gathered to-date indicates that the tram entered the curve, which is subject to a speed restriction of 20 km/h (12.5 mph), at around 70 km/h (43.5 mph).		
SUPPORTING REFERENCES	OTDR and other evidence gathered.		

2. URGENT SAFETY ADVICE	
USA DATE:	14 November 2016
TITLE:	Over-speeding risk at Sandilands Junction
SYSTEM / EQUIPMENT:	Tram operations
SAFETY ISSUE DESCRIPTION:	Sandilands junction is approached, from the New Addington direction, on a long, straight section of track in a tunnel. The speed restriction on this section is 80 km/h (50 mph). The 20 km/h sign associated with the curve is positioned adjacent to the curve entry transition and approximately 100 metres from the tunnel portal. A tram braking at a full service rate of 1.3 m/s ² will need a minimum distance of 180 metres to achieve the required speed reduction. Consequently a 75% reduction in speed is required in advance of a tight bend, with the initial braking point in a tunnel. We do not yet know why on the morning of 9 November, this speed reduction was not achieved.
CIRCUMSTANCES:	Before dawn in heavy rain.
SAFETY ADVICE:	The factors that led to the over-speeding are still under investigation. Until these factors are better understood, and before the junction re-opens to passenger operation, the RAIB advises London Trams and Tram Operations Ltd to jointly take measures to reduce the risk of trams approaching Sandilands Junction from the direction of New Addington at an excessive speed. Options for consideration should include the imposition of a further speed restriction before the start of the existing 20 km/h speed restriction around the curve and/or additional operational signs.

USA SIGN-OFF*			
INSPECTOR NAME:	John Cope	CI / DCI NAME:	Simon French
INSPECTOR SIGNATURE:	ELECTRONIC COPY	CI / DCI SIGNATURE:	ELECTRONIC COPY
DATE:	14 November 2016	DATE:	14 November 2016

*When sending this form by email insert ELECTRONIC COPY into the signatory boxes.

Jacob Gemma

From: Collis Jill
Sent: 14 September 2017 08:19
To: Griffiths Nathan; Carter Howard; Clarke Andrea (Exc); Morris Jonathan; Curry Justine; Bevins Richard; Everitt Vernon; Powell Gareth; Fox Jonathan; Kilonback Simon; O'Neill Rory (Trams); Lyons Greg; Evers Mark; Behan Catherine; Mason Paul; Brown Andy (Corporate Affairs); Gasson Sarah; Dimond Helen; Morley Vicky; O'Hara Jamie; Flude Tom; Quin Nicholas; Savill Keith; Marshall Kristy
Cc: Daniels Leon; Taylor Lisa; Kill Allan
Subject: Paper to Safety sustainability and HR Panel (Confidential & Privileged – TfL Restricted)
Attachments: Tram derailment at Sandliand update 28 September 2017.doc

Dear all,

Attached is the paper proposed to be presented to the next Safety Sustainability and HR Panel.

Would you review and let me have any comments as soon as possible.

Thanks

Jill

Date: 28 November 2017

Item: Tram Derailment at Sandilands, Croydon on 9 November 2016 - Update

This paper will be considered in public

1 Summary

1.1 This paper updates the Panel on the activity underway and planned following the Tram derailment at Sandilands on 9 November 2016.

1.2 The Rail Accident Investigation Branch (RAIB), Office of Rail and Road (ORR), British Transport Police (BTP) continue their investigations, alongside those of TfL and First Group. We continue to support all the agencies in their ongoing investigations. The RAIB has confirmed the areas that key recommendations are expected to cover prior to the publication of their final report.

1.3 Infrastructure-based measures in addition to those implemented prior to the resumption of service continue to be progressed, including follow-up and evaluation of systems discussed at the Trams Summit held on 24 January 2017 and measures to address the key areas as noted by the RAIB.

1.4 Tram passenger numbers are back to the levels recorded before the derailment and have improved marginally on the previous year.

2 Recommendation

2.1 The Panel is asked to **NOTE** this paper.

3 Background

3.1 Measures to assist all those affected by the tragedy remain in place. Work continues on a comprehensive programme of measures to further reinforce safety and confidence on the system. This paper provides an update on these aspects.

4 Programme

4.1 Our thoughts remain with those affected by the tragic accident. We remain focused on doing everything we can to offer support to all those affected and are dealing with requests for support quickly.

4.2 Via the Sarah Hope Line, we continue to encourage anyone requesting interim financial support, to lodge a formal claim via our claims handler, Gallagher Basset.

We are engaging proactively with the law firms representing the majority of claimants, to ensure that processes and communication are as efficient as possible, including processing appropriate interim payments and referrals to counselling and therapeutic support quickly.

4.3 Discussions are continuing with the London Borough of Croydon for a memorial and longer term community outreach arrangements. Details have been received from the Borough on its long-term plan to support those affected by the tram derailment either directly (bereaved families and passengers) or indirectly (first responders, school children and the wider community). These are being reviewed to determine a suitable level of TfL support. We have offered our support to Croydon Council as it progresses a memorial.

Infrastructure and Operations

4.4 Since the incident we have introduced a number of additional safety measures to the tram network, including:

- Additional speed restrictions and associated signage have been installed near Sandilands and at three other locations on the tram network. We will implement a permanent speed reduction across the London tram network by the end of September, meaning the maximum speed trams can travel will be 70kpm (previously 80kph). Step down speed signage has been installed at four locations, providing a graduated reduction in allowable line speed on approach to sharp curves.
- The size of speed signs was increased. Enhanced chevron signs have been installed at the four sites with significant bends to provide an additional visual cue for drivers. The number of speed signs will be increased and additional lineside digital signage will provide added speed warnings to drivers.
- An in-cab driver protection device should be fitted to all trams by the autumn. This will then be fully trialed. Any sign of driver distraction or fatigue will result in the driver being alerted immediately.
- We are working with safety experts to test various options to strengthen the glass fitted to trams.
- Work on developing an in-cab driver alert system for monitoring and managing tram speed is continuing.
- The iTram system is being progressed
- Potential track modifications are under consideration. We are currently tendering for a concept design in order to assess potential benefits.
- We are working to improve locally powered emergency lighting and are developing a specification for the tram fleet which will prevent unintentional interruption during an emergency.
- The CCTV recording system has been replaced and upgraded.

4.5 We continue to work with the wider tram industry on these improvements and will consider any further measures that could be introduced to improve safety. We also continue to work with the RAIB and will take on board all recommendations from this and the other investigations that are underway

4.6 We are continuing to explore the development of in-cab systems for monitoring and managing tram speed to provide live tracking and speed warnings. Such systems are rare on trams so we are seeking interest from the wider industry to help support us in their development and introduction of a system. We have published a Prior Information Notice to help in identifying suitable technology.

4.7 The Trams oversight panel established to review the resumption of service following the derailment reconvened and continues to meet. This comprises senior representatives from FirstGroup and TfL to provide assurance of the infrastructure and operator mitigations. It also provides a Forum for us to review FirstGroups safety performance and management arrangements. We continue to monitor the enhanced driver management arrangements FirstGroup have put in place, which includes the more frequent programme of speed checks, fatigue management and counselling.

Investigations

4.8. We continue to work with the RAIB to support their investigation and with the ORR and the BTP who are also conducting investigations. The RAIB has confirmed the areas that the key recommendations are expected to cover prior to the publication of their final report. These are listed below and are shown on the RAIB's website. <https://www.gov.uk/government/news/fatal-tram-accident-in-croydon> .

- provision of active tram protection to prevent serious accidents due to excessive speed at high risk locations
- research into active means of detecting the attention state of drivers and intervening in the event of inattention
- improved containment of passengers by tram windows and doors
- setting up of an industry body to facilitate more effective cooperation between UK tramway owners and operators on matters related to safety performance and the development of common standards

We are reviewing these areas to consider what further action we need to take in response to the final report when published.

4.9 RAIB's final report is also expected to highlight the importance of ensuring the availability of in-tram CCTV systems and any actions already taken to address the issue. If necessary, the RAIB has stated it will also make a recommendation for further improvement in this area.

4.10 Finally RAIB's has said the investigation into how Tram Operations Ltd manage fatigue risk may result in a recommendation.

4.11 SNC-Lavalin, the company undertaking TfL's independent investigation is on target to report on their conclusions in the autumn.

4.12 We are also reviewing our response to the derailment from an administrative handling perspective, (as opposed to an incident management or operational perspective). This review will also be completed in the autumn. The results of this review will be reported to the Panel meeting

Safety and Procedures

4.13 We continue to closely monitor the end-to-end process for acting upon safety-related complaints received through the TfL Customer Contact centre and ensuring complaints are passed on to the relevant party for review and action. This includes working closely with First Group, to ensure all tram related complaints are reviewed and appropriate action taken in response.

List of Background Papers:

None

Contact: Leon Daniels

Number:

Email:

Jacob Gemma

From: Collis Jill
Sent: 02 August 2017 08:22
To: Everitt Vernon; Gasson Sarah; Carter Howard; O'Neill Rory (Trams); Daniels Leon
Cc: Taylor Lisa; Brown Matt; Marshall Kristy; Edwards David (TfL Press Office); Flude Tom; Quin Nicholas; O'Hara Jamie; Evers Mark; Behan Catherine; Brown Andy (Corporate Affairs); Morley Vicky; Bevins Richard; Curry Justine; Morris Jonathan; Clarke Andrea (Exc); Savill Keith; Griffiths Nathan; Fox Jonathan; Quinn Amy; Powell Gareth
Subject: RE: Letter regarding Sandilands from RAIB - (Confidential & Privileged – TfL Restricted)
Attachments: Sandilands: RAIB website update - EMBARGOED

Given the RAIB letter and update to their website (attached) talks about the areas where the recommendations are to be made, should our reply build on this and make reference to it? – note the areas of recommendations could be wider than those we are already considering – eg safety management/risk assessment improvement as well as physical improvements. For example

“We continue to work with the wider tram industry on these improvements and will consider **what any further measures that could** be introduced to improve safety **in the key areas identified by RAIB**”

In their report the RAIB describe the incident as the tram over turned on a bend (and subsequently derailed) and a fatal accident – should we mirror this? so start our statement since the fatal accident at Sandilands.....

Regards

Jill

From: Everitt Vernon
Sent: 01 August 2017 17:54
To: Gasson Sarah; Collis Jill; Carter Howard; O'Neill Rory (Trams); Daniels Leon
Cc: Taylor Lisa; Brown Matt; Marshall Kristy; Edwards David (TfL Press Office); Flude Tom; Quin Nicholas; O'Hara Jamie; Evers Mark; Behan Catherine; Brown Andy (Corporate Affairs); Morley Vicky; Bevins Richard; Curry Justine; Morris Jonathan; Clarke Andrea (Exc); Savill Keith; Griffiths Nathan; Fox Jonathan; Quinn Amy; Powell Gareth
Subject: RE: Letter regarding Sandilands from RAIB - (Confidential & Privileged – TfL Restricted)

Thanks Sarah. Just a couple of small comments from me in the below. Should we also mention in para 2 the additional speed monitoring in place as reported in the Croydon Advertiser today?

Vernon

From: Gasson Sarah
Sent: 01 August 2017 17:25
To: Collis Jill; Carter Howard; Everitt Vernon; O'Neill Rory (Trams); Daniels Leon
Cc: Taylor Lisa; Brown Matt; Marshall Kristy; Edwards David (TfL Press Office); Flude Tom; Quin Nicholas; O'Hara Jamie; Evers Mark; Behan Catherine; Brown Andy (Corporate Affairs); Morley Vicky; Bevins Richard; Curry Justine; Morris Jonathan; Clarke Andrea (Exc); Savill Keith; Griffiths Nathan; Fox Jonathan; Quinn Amy; Powell Gareth
Subject: RE: Letter regarding Sandilands from RAIB - (Confidential & Privileged – TfL Restricted)

Hi all,

Attached is the letter that went to the RAIB last month, and the letter to us from the RAIB.

Based on this we have developed the below draft media response ahead of Thursday's update from the RAIB. As agreed at the board, we will put this onto our website on Thursday and use reactively for any media queries. We have put this in Mike's name to match what we have done previously when responding to the RAIB.

Any comments please let us know, we'll then send to Mike's office and City Hall.

Thanks

Sarah

Croydon tram derailment – TfL's response to latest RAIB update

Statement by Mike Brown MVO, London's Transport Commissioner

"Our thoughts remain with all those affected by the tragic tram derailment and we continue to do all we can to offer our support.

"Since the ~~incident~~ **derailment** we have introduced a number of additional safety measures ~~on~~ to the tram network, including additional speed restrictions, new signage for drivers and an upgrade of the CCTV recording system.

"An in-cab vigilance system is being trialed and should be fitted to all trams by the autumn. This will monitor for any signs of driver distraction or fatigue and will alert the driver and the control room immediately should this occur. Work on an alert system for monitoring and managing tram speed is underway and we hope to move to trialing this soon.

"We continue to work with the wider tram industry on these improvements and will consider any further measures that could be introduced to improve safety. We also continue to work with the Rail Accident Investigation Branch (RAIB) and will take on board all recommendations from this and the other investigations that are underway.

"The TfL Sarah Hope line remains available to all those affected and continues to provide help with counselling and other support."

Ends

Additional information:

So far we have completed a number of safety improvements to the tram network, including:

- Additional speed restrictions and associated signage have been installed near Sandilands and at three other locations on the tram network. We will implement a permanent speed reduction across the London tram network by the end of September, meaning the maximum speed trams can travel will be 70kpm (previously 80kph).
- Enhanced chevron signs have been installed at the four sites with significant bends to provide an additional visual cue for drivers. The size of speed signage will be increased and additional lineside digital signage will provide added speed warnings to drivers.
- An in-cab vigilance device is being trialed and should be fitted to all trams by the autumn, this device will monitor for any signs of driver distraction or fatigue and will alert the driver and the control room immediately should this occur.
- We are working with safety experts to test various options to strengthen the glass fitted to trams.
- Work on developing an in-cab driver alert system for monitoring and managing tram speed is underway and we hope to move to trialing these new systems soon.
- The CCTV recording system has been replaced and upgraded.

- The Sarah Hope Line is run by specially trained TfL staff to provide practical and financial help and can make referrals for counselling and specialised support. The contact details for the Sarah Hope Line are 0343 222 5678, or SHL@tfl.gov.uk.
- We and our insurers are dealing with all formal claims as quickly as we can, including making settlements, interim payments and providing access to counselling and other medical support.

From: Gasson Sarah

Sent: 31 July 2017 12:58

To: Collis Jill; Griffiths Nathan; Savill Keith; Carter Howard; Clarke Andrea (Exc); Morris Jonathan; Curry Justine; Bevins Richard; Everitt Vernon; Powell Gareth; Fox Jonathan; Kilonback Simon; O'Neill Rory (Trams); Lyons Greg; Evers Mark; Behan Catherine; Mason Paul; Brown Andy (Corporate Affairs); Dimond Helen; Morley Vicky; O'Hara Jamie; Flude Tom; Quin Nicholas

Cc: Daniels Leon; Taylor Lisa; Gaden Elizabeth; Shrestha Rumi; Kill Allan; Matt Brown ([REDACTED]@tfl.gov.uk)

Subject: RE: Letter regarding Sandilands from RAIB - (Confidential & Privileged – TfL Restricted)

Hi Jill,

Sorry to pounce as I know you weren't able to make the meeting, but we have just discussed this at the Sandilands board.

You may already have this in hand, but we agreed that the best way forward was a formal written response to the RAIB's letter from TfL outlining how we are addressing the points they raise and all the progress made to date.

We will then use that to draft a formal media response and also an update for our own website which we can point people to.

Let me know if that works for you.

Many thanks

Sarah

From: Collis Jill

Sent: 26 July 2017 12:10

To: Griffiths Nathan; Savill Keith; Carter Howard; Clarke Andrea (Exc); Morris Jonathan; Curry Justine; Bevins Richard; Everitt Vernon; Powell Gareth; Fox Jonathan; Kilonback Simon; O'Neill Rory (Trams); Lyons Greg; Evers Mark; Behan Catherine; Mason Paul; Brown Andy (Corporate Affairs); Gasson Sarah; Dimond Helen; Morley Vicky; O'Hara Jamie; Flude Tom; Quin Nicholas

Cc: Daniels Leon; Taylor Lisa; Gaden Elizabeth; Shrestha Rumi; Kill Allan

Subject: FW: Letter regarding Sandilands from RAIB - (Confidential & Privileged – TfL Restricted)

Dear all,

Please find attached a letter from RAIB about key areas their report will likely address and next steps. There is no date for publication of the report yet.

Note they ask us not to publish more widely until after they have updated their website on 3rd august.

I suggest we review our current plans and actions against the areas as noted in the report – most of which have actions underway.

I assume we will also provide a statement in case of enquiries after their website is updated.

Regards
Jill

From: Nicky Pirrie [mailto: [REDACTED]@dft.gsi.gov.uk]
Sent: 26 July 2017 11:00
To: Collis Jill
Cc: O'Neill Rory (Trams)
Subject: Letter regarding Sandilands

Hi Jill,

Please find attached a letter relating to the accident at Sandilands on 9th November 2016.
I have sent a hard copy in the post today.
Best regards,

Nicky

Nicky Pirrie
PA to Simon French, Chief Inspector, RAIB
RAIB (Rail Accident Investigation Branch) | Cullen House | Berkshire Copse Road
| Aldershot | Hampshire | GU11 2HP | [REDACTED] | [REDACTED]@dft.gsi.gov.uk

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Jacob Gemma

From: AndrewR Hall <[REDACTED]@dft.gsi.gov.uk>
Sent: 28 July 2017 09:57
To: REC.Handling; [REDACTED]@orr.gsi.gov.uk; Parsonage, John; Collis Jill; Duckering Stephen (Firstgroup); James Hammett; O'Neill Rory (Trams)
Cc: Simon French; Chris Ford; Richard Harrington; Andy Lewis; Joe Finlay; James Hotson; Andrew Herrod; Sarah Spacey
Subject: Sandilands: RAIB website update - EMBARGOED

Tracey/John/Jill/Steve/James/Rory

As explained in Simon French's recent letter, we will update our Sandilands website entry on Thursday 3 August. This will be around 10:00. The update will be based on the text below.

While I understand that you will need to discuss this with some others in your respective organisations, please restrict this as far as possible and treat the content as **embargoed until RAIB publish**. We are anxious not to cause further distress to those involved by the unexpected release of this information.

Thanks and regards

Andy

Andy Hall
Deputy Chief Inspector
RAIB
The Wharf
Stores Road
DERBY DE21 4BA
[REDACTED]

The RAIB investigation into the fatal accident that occurred near Sandilands Junction on the London Tramlink system is continuing.

At around 06:10 hrs on Wednesday 9 November 2016, a tram overturned on a bend. Seven people suffered fatal injuries in the accident. A further 51 people were taken to hospital.

Further details of the accident and our ongoing investigation were included in two interim reports which were published on 16 November 2016 and 20 February 2017 ([links](#)).

While the basic explanation of events that day remains as described in the second interim report, we have gathered and analysed considerably more evidence since it was published in February. This has allowed us to formulate draft recommendations.

In recent weeks, we have discussed the draft safety recommendations, and our justifications for making them, with the families of the people who died in the accident, with the organisations involved and with the safety authority (Office of Rail and Road).

We have recently written to Transport for London who own the tramway, Tram Operations Limited who operate the tramway and UKTram who are the trade organisation covering all UK tram operators, to formally confirm the areas that a number of our key recommendations are expected to cover. We did this so they can start to consider what action to take in response, prior to the publication of our final report. The letter has been copied to other UK tram operators and the safety authority.

Key recommendation areas addressed to UK tram operators, are likely to be:

- provision of active tram protection to prevent serious accidents due to excessive speed at high risk locations;

- research into active means of detecting the attention state of drivers and intervening in the event of inattention;
- improved containment of passengers by tram windows and doors; and
- setting up of an industry body to facilitate more effective cooperation between UK tramway owners and operators on matters related to safety performance and the development of common standards.

In addition, the RAIB's investigation into how Tram Operations Ltd manage fatigue risk may result in a recommendation.

Our final report will also highlight the importance of ensuring the availability of in-tram CCTV systems and any actions already taken to address the issue. If necessary, the RAIB will also make a recommendation for further improvement in this area.

This list is not exhaustive, but includes some of the important safety issues that are likely to take time to implement, making early consideration vital. Other areas within the scope of our investigation, such as consideration of underlying safety management and regulatory factors, may also give rise to recommendations.

We are encouraged to learn that some tramway organisations have already started work in a number of these areas.

We are now writing the final report. Once it is complete, it will be subject to formal, written consultation with those involved, prior to publication. We are aiming to publish the report in under a year from the date of the accident. However, the publication date remains subject to a number of factors, some of which are outside our direct control.

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Rail Accident Investigation Branch

RAIB
Cullen House
Berkshire Copse Road
Aldershot
Hampshire
GU11 2HP

www.raib.gov.uk

direct tel: [REDACTED]

e-mail: [REDACTED]@raib.gov.uk

our ref: 883

date: 25th July 2017

Jill Collis
Palestra
197 Blackfriars Road
Southwark London
SE1 8NJ

Dear Jill,

Investigation into the fatal tram accident at Sandilands, 9 November 2016

Preliminary advice on the areas of RAIB recommendations

As you are aware, the RAIB investigation into the accident at Sandilands on 9 November 2016 is entering its final stages. We have completed the vast majority of evidence gathering and our subsequent analysis. We are now in the process of drafting our report and finalising the safety recommendations. We have discussed the draft recommendations, and our justifications for making them, with your organisations in recent weeks as part of the informal consultation process. Once we have completed our internal review of the report we will commence formal consultation of the entire report.

While the basic explanation of events that day remains as described in the RAIB's second Interim Report, we have gathered considerably more evidence in the intervening period. This has allowed us to identify a range of causal factors and issues, and to formulate draft recommendations that we believe are necessary to improve safety.

Our key recommendation areas applicable to UKTram and all UK tram operators are likely to include:

1. provision of active tram protection equipment to prevent serious accidents caused by excessive speed at high risk locations;
2. research into active means of detecting the attention state of drivers and intervening in the event of inattention;
3. improved containment of passengers by tram windows and doors; and

4. setting up of an industry body to facilitate more effective cooperation between UK tramway owners and operators on matters related to safety performance and the development of common standards.

In addition, the RAIB's investigation into how Tram Operations Ltd manage fatigue risk has revealed some areas of concern that are likely to feature in a recommendation.

Our final report will also highlight the importance of ensuring the availability of in-tram CCTV systems and any actions already taken to address the issue. If necessary, the RAIB will also make a recommendation for further improvements in this area.

Although our recommendations will only be formally issued once our report is published later this year, I am writing to advise that you give urgent consideration to the adequacy of your existing risk control measures in each of these areas, as appropriate, and the need for any actions beyond those you have already planned or implemented.

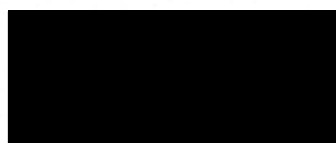
As the recent meetings made clear, the above list is not exhaustive, but includes some important safety issues that are likely to take time to address, hence my concern to give you early advice. Other areas within the scope of our investigation, such as the consideration of underlying safety management and regulatory factors, may also give rise to recommendations.

Once our final report is published the recommendations will be addressed to the safety authority for UK tramways, the Office of Rail and Road (ORR). You will then have a legal obligation to give each recommendation due consideration and to report to the ORR the actions taken in response.

We are aware that you have already started considering these issues and that some actions have already been taken. It would be desirable if you continue to inform the RAIB of any actions you take going forward, in order that these can be accurately reflected in our final report.

On the 03 August, we are planning to update the Sandilands entry on our web site to update the public on progress with our investigation and to give a first indication of the areas that are likely feature in our recommendations (as described in this letter). We are also in the process of providing personal briefings to the bereaved families. **I therefore ask that in order to avoid any distress to these families you restrict circulation of this letter, and wider dissemination of its contents, until after our web site has been updated.**

Yours sincerely



Simon French

Chief Inspector of Rail Accidents

cc Ian Prosser, ORR

cc other tram operators and UKTram

Jacob Gemma

From: Collis Jill
Sent: 15 November 2016 14:09
To: Carter Howard; Brown Mike (Commissioner); Daniels Leon; Everitt Vernon; Powell Gareth; Fox Jonathan; O'Neill Rory (Trams); Breen Tom; Behan Catherine; Kilonback Simon
Cc: Clarke Andrea (Exc); Morris Jonathan; Branks Kirsten; Tagg Ella (ST); Gourley Jennifer
Subject: RE: Croydon Tram Derailment - TfL Restricted - Confidential and Legally Privileged
Attachments: FW: CONFIDENTIAL and URGENT – draft Interim Report into derailment at Sandliands Jn, Croydon - response required by 12:00 hrs on Tuesday 15 November 2016

Dear all

Attached is the reply that was sent back to RAIB for your information. The latest information I have from RAIB is that the interim report will be published at 14:00 tomorrow.

Regards

Jill

Jill Collis | Director of Health Safety Environment
Everyone Home Safe and Healthy Everyday

Tel. [REDACTED]
email [REDACTED] tube.tfl.gov.uk

From: Gourley Jennifer **On Behalf Of** Carter Howard
Sent: 14 November 2016 12:02
To: Brown Mike (Commissioner); Daniels Leon; Everitt Vernon; Powell Gareth; Fox Jonathan; Collis Jill; O'Neill Rory (Trams); Breen Tom; Behan Catherine; Kilonback Simon
Cc: Carter Howard; Clarke Andrea (Exc); Morris Jonathan; Branks Kirsten; Tagg Ella (ST); Gourley Jennifer
Subject: Croydon Tram Derailment - TfL Restricted - Confidential and Legally Privileged

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

[Redacted]

Howard

Howard Carter, General Counsel, Transport for London
Windsor House, 42-50 Victoria Street London SW1H 0TL
e-mail: [Redacted] [tfl.gov.uk](mailto:[Redacted]@tfl.gov.uk)
Tel: [Redacted] ([Redacted])
Fax: [Redacted] ([Redacted])

Jacob Gemma

From: Collis Jill
Sent: 03 October 2017 16:32
To: Griffiths Nathan; Carter Howard; Bevins Richard; Everitt Vernon; Powell Gareth; Kilonback Simon; Fox Jonathan; O'Neill Rory (Trams); Lyons Greg; Behan Catherine; Evers Mark; Mason Paul; Brown Andy (Corporate Affairs); Gasson Sarah; Morley Vicky; Dimond Helen; O'Hara Jamie; Morris Jonathan; Flude Tom; Quin Nicholas; Savill Keith; Tagg Ella (ST); Taylor Lisa; Marshall Kristy; Daniels Leon; Kill Allan; Clarke Andrea (Exc); Brown Mike (Commissioner); Curry Justine
Subject: Sandilands update from railway industry health and safety advisory committee (Confidential & Privileged – TfL Restricted)

Dear all,

I have just attended the railway industry health and safety advisory committee. In the chief inspectors update Ian Prosser said the following regarding Sandilands

RAIB's report is nearing completion. Their website indicates the areas for potential recommendations. RAIB are hoping to publish in early December. The ORR's investigation with BTP will be complete about same time.

A member of the committee asked "if the upshot of ORR/BTP investigation is prosecution, is there a sequence for the police trial and ORR's prosecution etc. Ian Prosser stated the usually the inquest takes place first before any H&S prosecution. This is under the Work- related death protocol. (Available on ORR's website). However, this does not need to be the case. Normally ORR and police do same, they tend to consult/discuss with victims families and take their feelings into account.

Another member asked if fatigue was considered. Ian Prosser assure them that both ORR and RAIB have looked at fatigue and RAIB have made comments about it already, in previous reports. He said Obviously ORR have gone down that line of enquiry as well .

Regards

Jill

Sent from my iPad

Jacob Gemma

From: Collis Jill
Sent: 10 October 2017 13:04
To: Brown Mike (Commissioner); Everitt Vernon; Daniels Leon; Powell Gareth
Subject: SNCL report - Confidential & Privileged - TFL Restricted
Attachments: RTUKR-T39073-001-Issue 1.pdf

Dear all,

The final report – do you have anything you consider needs amending/clarifying?

If so would you let me know by close play Monday 23 October

Regards

Jill



SNC • LAVALIN

Independent investigation into the tram derailment at Sandilands Junction, 9 November 2016

Report No: RTUKR-T39073-001

   snclavalin.com

25 September 2017

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1 Executive Summary

The incident and consequences

At about 06:07 hrs on Wednesday 9 November 2016, London Trams (LT) tram No 2551, travelling from New Addington towards East Croydon, overturned on a 30m radius curved track with a Permanent Speed Restriction (PSR) of 20km/h, on the approach to Sandilands tramstop.

Of the 70 passengers on board, seven lost their lives and 51 passengers were injured, 16 seriously. Tram No 2551 is a Bombardier CR4000 unit operated by Tram Operations Limited (TOL) on behalf of LT.

The overturned tram impacted an overhead electricity stanchion, lineside equipment cabinets as well as rails being stored nearby. Significant damage was sustained to both the tram and the adjacent infrastructure.

TOL, LT and Transport for London (TfL) implemented their respective emergency plans and responded to the incident. Tram services were resumed east of Croydon at 12:30 on Friday 18 November.

This independent investigation was commissioned in order to:

- Record the events and state of the related systems before and after the incident
- Identify the causal chain including the initiating event, immediate causes, contributory and root causes.
- Formulate recommendations to address the findings.

Operating agreement

Under the current Operating Agreement, TOL (the current Transport Undertaking (TU), as defined by The Railways and Other Guided Transport Systems (Safety) Regulations (2006) (ROGS) [R-6]) is responsible for the safe operation of the trams.

LT (a subsidiary of TfL) has current responsibility for the provision of the infrastructure maintenance (since 2011) and for the tram maintenance (since 2014) and have therefore assumed responsibility as the Infrastructure Manager (IM) (as defined by ROGS).

Under ROGS, neither the IMs nor the TUs of a tramway system require Safety Certification or Safety Authorisation, but are required to operate their own Safety Management System (SMS).

The system was originally given approval, as a private consortium (Tramlink), to operate services by Her Majesty's Railway Inspectorate (HMRI) in 2000. TfL took over Tramlink in 2008.

Methodology

The findings of several workstreams are presented together in a causal chain diagram. This identifies the initiating event that led to the incident along with immediate and other contributory factors that contributed to the incident. The investigation is partially complete, pending review of further information from TOL and information retained by Rail Accident Investigation Branch (RAIB) and British Transport Police (BTP). This investigation has not had access to the tram driver, or his records, and has had no opportunity to interview him.

Findings

The causal chain is described as two possible contributory chains, either one of which is credible. Completion of investigations may enable one to be eliminated to confirm one as the most likely causal chain. The order in which they are presented gives no indication as to which is considered most likely. This report describes the initiating event and immediate

cause as shared conclusions, and then discusses both the probable contributory and associated root causes in turn.

Initiating event

- The initiating event of the incident is that tram 2551 entered the Sandilands curve at approximately 73km/h, significantly above the 20km/h PSR in place. This resulted in the tram losing contact with the rails, overturning, striking several items of infrastructure and coming to rest on its right hand side (relative to the direction of travel).

Immediate cause

- The immediate cause was the tram speed not being reduced to below its overturning speed as it entered the 30m curve at Sandilands Junction.

Contributory Causes (1) – Loss of situational awareness

- The system does not provide conspicuous warning/cues to the driver on where to operate the brakes of the tram on the approach to the hazard of the 30m radius curve and junction. The braking is required to ensure that the tram speed is below the tram overturn speed, is able to stop as required for the signal, and is controlled through a 20 km/h PSR on the curve.
- Under this theory, the driver became disorientated as to the location and/or direction of travel between Lloyd Park and approach to Sandilands curve and did not initiate braking at the expected/required point on the approach to the curve.
- Visibility of the Sandilands curve, speed restriction signage and signal SNJ07S is achievable after the required point of first braking. Later sighting of the curve and signage offers little opportunity for the driver to recover from earlier failure to reduce the speed of the tram.
- The system did not detect or control excessive speed of trams.

Root Cause (1) – Loss of situational awareness

- The driver of the tram did not identify the need to brake the tram in the approach to the Sandilands curve due to a temporary loss of situational awareness.
- The system design does not provide adequate engineering controls for all foreseeable human failures that could result in a temporary loss of or lack of situational awareness.

Contributory Causes (2) – Incapacitation of driver

- The Driver Management systems may not have prevented the driver booking onto his shift when not fit to work.
- The driver became incapacitated between Lloyd Park tram stop and the approach to Sandilands curve and did not initiate braking at the expected point on the approach to the curve. The cause of the incapacitation is unknown, but could include loss of alertness as a result of fatigue, a medical event or condition.
- The level of functionality of the DSD was not sufficient to recognise that the driver was not fully vigilant.
- The system did not detect or control for excessive speed of trams.

Root Cause (2) – Incapacitation of driver

- The driver of the tram did not identify and act on braking cues in the approach to the Sandilands curve due to incapacitation.

- The system design does not provide adequate engineering controls for foreseeable human failures that could result from incapacitation.

Discounted theories

The following theories have been discounted based on balance of probability and consideration of known and indisputable facts:

- Obstruction on the infrastructure
- Failure of the infrastructure, control systems or tram.
- Malicious or deliberate act of the driver; Distraction of the driver from a mobile phone or radio.

Summary of Recommendations

The following recommendations are made with the following categorisation:

- **Primary (P)** – those that arose directly from the events leading to the incident (including the theories stated).
- **Secondary (S)** – those that have arisen from topics either relating indirectly to the incident or that would have affected the incident and resulting events (including the theories stated)
- **Observations (O)** – these are recommendations based on other areas that can be improved.

Reference	Recommendation	Description
R1 (P)	Review available cues to the driver of the braking points and the approaching curve	The investigation has highlighted that further cues could be added to the current infrastructure, as to the upcoming hazards (30m radius curve, junction) at Sandilands. A review should be conducted to consider upgrading the infrastructure cues available to the driver in order to maximise opportunity for the driver to predict suitable braking in advance of the curve.
R2 (S)	Review the arrangements for the monitoring management and of speeding	TOL should review how indicators in relation to the measurement of operational speed compliance are measured and reported and whether implementing leading indicators would give useful visibility of trends, increasing their ability to focus on areas of concern and take appropriate action. TfL/LT should maintain visibility of the implementation of monitoring and any controls that are identified as a result.



Reference	Recommendation	Description
R3 (P)	Review of traction brake controller (TBC) driver's safety device (DSD) design	<p>Investigate the design limitations of the TBC, DSD and surrounding cab ergonomics in order to establish whether the TBC can be kept in the operating position by a driver who is "non-vigilant".</p> <p>Make recommendations to improve the design, or make additional controls, where this is seen to be reasonably practicable in line with obligations under the Health & Safety at Work etc. Act 1974 [R-10].</p>
R4 (P)	Review the arrangements for the monitoring and management of fatigue and fitness to work	<p>TOL should review how safety issues in the areas of fatigue and fitness to work are monitored in service, measured, reported and what indicators are used to monitor the success of controls in place.</p> <p>TOL should consider implementing leading indicators in areas where possible in order to gain suitable visibility from trends and increase their ability to refocus on areas of concern.</p> <p>TfL/LT should maintain visibility of the implementation of any additional controls and the results of monitoring undertaken.</p>
R5 (S)	Review route risk assessments and network risk model to reflect new understanding of risk arising from the Sandilands investigation	<p>It is recommended that LT and TOL review and update the Route Design Risk Assessment and Network Risk Model. As part of this review, LT and TOL should examine and document human factors risks and the controls put in place as a result of this investigation, identifying any additional mitigations required to reduce the risks associated with excess speed.</p> <p>Derailment scenarios should be benchmarked against those of rail operations to ensure all credible scenarios have been considered.</p>
R6 (O)	Review mechanisms used to promote Organisational Learning	<p>Both TOL and LT should further promote the use of confidential reporting systems and ensure that the outputs of these systems are used to support organisation learning.</p> <p>TOL and LT should further promote the near miss/incident reporting system in order to ensure that they are continuing to learn from incidents and near misses that occur within their organisation.</p> <p>TOL and LT should review the processes in place to capture, review, action and act on incidents and near misses in other organisations in order to learn from the lessons of failure in other systems.</p>

Reference	Recommendation	Description
R7 (O)	Review near miss reporting mechanisms	LT should request a review of the TOL incident reporting process in order to determine whether the process is fit to be used to escalate a potential safety issue quickly to the appropriate owner within the business.
R8 (O)	Consider feasibility of increasing containment of tram vehicles	LT should consider the feasibility of increased containment of passengers from an overturn event at typical network speeds.

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3 Glossary of Abbreviations and Acronyms

Term	Description
BT	Bombardier Transportation
BTP	British Transport Police
CB	Circuit breaker
COG	Centre of Gravity
DSD	Drivers Safety Device
ECR	East Croydon Railway Stop
EOS	Enforcement and On-Street Operations
ERU	Emergency Response Unit
HSE	Health and Safety Executive
HMRI	Her Majesty's Railway Inspectorate
HSW	Health & Safety at Work Act
LSTCC	London Streets Traffic Control Centre
LT	London Trams. The Infrastructure Manager (ROGS).
NR	Network Rail
OCC	Operations Control Centre
ORR	Office of Rail and Road
OTDR	On tram data recorder
PPI	Point Position Indicator
PSR	Permanent Speed Restriction
RAIB	Rail Accident Investigation Branch
ROGS	The Railways and Other Guided Transport Systems (Safety) Regulations 2006
ROTS	The Railways and Other Transport Systems (Approval of Works, Plant and Equipment). Regulations 1994
RSSB	Railway Safety & Standards Board
RTC	Risk Triggered Commentary
SMS	Safety Management System
SPAS	Signal Passed at Stop
TBC	Traction brake controller
TCL	Tramtrack Croydon Limited
TfL	Transport for London
TMS	Tram Management System
TOL	Tram Operations Ltd. The Transport Undertaking (ROGS).
TSR	Temporary Speed Restriction
USA	Urgent Safety Advice

4 Introduction

At about 06:07 hrs on Wednesday 9 November 2016, London Trams (LT) tram No 2551, travelling from New Addington to East Croydon, overturned on a 30m radius curved track with a Permanent Speed Restriction (PSR) of 20km/h, on the approach to Sandilands tramstop.

Of the 70 passengers on board, seven lost their lives and 51 passengers were injured, 16 seriously. Tram No 2551 is a Bombardier CR4000 unit operated by Tram Operations Limited (TOL) on behalf of LT.

The overturned tram itself impacted an overhead electricity stanchion, lineside equipment cabinets as well as rails being stored nearby (see Figure 1 and Figure 2). Significant damage was sustained to both the tram and the adjacent infrastructure. Work is ongoing as a part of a separate workstream to investigate the performance of the tram structure during the overturn.

TOL, LT and Transport for London (TfL) implemented their respective emergency plans and responded to the incident. An independent investigation of the event was commissioned to determine its causes and the surrounding circumstance. Tram services East of Croydon were resumed at 12:30 on Friday 18 November.

This report describes the findings of this investigation. The findings from several workstreams are combined and presented using a causal analysis. This technique seeks to identify the main initiating event that led to the incident along with immediate and contributory causes of the incident, together with their root causes.

The report references sources (indicated for example by [R-1] etc.), where necessary.

4.1 Definitions

The below definitions were used in order to construct the root cause analysis of the causal chain, detailed in this report.

Initiating Event – the event that directly led to the incident in question (in this case, the tram overturning and striking infrastructure)

Immediate Cause – the cause that led directly to the initiating event happening.

Contributory Causes – these can be numerous and complex, as there can be several layers of potential controls that may have failed. Here we have included contributory causes that may have influenced the outcome, including controls that weren't designed to be present, but are present in other transport systems.

Root Causes – An agent, failure or fault from which a chain of effects or failures originates.



Figure 1 - Tram 2551 overview of resting position on adjacent tracks



Figure 2 - Tram 2551 roof against infrastructure

5 Terms of Reference

This investigation has been commissioned in order to:

- Record the events and state of the related systems before and after the incident
- Identify the causal chain including the initiating event, immediate causes, contributory and root causes.
- Recommend actions for TfL to consider to learn from the incident.

A review of the emergency response, handling and communication of all parties is to be undertaken by TfL and is out of the scope of this report.

6 Overview of network

6.1 Location

The London Tram network is shown in Figure 3 with the critical Lloyd Park to Sandilands section highlighted. It includes a long largely straight section of the former Woodside and South Croydon Railway.

The tramway passes through three consecutive separate tunnels approaching the curve at Sandilands. At each end of the straight former railway sections there are small radius curves providing connections to the newer tramway alignments, both of which have 20km/h speed limits (see Figure 3 – LT Network highlighting Lloyd Park to Sandilands).

The track construction consists of S49 rail on Vortok fastened lightweight concrete sleepers and traction power is provided through the 750V DC overhead line equipment.

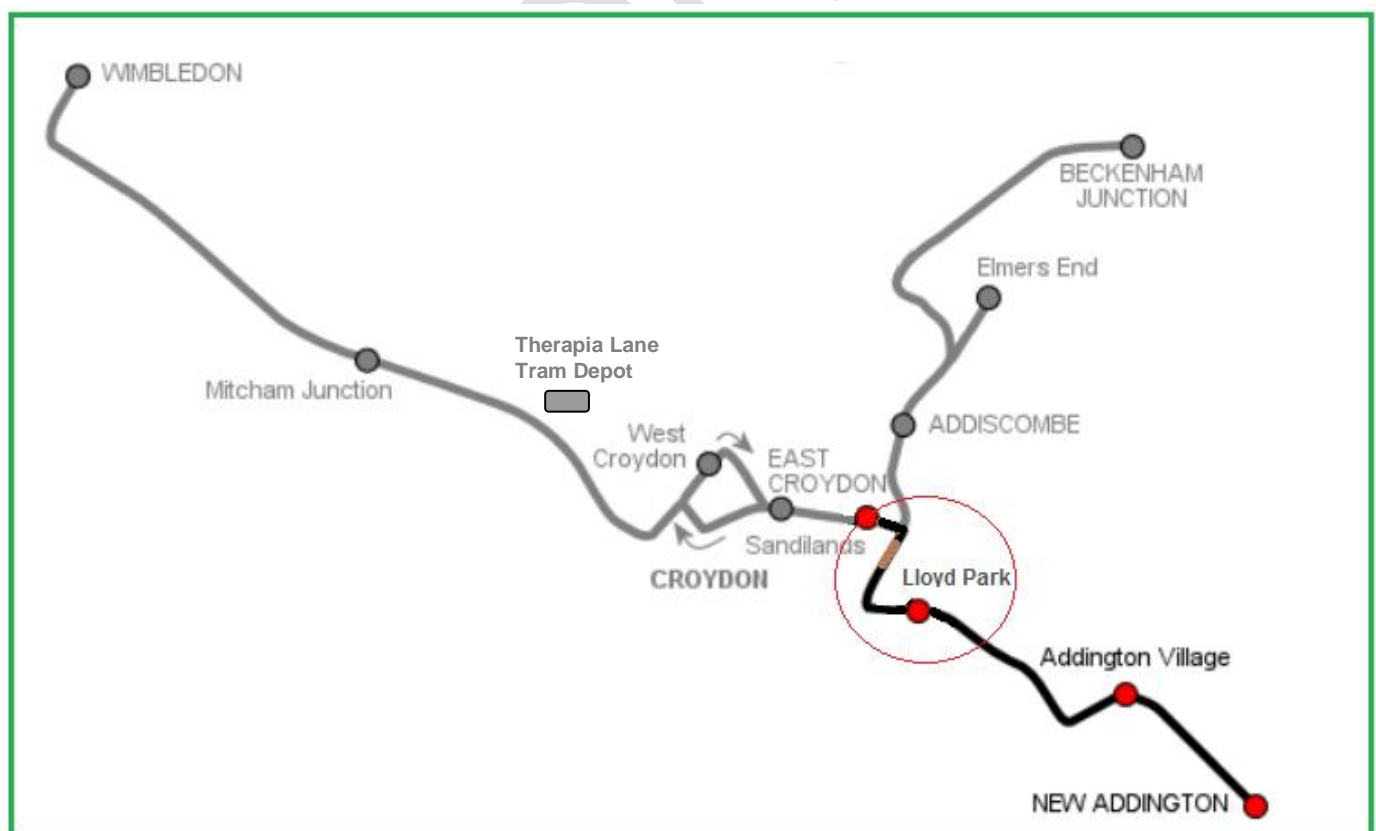


Figure 3 – LT Network highlighting Lloyd Park to Sandilands

6.2 Responsibilities

Under the current Operating Agreement (recorded in the 2007 contract) [R-4] TOL is responsible for the safe operation of the trams.

Since 2011 and 2014 respectively LT have assumed responsibility for the provision of infrastructure and trams maintenance from TOL.

The system was originally given authority to operate by HMRI [R-3]. The original submission to the HMRI was based on the applicable and current guidance for tramways at that time [R-7], using 'line of sight' principles, with specific conditions for application of signalling in areas segregated from street running.

A system running on line of sight is described as:

“a tram should be able stop before a reasonable visible stationary obstruction ahead from the intended speed of operation” ([R-7] paragraph 22)

In parallel with the line of sight principles, safe operation also requires drivers to have knowledge of the route to anticipate key tasks, such as reducing speed in line with speed restrictions, signals and point position indicators. The driver also needs to know the location of traffic junctions, tram stops and pedestrian crossings.

The reliance on the driver as the principal mitigation for speed control on the system means that the Operator requires robust management of driver competence (including compliance with speed limits), as well as procedures to manage fitness to work and fatigue requirements.

7 Sequence of Events

7.1 Prior to Incident

On the morning of 9 November 2016, heavy rain was falling, it was dark and the temperature was around 4° C.

The fleet of 30 trams required for the day's operation was available for service; both the infrastructure and trams were in serviceable condition.

Information associated with the driver's booking-on time has not, at this stage, been made available to this investigation and so is not included in this timeline.

By examining records (including 'loop' data) from the Operational Control Centre (OCC) and the On Tram Data Recorder (OTDR) data [R-2], the following timeline has been established:

- 05.16 Tram 2551 left the depot, having been prepared for service by the driver, and entered service at Therapia Lane, en route to New Addington on Line 3.
- 05.47 The tram arrived at New Addington on time in accordance with the Working Timetable (WTT).
- 05.55 The driver, having changed cabs commenced his return journey. Tram 2551 was the fifth tram to depart New Addington that morning on Line 3 and called at each of King Henry's Drive, Fieldway, Addington Village, Gravel Hill, Coombe Lane tramstops in accordance with the WTT. The previous four trams did not exhibit any issues with maintaining the WTT.
- 06:02:27 Tram 2551 was stationary at Coombe Lane tramstop and departed Coombe Lane at 06:02:44 again in accordance with the WTT.
- 06:05:07 Tram 2551 arrived and was stationary at Lloyd Park tramstop departing Lloyd Park tramstop between 06:05:08 and 06:05:21 in accordance with the WTT.

This tramstop is the final stop prior to the point at which tram 2551 derailed, located approximately 1375 metres prior to the Sandilands curve.

7.2 During Incident

Appendix A includes a visual representation of the last 650 metres prior to the start of the curve to give a visual overview of the traction, braking and sanding applications along with the speed profile of the tram in relation to key features of the infrastructure such as the three tunnels, the inner portals between each tunnel and the location of the route signage. The relevant section of the diagram is replicated in Figure 4 (indicating the final 355 metres /15 seconds of the tram's movements)

By examining records (including 'loop' data) from the OCC and OTDR data, the following timeline has been established.

NOTE: All OTDR timing and distance are subject to validation by RAIB through its own investigation, the findings of which will be shared with this investigation when concluded.

NOTE: The traction and braking control on the tram has a speed control function. It is not possible from the OTDR data to determine whether the traction and braking were applied by the driver or the control system when maintaining a constant (or near to constant) speed.

- 06:05:21 Tram 2551 departed Lloyd Park tramstop, increasing speed steadily on the approach to the Coombe Road tunnel, reaching maximum line speed (80km/h) at 06:06:33.
- 06:06:34 Tram 2551 arrived at the entry point to Coombe Road tunnel travelling at 79km/h and continuing to take traction.
- 06:06:40 Tram 2551 passed through the inner portal between the Coombe Road tunnel and the Park Hill tunnel and maintained traction and travelling at 79km/h throughout until the inner portal between the Park Hill and Woodside tunnels.
- 06:06:46 [denoted "A" on diagram] Tram 2551 passed through the inner portal between the Park Hill tunnel and Woodside tunnel (approximately 330 metres from the curve), taking traction and travelling at around 79km/h. (It is understood that this is the location that drivers are trained to initiate braking in preparation for the speed reduction to 20km/h at the Sandilands Curve.) The tram continued into the Woodside tunnel and continued to take power.
- 06:06:52 [denoted "B" on diagram] The tram coasted then initiated braking at 06:06:52 for a period of less than one second travelling 13 metres before returning to coasting and travelling a further 9 metres. Tram is approximately 180 metres from the curve.
- 06:06:53 [denoted "C" on diagram] The tram took traction again, travelling a further 92 metres until 06:06:57 travelling at 78km/h. The tram then coasted for a further 12.5 metres before braking at 06:06:58, approximately 50-55 metres before the start of the curve.
- 06:06:58 [denoted "D" on diagram] The tram braked, with a rate of retardation in line with that of a normal service braking applied by the driver (around 1.3 ms^{-2}), with the sanding system being initiated (either automatically by the wheel slip/slide protection system, or manually by the driver) at 06:06:59 until 06:07:01.
- 06:07 [denoted "E" on diagram] TOL Control recorded that: "TMS generated an alarm that all Circuit Breakers (CB) between East Croydon Railway Stop (ECR) and Sandilands had tripped. Driver informed Control that he was in a bad state, the tram was on its side and several passengers were injured and he required help urgently." The Duty Manager called all emergency services and informed TOL and LT on-call managers.

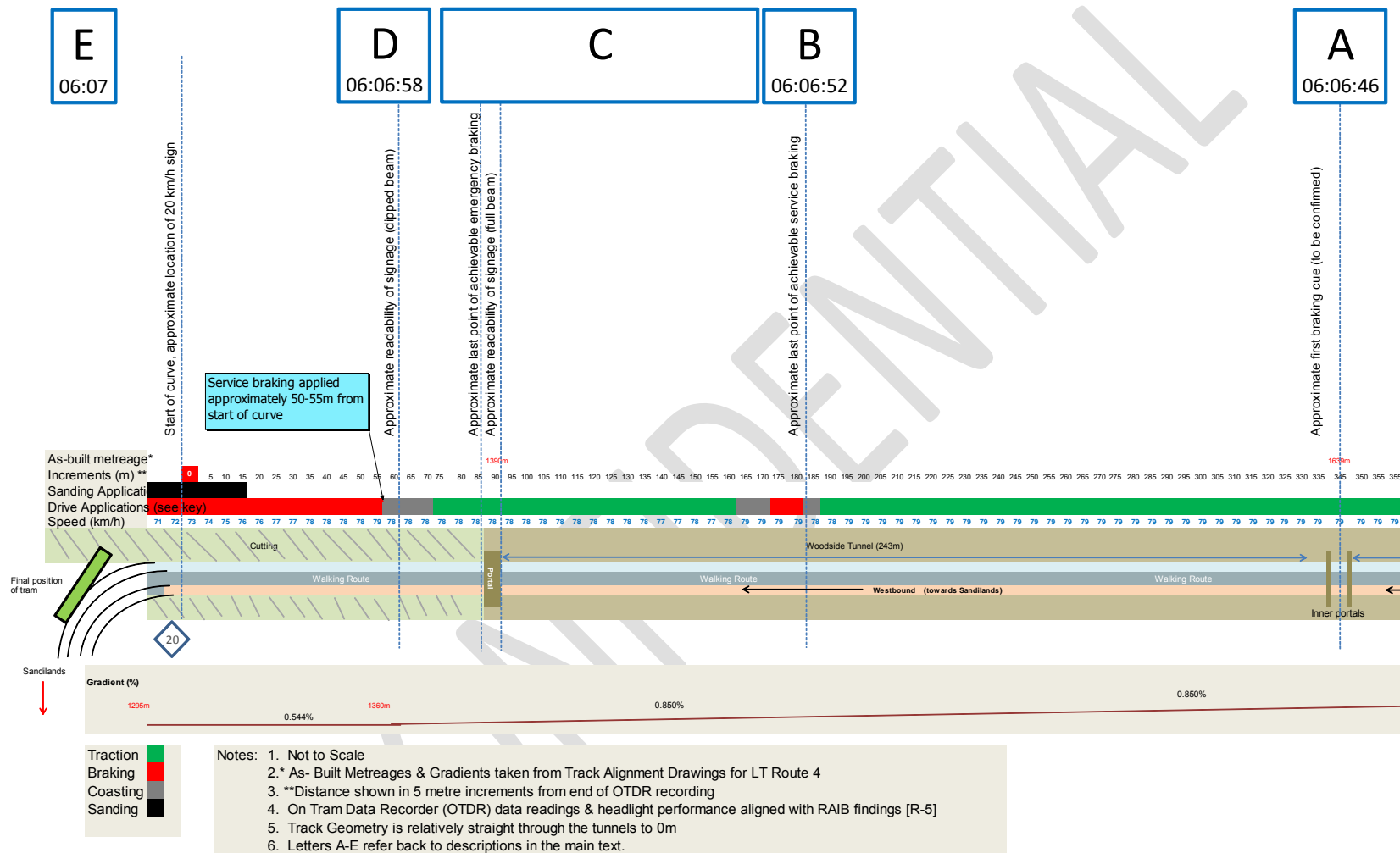


Figure 4 - Extract of Appendix A Sequence of events (schematic) over final 15s/330m (approximation) before curve.

7.3 Post Incident

The following account is an abbreviated timeline of events immediately after the incident.

- 06.15 Director, London Trams received call from TOL Operations Director and passed on information to TfL on-call manager and progressively to others in TfL as appropriate.
- Initial reports indicated that the derailment was “in the Sandilands tunnel.” This was corrected when emergency services arrived
- 06.30 Emergency services and TOL Incident Officer were on site, by which time the Metropolitan Police were reporting fatalities. Area declared a crime scene. Driver arrested. Police took details from survivors.
- 06.36 TfL implemented its command and control structure in line with its emergency plan.
- 06:42 RAIB was notified via its telephone incident line, and deployed five inspectors and two support staff to the site of the incident.
- 07.07 Under the TfL emergency plan, TfL Director of Surface Transport appointed Gold command, TfL Managing Director at London Trams Silver, and Head of Road Space Management Sponsorship Silver. Bronze commanders appointed for London Streets Traffic Control Centre (LSTCC), Buses and Enforcement and On-Street operations (EOS).
- 07.36 HSE Senior Manager confirmed RAIB and ORR informed and estimated time of arrival on site of 08.30.
- 09.05 Switching implemented to de-energise and earth affected section.
- 09.30 Survivor/ bereaved welfare arrangements introduced. Buses used as shelter and to transfer injured to hospital.
- 10:02 The first three RAIB inspectors arrived on site. RAIB collection of OTDR.
- 12.00 51 survivors had been taken to hospital, 20 at St George’s Hospital (4 serious) and 31 to Croydon University Hospital (4 serious). 5 fatalities are known with suspicion of 2 more. Joint working and cooperation between all agencies. British Transport Police (BTP) in charge of site and moving into investigation phase following removal of casualties.
- 13.39 TfL Director of London Rail took over as Gold command.
- 15.25 Head of Health and Safety (Surface) confirmed commission of independent investigation.
- 16.32 RAIB issued a statement on the incident indicating that excessive speed was considered to be a factor.

7.4 Immediate actions taken to resume operations

TfL established an oversight panel of Senior Managers to direct and review assurance in respect to resumption of services east of Croydon. LT and TOL implemented the following actions, which enabled operations to restart on Friday 18th November 2016.

7.4.1 Urgent Safety Advice

On 14th November 2016, RAIB issued an Urgent Safety Advice (USA) notice to LT and TOL, requiring them to reduce the risk of trams approaching the Sandilands junction from New Addington at excessive speed before restart of service. LT introduced new Temporary Speed Restrictions, including new signage and driver briefings (by TOL) on this advice.

7.4.2 Peer Review

In order to review the adequacy of the actions taken to resume services east of Croydon, LT also sought peer review from the UK tram trade body, UKTram, who on 16th November 2016, recommended increasing speed monitoring controls upon restart of operations, and that consideration of illuminated speed triggered detection signs and corner chevron markers should be given in the near future.

7.5 Subsequent work

The following work has been implemented on the system since the reinstatement of services, which address some of the recommendations included within this investigation report.

- Retroreflective chevrons have been added to a number of locations across the tramway, including the 30m radius Sandilands curve infrastructure
- TOL have increased speed checks across the network
- Speed activated warning signage is being trialled at a number of locations across the tramway including the approach to the Sandilands curve.

8 Investigation of Causal Factors

8.1 Methodology

The investigations into the tram derailment on 9 November 2016 are ongoing and the complete set of contributory factors are still to be fully determined as the findings and knowledge are made available from:

- BTP
- TOL
- the ongoing RAIB investigation.

A series of surveys, interviews, workshops and documentation reviews were carried out in order to determine the initiating event for the tram derailment, and to establish the immediate and contributory causes. From these, the root causes were drawn. The key areas reviewed covered:

- Infrastructure
- Rolling Stock
- Safety and Operations management
- Human Factors

This investigation has not had access to the tram driver or his records and has had no opportunity to interview him.

9 Overview Diagram – Causal Chain

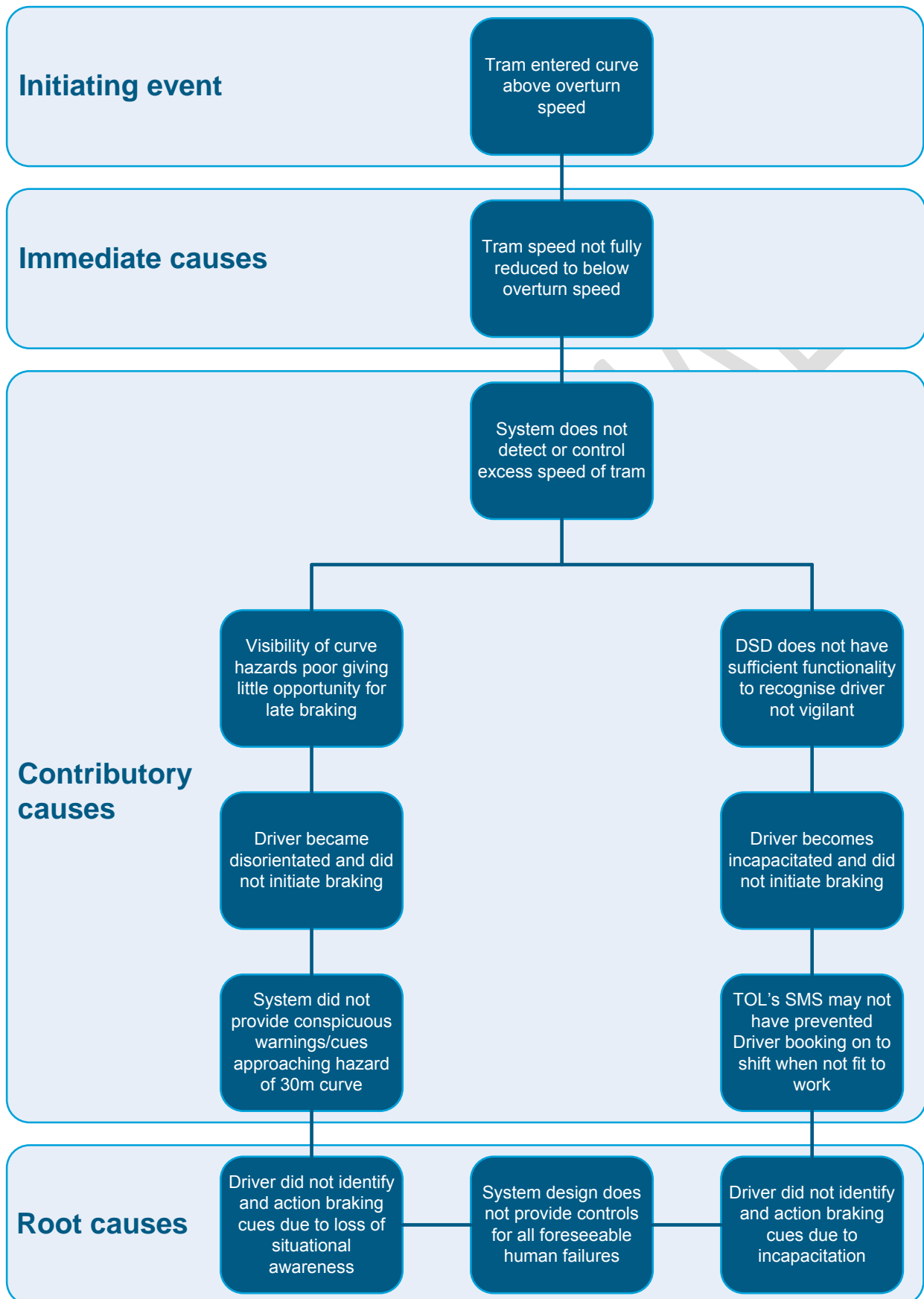


Figure 5 - Overview of Causal Chain

10 Overview

The causal chain (see Figure 5 - Overview of Causal Chain) is described as two possible contributory chains. Completion of investigations may enable one to be eliminated or identified as more probable than the other, to confirm one as the most likely causal chain. This report describes the initiating event and immediate cause as shared conclusions, and then discusses both the probable contributory and associated root causes in turn.

11 Initiating event

11.1 Conclusion

The event that initiated the derailment was tram 2551 entering the Sandilands curve at approximately 73 km/h, significantly above the 20 km/h PSR in place. This resulted in the tram losing contact with the rails, overturning, striking several items of infrastructure and coming to rest on its right hand side.

11.2 Discounted

The investigation to date has discounted the following, through site survey, infrastructure surveys as well as checks and testing of the tram systems.

- The presence of any obstruction on the infrastructure
- Failure of the infrastructure
- Failure of the tram system.

The surveys and testing did not identify anything relating to the condition of the tram or infrastructure which could have initiated the derailment.

12 Immediate Cause

12.1 Conclusion

The tram entered the curve in excess of the PSR as a result of neither the service braking nor the emergency brake being initiated by the driver in time to reduce the tram to below the tram overturn speed. The overturn speed is the speed at which the tram would overturn, based on its Centre of Gravity (COG) and the radius and cant of the track curve that it is entering. The overturning speed of the tram is estimated to be between 45km/h and 52km/h, depending on the loading on the day. A normal level of service braking was initiated by the driver approximately 2.5 seconds before the start of the curve [R-5], which equates to around 50-55m before the 20km/h sign at the curve. This is later than the trained point to commence braking and also later than the last point at which the service or emergency brake could achieve the required deceleration before the Sandilands curve.

12.2 Discounted

The investigation to date has discounted the following, through testing of the tram systems and study of the OTDR data.

- Failure of the tram braking system and controls
- Malicious act of the driver.

The testing (undertaken by RAIB) did not identify anything relating to the condition of the tram braking system and controls which could have led to the failure of the tram to brake sufficiently on the approach to the curve.



The reported actions of the driver are concluded to be inconsistent with a deliberate act to overturn the tram by the driver.

13 Contributory & Root Causes

The conclusions below are based on two main theories, either of which is considered to be a viable option:

1. “Loss of situational awareness”, and
2. “Driver incapacitation”.

The order in which they are presented gives no indication as to which is considered the most likely at this stage.

13.1 Contributory Causes (1) – Loss of situational awareness

Situational awareness is the state where a person is aware of where they have been, where they are now where they are supposed to be next. It also informs the person of anyone or anything that is a threat to their health [R-11]. The awareness comes from a number of factors, including knowledge, experience and education. Because of this, a person’s situational awareness is individual, and potentially different to those around them.

A person’s situational awareness is only as accurate as their own perception of the situation. What the person is thinking is their situation may not accurately reflect reality. How someone interprets a situation will rely on several factors including the type and quality of the information presented and their past experiences, as well other factors that may diminish their ability to rationalise information, such as fatigue or distraction.

Temporary loss of and lack of situational awareness is well recognised in multiple industries, such as fire fighting, policing, air traffic control, aviation, ship navigation as well as for simpler activities such as driving a car or riding a bicycle. Its contribution in accidents is well documented, and has been cited as a causal factor of many accidents by investigations [B-12][R-11]. Guidance on managing situational awareness is published and available in many industries, including UK mainline rail (RSSB) and the Health and Safety Executive (HSE).

In this causal chain, the driver did not anticipate the presence of the upcoming curve and therefore the necessary braking required in advance of entering the curve, due to a temporary loss of awareness of his position (and the subsequent braking activities required at that point). It is concluded from OTDR data [R-2], that this error state would have occurred after the preceding tram stop at Lloyd Park where the driver appeared to be attentive to the required driving activities less than 2 minutes before.

13.1.1 Background

Hazards

There are two hazards which require the control of speed into the Sandilands curve:

- The presence of a 30m radius curve on the route, and the combined centre of gravity of the tram was such that an approach speed of (estimated) 45-52km/h would cause the tram to overturn. The curve was therefore allocated with a 20km/h PSR to provide a large safety factor against this hazard. The track is also canted to mitigate the effects of the overturn forces.
- Signal SNJ07S is situated on the curve, within the 20km/h PSR zone; this signal exists to protect against a conflict with the converging line at Sandilands Junction at the west end of the curve. Failure to control speed on the approach to this signal increases the likelihood of a Signal Passed at Stop (SPAS) with potential for collision if the signal overlap distance is exceeded.

Signage and cues

The system design did not include any additional aids to drivers to make them aware/remind them that there was an upcoming speed step down requirement prior to the curve and associated (20km/h) PSR. This was controlled operationally through training and route knowledge accumulated through experience. The braking required to successfully bring the tram from the linespeed through the tunnels (80 km/h) to the PSR (20km/h) needs to be initiated well in advance of the curve, understood to be usually initiated within the final (Woodside) tunnel, around 330m before the start of the curve. The last point of achievable service braking is around 180m before the start of the curve [R-5]. The curve beyond the tunnel exit and its 20km/h PSR sign would be extremely difficult to detect by the driver at this point under the conditions experienced on the 9th November 2016 [R-5] (see Final sequence of events).

The signs are standard across the tramway, they comply with current guidance [R-9] and those at Sandilands Junction at the time of the incident were clean and in good condition.

The reflective signage indicating the 20km/h PSR is readable (i.e. the numerals can be read) on a clear night, from the driving position of a tram driven at caution, from a distance of around 60m (dipped beam) and 90m (on full beam) [R-5]. This figure could be reduced by heavy rain, such as that experienced on the morning of the incident [R-5]. The ability of the driver to detect the signage will also be influenced by the tram speed, the driver's visual acuity, the local lighting as well as any other tasks that the driver was undertaking. See Figure 6 below.



Figure 6 - 20km/h board on exit from Woodside tunnel (photo taken around 85m from the start of the curve)



Figure 7 - 20 km/h PSR board on 30m radius curve, with the entrance to the Elmers End/Beckenham Junction branch line showing opposite

The incident has highlighted that there is no relevant signage that can be sighted from the required start of braking. Knowledge of the route and the next maximum permissible speed is therefore required and the ability to successfully complete this task is dependent on the driver correctly identifying the point for the start of braking.

The braking cue point (nominally towards the start of the Woodside tunnel, see Appendix A and Figure 4 for details), can be ambiguous in certain environmental conditions and is therefore a contributory factor to this theoretical causal chain (see section on human factors below)

The Regulator at the time of commissioning the tramway (HMRI) did not provide any clear guidance on signage layout principles in this area.

Risk Assessment

The original system risk assessment did not explicitly consider all the foreseeable failures from human error (e.g. incapacitation, loss of situational awareness, distraction etc) and the risks presented should tram speed not be adequately controlled.

Whilst the risk assessment identified derailment risk, it did not include subsequent factors such as overturning or striking infrastructure/objects.

It was assumed that a competent driver would always comply with the 20km/h PSR. It is not current practice on tram systems to use engineering controls to control or supervise vehicle movements. Such controls have been progressively introduced to the mainline railway over the last few decades and are now routine. UK light rail systems are operated on “Line of Sight” meaning that the driver is fully responsible for controlling the train at all times. Operational controls are used to manage risks associated with driver failure/error by seeking to ensure that the drivers are alert and competent.

Human Factors

This theory assumes the driver makes a mistake in the interpretation of his location on the route. This could feasibly include a mistake in:

1. Perceived progression along the tunnel(s)
2. Perceived direction of movement within the tunnel(s).

The tunnel is the third in a series of three consecutive tunnels, separated only by a small gap between structures. The driver would need to correctly identify the start of the Woodside tunnel to correctly initiate the braking task. It is considered that the start of the third tunnel may be difficult to locate in some conditions, such as darkness.

The tunnel lighting is designed to be symmetrical so might lead to driver disorientation due to the environment appearing similar in both directions.

Other interpretations of this theory include a situation where the driver undergoes other types of human error, of either a “slip” or a “lapse”, thus omitting the braking task within the tunnel when heading towards the curve in question.

Whilst not a direct link in the theory relating to loss of situation awareness, fatigue and other medical issues can affect the performance of the driver in the collection, interpretation and actioning of information and cannot be discounted yet as being contributory causes. Information on the fitness of the driver and relevant historical information is not currently available to this investigation.

13.1.2 Conclusions

- The system does not provide conspicuous warning/cues to the driver on where to brake the tram on the approach to the hazards of the 30m radius curve and junction at Sandilands. A significant amount of braking is required to ensure that the tram speed is reduced from the 80 km/h linespeed to below the tram overturn speed, and is controlled through a 20 km/h PSR on the curve.
- Under this theory, the driver became disorientated as to the location and/or direction of travel between Lloyd Park and approach to Sandilands curve and did not initiate braking at the expected/required point on the approach to the curve.
- Visibility of the Sandilands curve, speed restriction signage and signal SNJ07S is achievable after the required point of first braking. Later sighting of the curve and signage offers little opportunity for the driver to recover from earlier failure to reduce the speed of the tram.
- The system did not detect or control excessive speed of trams.

It is also noted that factors noted below in “incapacitation of driver” (section 13.3) would reduce the driver’s ability to maintain situational awareness and would play a part in this causal chain.

13.1.3 Discounted

The following theories were discounted based on the evidence known about the driver, a site survey of the site and infrastructure, and discussions with the Infrastructure Managers and RAIB.

- Any deficit in competence of the driver to undertake the braking activity required
- Any distractions from mobile phone or cab radio away from the braking activity required.



13.1.4 Recommendations

Reference R1	Review available cues to the driver of the braking points and the approaching curve
Recommendation	The investigation has highlighted that further cues could be added to the current infrastructure, as to the upcoming hazards (30m radius curve, junction) at Sandilands. A review should be conducted to consider upgrading the infrastructure cues available to the driver in order to maximise opportunity for the driver to predict suitable braking in advance of the curve.
Background	<p>The review should consider:</p> <ul style="list-style-type: none">• How the risk from directional disorientation can be managed by the use of intermediate speed step downs between significantly different PSRs.• Highlighting the presence of the curve itself by use of retro reflective chevrons.• Whether any risks associated with the transition to/from lit tunnels to the wider infrastructure are mitigated by the current design and condition.• The medical standards used for visual acuity of driver and use this to assess suitability against any implemented controls. <p>The risks and controls discussed above should be considered for each location on the Croydon Tram network where similar hazards may exist.</p>

Reference R2	Review the arrangements for the monitoring and management of speeding
Recommendation	<p>TOL should review how indicators in relation to the measurement of operational speed compliance are measured and reported and whether implementing leading indicators would give useful visibility of trends, increasing their ability to focus on areas of concern and take appropriate action.</p> <p>TfL/LT should maintain visibility of the implementation of monitoring and any controls that are identified as a result.</p>



Reference R2	Review the arrangements for the monitoring and management of speeding
Background	<p>Speed management is a vital constituent part of running a safe tramway system.</p> <ul style="list-style-type: none"> • TOL should develop and document an effective system to monitor compliance with speed limits, and ensure that they adjust their recruitment, training, and procedures as necessary in order to increase levels of compliance and reporting. This system could include unobserved arrangements (for instance through review of OTDR data or by running automated reviews of loop data if this could yield a suitable level of analysis). • The review should include how driver training addresses anticipation of speed restrictions, braking cues etc. • TOL should investigate the use of Risk Triggered Commentary (RTC) and consider whether using RTC could be used to enhance situation awareness in certain locations.

13.2 Root Cause 1 – Loss of situational awareness

13.2.1 Conclusion

- The driver of the tram did not identify the need to brake the tram in the approach to the Sandilands curve due to a temporary loss of situational awareness.
- The system design does not provide adequate engineering controls for all foreseeable human failures that could result in a temporary loss of or lack of situational awareness.

13.3 Contributory Causes (2) – Incapacitation of driver

13.3.1 Background

In this context, incapacitation can be thought of as a continuum, which can extend at one end, from “no incapacitation” through small loss of alertness/attention (perhaps due to tiredness or distraction), and through more serious incapacitation, where an individual is unable to function normally (for instance, during a stroke), and extending to complete physical and mental incapacitation (for instance, being unconscious as a result of a heart attack, or in a deep sleep).

This causal chain states that the driver may have been incapacitated enough to be unable to initiate braking or attend to the braking task. This incapacitation would have been temporary as the driver is known to have reacted to the overturned tram and called for assistance.

Operational controls are used by TOL to ensure that the driver is fit to work. This includes screening for use of drugs and alcohol, planning supervising and management of work/rest patterns for all drivers, as well as providing supervision of any medical issues that the driver may be experiencing.

Incapacitation through alcohol, drugs and medical conditions are easily checked after an incident, however personal fatigue is more difficult to objectively quantify. Therefore, a review was undertaken of the fatigue controls in place in TOL.

It was found that TOL had identified fatigue in their risk assessments and implemented a Management of Fatigue policy in the business. However, the associated procedures and



supporting processes relating to the policy within the business missed opportunities to raise awareness and manage fatigue at a working level.

TOL did not measure fatigue management controls at Executive level and, because of this, it would have been extremely difficult for TOL Executive or TfL to have had a good level of visibility of any arising issues in this area.

If this theory is the correct causal chain leading to the accident (that the driver became incapacitated), the Driver’s Safety Device (DSD) could have been expected to intervene. The DSD requires the driver to maintain a force onto the Traction Brake Controller (TBC) at all times. If this force is not maintained then the emergency brakes are initiated to stop the tram. The DSD did not operate in this instance.

It may be possible to maintain a force on the DSD whilst being incapacitated in certain circumstances, and a vigilance device (where the system monitors movement inputs of the driver) may give a better indication of the attention of the driver.

From review of the OTDR it was found that any incapacitation occurred after the preceding tram stop at Lloyd Park, as the driver was able to perform driving tasks prior to this point (less than 2 minutes prior to the derailment).

Refer to the discussion in 13.1.1 (under ‘Risk assessment’) regarding the use of speed monitoring on light rail.

13.3.2 Conclusions

- The Driver Management systems may not have prevented the driver booking onto his shift when not fit to work.
- The driver became incapacitated between Lloyd Park tram stop and the approach to Sandilands curve, preventing him from initiating braking at the expected point on the approach to the curve. The cause of the incapacitation is unknown, but could include loss of alertness as a result of fatigue, a medical event or condition.
- The level of functionality of the DSD was not sufficient to recognise that the driver was not fully vigilant.
- The system did not detect or control excessive speed of trams.

13.3.3 Discounted

The investigation to date has discounted the following, through testing of the tram systems and study of the OTDR.

- Failure of the DSD to activate emergency braking.

This means that the DSD was not triggered by loss of driver interface; a force was maintained by the driver on the TBC, suitable to sustain the DSD, throughout the approach to the Sandilands curve.

13.3.4 Recommendations

Reference R3	Review of traction brake controller (TBC) driver’s safety device (DSD) design
Recommendation	<p>Investigate the design limitations of the TBC, DSD and surrounding cab ergonomics in order to establish whether the TBC can be kept in the operating position by a driver who is “non-vigilant”.</p> <p>Make recommendations to improve the design, or make additional controls, where this is seen to be reasonably practicable in line with obligations under the Health & Safety at Work etc. Act 1974 [R-10].</p>



Reference R3	Review of traction brake controller (TBC) driver's safety device (DSD) design
Background	<p>The HMRI guidance at the time of approval [R-7] that is still in place [R-9] states:</p> <p><i>“299 The following should be provided:</i></p> <p><i>(a) a traction and brake controller, which incorporates a hazard braking position (it may also incorporate a driver's safety device);</i></p> <p><i>(b) a driver's safety device, designed so that it cannot be kept in the operating position other than by a vigilant tram driver;”</i></p>

Reference R4	Review the arrangements for the monitoring and management of fatigue and fitness to work
Recommendation	<p>TOL should review how safety issues in the areas of fatigue and fitness to work are monitored in service, measured, reported and what indicators are used to monitor the success of controls in place.</p> <p>TOL should consider implementing leading indicators in areas where possible in order to gain suitable visibility from trends and increase their ability to refocus on areas of concern.</p> <p>TfL/LT should maintain visibility of the implementation of any additional controls and the results of monitoring undertaken.</p>
Background	<p>Driver management is a vital constituent part of running a safe tramway system, particularly where a major control for many risks to the driving task is the competency and alertness of the driver.</p> <p>The review should consider:</p> <ul style="list-style-type: none"> • The technologies available to supplement the existing operational controls. • Whether daily fitness for work is a self declaration or is supported by observation of individuals by supervisory staff. • The actions expected of individuals if they feel fatigued and/or unfit for duty, or become so whilst on shift. • How the importance of fatigue and fitness management is reinforced to TOL employees beyond their initial employment and associated induction process; whether TOL's fitness management arrangements materially changed since previous audits. • Whether any TOL staff policies could influence behaviour of staff to report to work in an unfit or potentially unfit condition. • The role played by confidential reporting systems.

13.4 Root Cause – Incapacitation of driver

- The driver of the tram did not identify and act on braking cues in the approach to the Sandilands curve due to incapacitation.
- The system design does not provide adequate engineering controls for foreseeable human failures that could result from incapacitation.

13.5 Risk Assessment

13.5.1 Background

LT manage an extensive Network risk model which is used to prioritise risk management activities.

When the original risk assessment was conducted, the risk from derailment was considered based on historical incidents at other light rail systems. In the last 50 years, instances of high speed derailments where the vehicle has overturned on a light rail system are extremely rare. Additional risk assessments are owned and managed by TOL.

13.5.2 Conclusion

The risk assessment considering the potential for derailment did not consider overturning at speed or striking infrastructure/other lineside objects.

13.5.3 Recommendation

Reference R5	Review route risk assessments and network risk model to reflect new understanding of risk arising from the Sandilands investigation
Recommendation	<p>It is recommended that LT and TOL review and update the Route Design Risk Assessment and Network Risk Model. As part of this review, LT and TOL should examine and document human factors risks and the controls put in place as a result of this investigation, identifying any additional mitigations required to reduce the risks associated with excess speed.</p> <p>Derailment scenarios should be benchmarked against those of rail operations to ensure all credible scenarios have been considered.</p>
Background	<p>The risk assessments did not fully consider the scenarios of:</p> <ul style="list-style-type: none"> • Human behaviour resulting in a failure to comply with speed limits • A tram overturning following a derailment • A tram striking an object following a derailment <p>It remains necessary for both LT and TOL to have appropriate risk assessments for their areas of responsibility and to cooperate for those areas where risks require joint management. These are obligations defined within the HSW [R-10], and ROGS [R-6].</p>

14 Observations

14.1 Speeding & fatigue management

14.1.1 Background

A review of incidents involving speeding and derailment on curves was conducted in order to identify other human failures in this type of situation. The findings of this review are outlined in Appendix B. Notably, a previous report of speeding on the network, initiated on the 31 October 2016, at the Sandilands curve, had not been processed at the time of the derailment. The timely investigation of this near miss, may have affected the outcome of this incident. This and other incidents of speeding and other human failures, demonstrate the risks that are presented when the human driver fails.

In addition to the formal reporting outlined, reported instances of fatigued drivers on the network have been circulated on social media.

14.1.2 Conclusion

Safety related near miss reporting should be able to be cascaded and acted on quickly within the organisation.

14.1.3 Recommendations

Reference R6	Review mechanisms used to promote Organisational Learning
Recommendation	<p>Both TOL and LT should further promote the use of confidential reporting systems and ensure that the outputs of these systems are used to support organisation learning.</p> <p>TOL and LT should further promote the near miss/incident reporting system in order to ensure that they are continuing to learn from incidents and near misses that occur within their organisation.</p> <p>TOL and LT should review the processes in place to capture, review, action and act on incidents and near misses in other organisations in order to learn from the lessons of failure in other systems.</p>
Background	<p>The use of near miss, incident and confidential reporting systems enables organisations to gain visibility of possible blind spots in their safety management systems. Considering incidents and near misses within other transport systems will enable applicable lessons from other organisations to be identified.</p>

Reference R7	Review near miss reporting mechanisms
Recommendation	<p>LT should request a review of the TOL incident reporting process in order to determine whether the process is fit to be used to escalate a potential safety issue quickly to the appropriate owner within the business.</p>
Background	<p>The near miss event that occurred on 31 October 2016 did not get escalated quickly enough within the TOL and LT organisations during the 8 intervening days to assist in any relevant interventions.</p>

14.2 Containment

14.2.1 Background

The structural integrity of a vehicle provides protection for those travelling in the vehicle.

The incident has highlighted that whilst the structural integrity of the tram remained intact, the integrity of the windows and doors was compromised when it experienced the overturn event at speed.

Whilst the details of the passenger injury mechanisms are still to be confirmed, it can be concluded that in a number of cases, loss of separation between the inside and the outside of the tram was a contributory factor to the severity of the injuries sustained by the passengers.

Initial review of the window and door systems has concluded that the design is compliant with standards, and performed as the design intended during the incident.

14.2.2 Conclusion

Whilst the design of the tram is as expected and consistent with practices elsewhere in UK light rail and bus systems, there is opportunity to consider implementing increased containment measures for trams within the light rail operating environment. This approach has been implemented in mainline railways in recent years as a result of several incidents where containment of passengers had been identified as an issue.

The impact of any such measures on other road users must be fully assessed, for example the impact of any increase in weight on braking distances and the consequences of collision with other vehicles and pedestrians.

14.2.3 Recommendation

Reference R8	Consider feasibility of increasing containment of tram vehicles
Recommendation	LT should consider the feasibility of increased containment of passengers from an overturn event at typical network speeds.
Background	The overturn event highlighted that the structural integrity of the tram was heavily compromised during the incident, leading to several fatalities and many injuries.



15 Summary of Recommendations

The following recommendations are made with the following categorisation:

- **Primary (P)** – those that arose directly from the events leading to the incident (including the theories stated).
- **Secondary (S)** – those that have arisen from topics either relating indirectly to the incident or that would have affected the incident and resulting events (including the theories stated)

Where the recommendations relate to a particular theory, this is stated.

- **Observations (O)** – these are recommendations based on other areas that can be improved.

Reference	Recommendation	Description
R1 (P)	Review available cues to the driver of the braking points and the approaching curve	The investigation has highlighted that further cues could be added to the current infrastructure, as to the upcoming hazards (30m radius curve, junction) at Sandilands. A review should be conducted to consider upgrading the infrastructure cues available to the driver in order to maximise opportunity for the driver to predict suitable braking in advance of the curve.
R2 (S)	Review the arrangements for the monitoring management and of speeding	TOL should review how indicators in relation to the measurement of operational speed compliance are measured and reported and whether implementing leading indicators would give useful visibility of trends, increasing their ability to focus on areas of concern and take appropriate action. TfL/LT should maintain visibility of the implementation of monitoring and any controls that are identified as a result.
R3 (P)	Review of traction brake controller (TBC) driver's safety device (DSD) design	Investigate the design limitations of the TBC, DSD and surrounding cab ergonomics in order to establish whether the TBC can be kept in the operating position by a driver who is "non-vigilant". Make recommendations to improve the design, or make additional controls, where this is seen to be reasonably practicable in line with obligations under the Health & Safety at Work etc. Act 1974 [R-10].

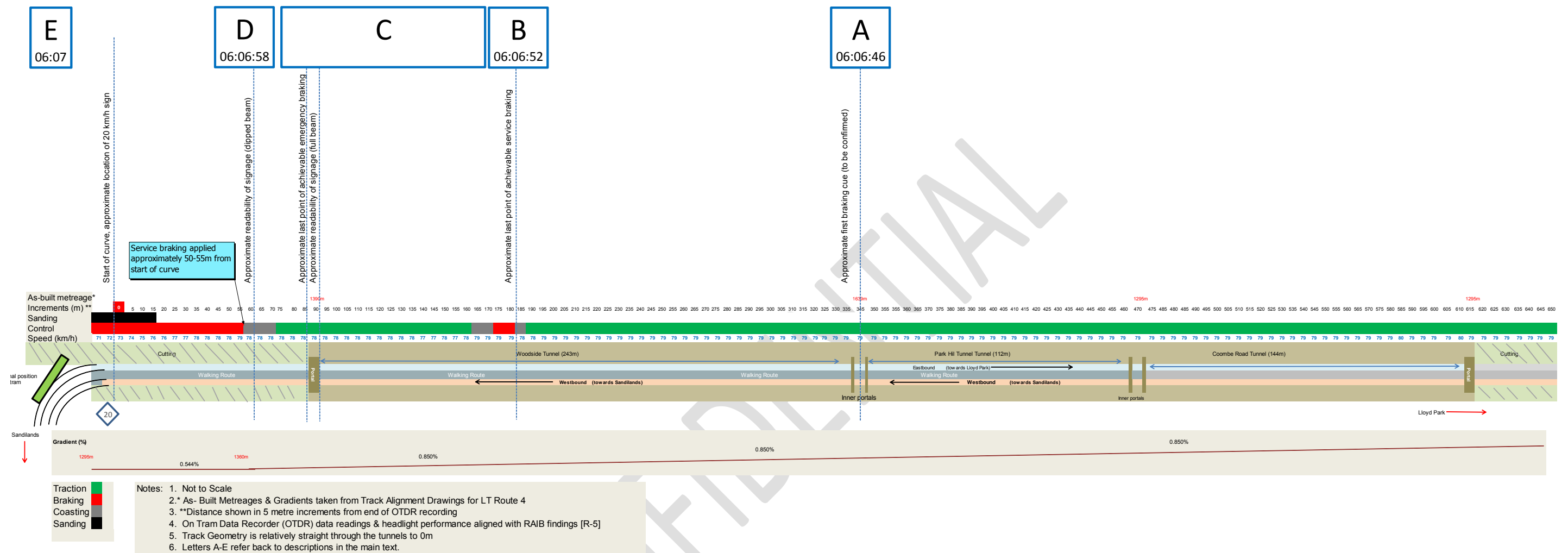


Reference	Recommendation	Description
R4 (P)	Review the arrangements for the monitoring and management of fatigue and fitness to work	<p>TOL should review how safety issues in the areas of fatigue and fitness to work are monitored in service, measured, reported and what indicators are used to monitor the success of controls in place.</p> <p>TOL should consider implementing leading indicators in areas where possible in order to gain suitable visibility from trends and increase their ability to refocus on areas of concern.</p> <p>TfL/LT should maintain visibility of the implementation of any additional controls and the results of monitoring undertaken.</p>
R5 (S)	Review route risk assessments and network risk model to reflect new understanding of risk arising from the Sandilands investigation	<p>It is recommended that LT and TOL review and update the Route Design Risk Assessment and Network Risk Model. As part of this review, LT and TOL should examine and document human factors risks and the controls put in place as a result of this investigation, identifying any additional mitigations required to reduce the risks associated with excess speed.</p> <p>Derailment scenarios should be benchmarked against those of rail operations to ensure all credible scenarios have been considered.</p>
R6 (O)	Review mechanisms used to promote Organisational Learning	<p>Both TOL and LT should further promote the use of confidential reporting systems and ensure that the outputs of these systems are used to support organisation learning.</p> <p>TOL and LT should further promote the near miss/incident reporting system in order to ensure that they are continuing to learn from incidents and near misses that occur within their organisation.</p> <p>TOL and LT should review the processes in place to capture, review, action and act on incidents and near misses in other organisations in order to learn from the lessons of failure in other systems.</p>
R7 (O)	Review near miss reporting mechanisms	<p>LT should request a review of the TOL incident reporting process in order to determine whether the process is fit to be used to escalate a potential safety issue quickly to the appropriate owner within the business.</p>
R8 (O)	Consider feasibility of increasing containment of tram vehicles	<p>LT should consider the feasibility of increased containment of passengers from an overturn event at typical network speeds.</p>

16 List of References

- [R-1] Terms of Reference provided to SNC-Lavalin on 24th November 2016. Amended 10th January 2017
- [R-2] OTDR data file
- [R-3] HMRI Authority to Operate, 19th May 2000
- [R-4] Operating Agreement, TfL
- [R-5] Rail Accident Investigation: Interim Report 2, February 2017, Fatal accident involving the derailment of a tram at Sandilands Junction, Croydon 9th November 2016. January 2017, RAIB
- [R-6] The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (ROGS)
- [R-7] Railway Principles and Guidance, Part 2, Section G – Tramways, 1997, HMRI
- [R-8] Discussion with Chris Ford, RAIB, 27th January 2017 (Wendy McCristal & Peter Howarth, SNC-Lavalin; Tom Breen, LT)
- [R-9] Railway Safety Publication 2, Guidance on Tramways, ORR, 2006
- [R-10] Health & Safety at Work Act, 1974
- [R-11] <http://www.hse.gov.uk/construction/lwit/assets/downloads/situational-awareness.pdf>

Appendix A Final sequence of events



Appendix B Review of Previous Incidents

The following review of previous speeding related incidents on the Croydon system, other light rail systems and mainline rail was undertaken. The review highlighted the potential for human failure, and how speed and control of the tram could be compromised by errors made by the driver, including loss of situational awareness.

The reported speeding on the Croydon system is also noted as a potential near miss report, that did not receive attention in time to affect the events of 9 November 2016.

Management of speeding incidents by TOL

It is understood that there have been 3 instances of formal driver disciplinary action for speeding in the last 5 years.

Reported over speeding - 31st October 2016 [B-1]

In addition to the speeding incidents above, a report was made to TfL Customer Services of an over speeding incident on the Tram network on the 31st October via email on the day of the incident. TOL responded to the email on the 2nd November indicating that they would conduct an investigation to identify the tram and the driver.

TfL did not receive any information regarding this event in the time between its initial reporting and the incident on the 9th November [B-10]. All events are recorded in a daily incident record, and shared with TfL on a periodic basis.

Manchester Metrolink - June 2016 [B-2]

A Metrolink tram is reported to have taken a 10mph curve at 28mph, causing the passengers to be thrown from their seats and causing minor injuries to three passengers. The driver is alleged to have not reported the incident; the incident came to light after passengers complained. The driver is reported to have been suspended from duties. RAIB were not requested to investigate.

Mitcham Junction (London Tramlink) - 29th December 2014 [B-3]

A tram travelling towards Wimbledon, on a segregated section of ballasted track, encountered a facing point Points Position Indicator, displaying a “failed” indication. The driver was instructed to attempt a manual operation of the points. The points were unpowered and in operating the points manually, the points were not properly fitting up and secured, resulting in the tram derailing as it passed over the points. The requirement to correctly move the point manually is described in TOL’s Tram Driver training material and assessment guidelines. However the importance of this requirement in avoiding derailments is not explicitly described to Tram Drivers in their written training material.

The investigation noted that there may be issues related to the points being damaged by trams trailing through the points at excessive speed and recommended that London Trams should consider the current capability or development of TMS to audit average speeds at selected locations on the tramway. The investigation report also noted that TOL should supply LT with copies of its regular speed monitoring reports.

Hong Kong - 17th May 2013 [B-4]

A 761P tram, running between Tin Shui Wai and Yuen Long, derailed as it took a 15 km/h curve at 41 km/h. 77 people were reported to have been injured during the incident. The tram remained upright throughout the incident. The driver was found guilty of committing a negligent act.

**New Addington (Croydon Tramlink) - 23rd November 2005 [B-5]**

This RAIB investigation considers a collision between two trams on the points leading to a single line section. The following relevant recommendations were made in the RAIB report:

- Tram Operations Ltd should carry out a programme to re-train all their drivers on the necessity to use the hazard brake in an emergency. Training and routine assessments should include understanding and demonstration by the driver in the operation of the hazard brake. The process of ‘feathering’ to avoid the final jerk should be retained (paragraph 50).
- The Office of Rail Regulation (Her Majesty’s Railway Inspectorate) should consider reviewing Railway Safety (Principles and Guidance), Part 2G “Guidance on Tramways” to include the provision of suitable over-run distances, and/or detection and warning systems at the design stage of tramway systems where they are a simple and cost effective means to mitigate against fouling point collisions at the entry to single line sections (paragraph 57).

Norbreck (Blackpool Trams) - 5th August 2009 [B-6]

This RAIB investigation considers a collision with a pedestrian at a tram stop. The following relevant recommendations were made in the RAIB report:

- BTS management should develop and document a company-wide policy for the determination and application of speed limits throughout the network. This should include a maximum speed for non-stopping trams through tram-stops. They should also develop, document, train and brief a speed limit signage policy. The purpose of this recommendation is to introduce a universal speed limit policy, agreed by all parts of BTS and a corresponding speed limit signage policy. These should both be documented. Derivation of any timetables should fully take account of the speed limits applied.
- BTS should develop and document an effective and consistent system to monitor compliance with speed limits among tram drivers, and adjust BTS recruitment, training and compliance procedures as necessary to increase levels of compliance. The purpose of this recommendation is to improve the measurement of levels of non-compliance with speed limits and bring about improved levels.

Phipps Bridge (Croydon Tramlink) - 25th May 2006 [B-7]

This RAIB investigation considers a derailment on facing points. The following relevant recommendations (now more than 10 years old) are made:

- Tram drivers must be trained to be ready to use the emergency brake without hesitation when it is necessary to do so, and this is included in the training given to drivers on the Croydon system.
- A poor relationship exists between TCL and TOL, and this has the potential to affect the safe operation of the tramway.
- Although systems and procedures exist for the co-ordinated management of safety and the exchange of safety related information between the companies, these systems are not being correctly operated. It is important that these problems are addressed before more serious consequences occur. HMRI are aware of these issues and are in discussion with both TCL and TOL, as well as Transport for London, the transport authority from whom TCL hold the concession to operate the system, to develop ways to improve the situation.
- TOL should review its driver training programme, to ensure that the training given to new drivers is keeping risks as low as is reasonably practicable (paragraph 83).

**Santiago de Compostela - 24th July 2013 [B-8]**

A high speed mainline train, travelling between Madrid and Ferrol, transitioning into ETCS area with an agreed ETCS isolation, derailed as it entered a 80 km/h curve at 190 km/h. The driver is reported to have been using a mobile phone at the time. The incident caused 80 fatalities and 144 injuries. The line has similarities in that there are multiple tunnels with reported difficulties in retaining situational awareness throughout the network but should be noted that this is a high speed system and therefore bound by a different operational concept.

Waterfall, Australia - 31st January 2003 [B-9]

A Tangara (G7) interurban train derailed at speed on a curve near Waterfall, New South Wales, Australia. Seven people were killed, including the driver, after the train driver suffered a heart attack and became incapacitated. The train was travelling at 117km/h (73 mph) on a curve designed for 60km/h (37 mph). The train derailed and overturned, and collided with the cutting sides. Neither the deadman's handle nor the guard had acted to intervene as planned in this scenario.

Philadelphia, 12th May 2015 [B-11]

On May 12, 2015, an Amtrak Northeast Regional train from Washington, D.C. bound for New York City derailed and crashed on the Northeast Corridor in the Port Richmond neighbourhood of Philadelphia, Pennsylvania. Of 238 passengers and 5 crew on board, 8 were killed and over 200 injured, 11 critically. The train was traveling at 102 mph (164 km/h) in a 50 mph (80 km/h) zone of curved tracks when it derailed. Investigation reports cited loss of situational awareness of the train driver after his attention was diverted to an emergency involving another train [B-11][B-12].

References

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Amendment Record

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1	First Issue	Rory O'Neill (LT); Jonathan Fox, Catherine Behan, Jill Collis, Jonathan Morris (TfL)	25/09/17

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