Evaluation of the Longer Semi-Trailer Trial: Annual Report 2017

A report for the Department for Transport

September 2018

Issue 1

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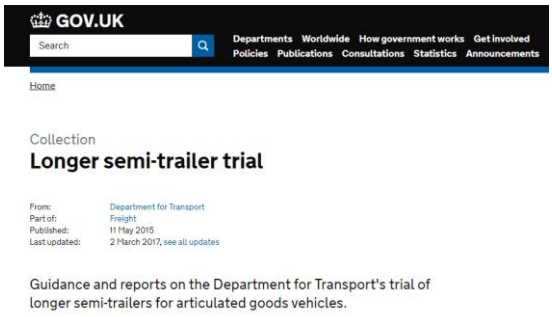
LST Trial information and contacts

The latest information regarding the trial, including participation criteria and data collection requirements, are always available from the DfT website.



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The project is sponsored by the DfT Freight Policy Group. All communications should, in the first instance, be directed to the project manager/sponsor.

Acknowledgements

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LST TRIAL EVALUATION: HEADLINES

(Rounded figures – as at 31 Dec 2017)

Trial Take Up		Revised trial target total: 2,800 LSTs
2,073 (74%)		LSTs registered on Vehicle Special Orders (VSOs[1]) (% of trial target of 2,800 trailers)
1,939 (69%)		LSTs on the road and submitted trial data (% of trial target of 2,800 trailers)
163		Number of operators with trailers on the road
Utilisation and km saved		
3.6m		Journey legs travelled by LSTs during the trial
443m		km travelled by LSTs during the trial, estimated to be: **85% Trunk / 13% Principal / 2% Minor Roads**
29.3 –32.9m		Vehicle km 'saved' by LST operations (end 2017) Lower - Upper bound (includes some return legs)
Journeys saved		Estimates of equivalent 'standard trailer' journeys saved across whole trial period and all operators
235-270,000		Journeys by 13.6m trailers saved by using LSTs Lower - Upper bound (includes some return legs)
1 in 14 (7%)		Average saving across all operators 1 in 'n' journeys (x% distance saved)
1 in 8 (13%)		Highest saving achieved by individual operators
Emissions saved		Estimates compared to the emissions from delivering an equivalent quantity of cargo on 'standard trailers'
To date	**To 10 yrs**	Savings of CO, PM (Exhaust) and VOC also calculated.
28,000	**67,000**	**CO2(e)[2]** Tonnes of CO2(e) 2012-2017.
141	**336**	**NOx** Tonnes of NOx 2012-2017 of which 6.2% saved on roads within 200m of 'Designated Areas'

[1] A VSO grants permission for a specific operator to operate specific special trailer(s) on GB roads for the duration of the VSO. All LSTs require a VSO to operate. The operator must apply to the Vehicle Certification Authority (VCA) for a VSO before the trailers are used on the road, citing all the trailer Vehicle Identification Numbers (VINs). This is often done as soon as the VINs are fixed by the manufacturer during build

[2] Carbon dioxide equivalent" or "CO2e" is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO2e signifies the amount of CO2 with an equivalent global warming impact

Injury incidents – National

Collisions	Casualties	*Collisions / Casualties where LST involved **on public highways or public access areas** (2012-2017) resulting in injury*
22 (3)	**31 (3)**	**All personal injury incidents involving an LST** (Brackets show incidents/casualties judged to be 'LST Related')
45	**72**	**Three-year average safety incident rate (ALL collisions or casualties per billion vehicle km, 2015-2017)**
156	**223**	**Equivalent three-year rate for all GB articulated HGVs, 2014-2016(per billion vehicle km (bvkm)**
0.29	**0.32**	**Collision/Casualty rate ratio (LST vs All GB Artic. HGVs)**

On a per kilometre basis, nationally, LSTs have been involved in around 70% fewer personal injury collisions and casualties than GB articulated HGV average.

Injury incidents – Urban Only / Minor Road Only

Collisions		*Collisions / Casualties where LST involved **on public highways or public access areas** (2012-2017) resulting in injury*
URBAN	**MINOR**	URBAN = ONS Urban areas - excluding motorways MINOR = Operations OFF Motorway/Trunk /Principal roads
3	**2**	**Personal injury incidents involving an LST** (All – regardless of any 'LST Related' judgement)
52	**226**	**Safety incident rate (collisions per billion vehicle km) over whole trial for distance est. of 13.1% Urban and 2,0% Minor**
560	**973**	**Equivalent rate for all GB articulated HGVs (per bvkm)**
0.09	**0.23**	**Collision rate ratio (LST vs All GB Artics)**

On a per kilometre basis, compared with the average for all GB articulated HGVs, LSTs on the trial have been involved in 90% fewer personal injury collisions per km when operating on roads in urban areas and 72% fewer when on minor roads

Damage-only incidents 1 damage-only event reported to the trial for every:

1 in 2.6m km **1 in 20,000 legs**	**Further work on damage incident rates is planned, using results from the 2018 revised data collection framework**

Intermodal effects of introducing LSTs

The introduction of ISO longer containers carried by LSTs and rail is sufficient for rail to protect its market against increase in load capacity of LSTs for road-only operations, but not sufficient to draw additional freight onto rail. The introduction of LSTs during the trial was a second order influence on operators' modal choice.

Executive Summary

The Department for Transport (DfT) is evaluating the impact of the operation of longer semi-trailers (LSTs) on Great Britain's (GB) roads. These trailers are up to 2.05m longer than the standard 13.6m units commonly seen on the roads in this country. DfT launched the 10-year trial in 2012, permitting up to 1,800 to operate under Vehicle Special Orders (VSOs) granted by the Vehicle Certification Agency (VCA). Following a consultation process during 2016, DfT announced an extension to the trial with a further 1000 trailer allocations being offered from 1 April 2017. At the time of writing around 200 trailers remain to be allocated and all the trailers are expected to be on the road during 2019.

The trial is designed to evaluate the impact of LST operations on efficiency, emissions and safety. A reduction in emissions may be expected because the increased trailer length should allow the same quantity of goods to be transported in fewer journeys. Evaluation of the trial will determine whether this potential reduction in emissions is realised, without a detrimental effect on safety. The trial is also considering the issue of non-injury incidents resulting in asset damage.

This report contains a full analysis of the data to the end of 2017.

LST Trial Public Summary

As in 2016, this main report will be published in parallel with a Public Summary, also authored by Risk Solutions. This is in response to increased interest from individuals in the public sector, haulage industry and civil society groups who have a valid interest in understanding the key results of the trial, and the evidence supporting them, but do not necessarily have the resources to study the main report in depth. The public summary will contain references to the relevant sections of the main report to allow direct access to the source of all key results.

This Executive Summary

The Public Summary will, for most readers, serve the purpose of an executive summary to the main report and so we have not sought to reproduce that overall narrative summary of results in this executive summary. Instead we focus on three areas:

1. Summarising the key results behind the 'headlines', for the informed reader
2. Summarising the current status of the trial in relation to the key questions it is intended to address (See also Section 9 of the report)
3. Stating the recommendations we have for the trial, which this year, are updates to recommendations made last year, on which work is ongoing.

A Summary of key results

Trial inputs and activities

- The original **planned LST fleet of 1800 trailers was on the road or on VSO at the end of 2016**. Following the extension of the trial in April 2017 to permit another 1000 LSTs, around 200 of these are on the road and another 600 allocated.
- There is a good mix of trailer designs, including single/dual deck, flatbed and skeletals, including a design carrying bespoke 50-foot ISO containers on a road-rail operation. About 70% of the trailers self-steering axles and 30% command-steer.
- Qualitative feedback suggests that experience with the trailers continues to be positive for a clear majority of participants.

Intermodal effects of introducing LSTs

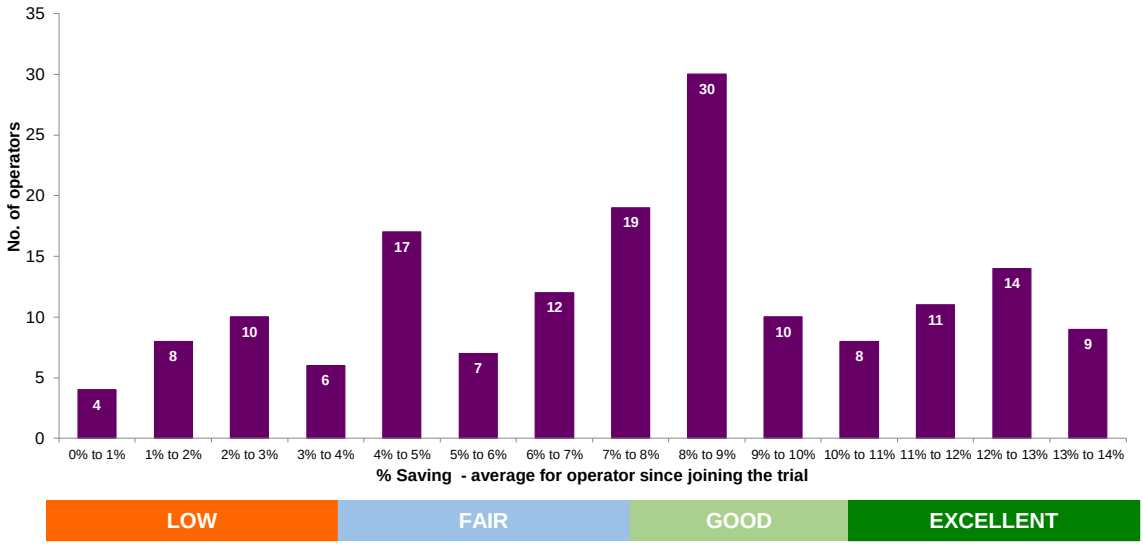
- Although the trial focus is on the operation of LSTs on the road, one of the key areas of the work in 2017 has been to assess whether the availability of LSTs would have a material effect on the amount of intermodal freight movement, given the increased capacity of the LSTs compared to other standard trailers.
- The pre-trial analysis put forward two scenarios:
  a. **No LST+Rail option** – the baseline in 2011 when there was no design for a 50ft intermodal container (i.e. to fit an LST) nor any experience of moving such a container within existing rail freight operations. In this scenario, the pre-trial analysis forecast a significant move of freight from existing/forecast rail to road.
  b. **With LST+Rail option** – in which the necessary container was designed and built and shown to be compatible with existing rail freight operations. In this scenario, the pre-trial assessment forecast a move of freight from road to rail.
- We have carried out a new study of the potential intermodal effects of LST availability, with the benefit of insights not available to the pre-trial study, including:
  - Six years of real world LST operational experience informing discussions on this topic with stakeholders and operators from the road and rail sectors
  - Demonstration of a company incorporating a 50ft container (which they designed) into an existing road-rail operation alongside 45ft units
  - More recent freight market studies and DfT Rail Freight Strategy
  - Changes in the market for rail freight wagons compatible with 50ft units
- The new study concludes that:
  - **Overall where routes operating LSTs (during the trial) might have competed with rail at a limited level, rail has been able to respond effectively and integrate LST operations into its business model.**
  - **This LST+Rail option will not allow rail to increase its forecast volume, but is effective enough to avoid rail losing potential traffic to LSTs.**
  - **The effect of introducing LSTs can be regarded as neutral or at least a second order influence on operator's modal choice**
- The main themes in the discussion of why this is the case are show below.

Theme 0	The introduction of the trial LSTs on the trial has not been a factor in decisions to use/not use of rail. The availability of LSTs with a slightly larger load capacity, is a second order influence on their decisions. The primary influences are in Themes 1-4
Theme 1	The limited number of rail-connected distribution centres (depots) remains a major constraint on any decision to use rail
Theme 2	Highly variable demand for freight requires flexibility (which road can currently meet better than rail)
Theme 3	Collection and delivery time criticality for many commodities (which road can currently meet better than rail.
Theme 4	For price to become a dominant factor, such that freight will move from rail to road, the additional load per vehicle would need to be much more than the saving of 15% or less offered by LSTs. Double-Deckers are the competitor to both LST and rail (rather than LSTs competing with rail).

- A more detailed presentation of the study is included in the report as Annex 3.

Trial outcomes 1a: Distance/journeys saved

- LSTs are operated at high levels of utilisation.
  - Empty running of LSTs is only 2/3 that for regular semi-trailers
  - LSTs have used the full additional length for 34% of their distance travelled, with all or part of the additional length in use for around 54% of all distance.
- We estimate that around 30% of all distance covered by LSTs includes a leg to or from a retail site, taking into account the analysis of empty return legs.
- Since the start of the trial, the use of LSTs has removed between 29 and 33 million vehicle kilometres of freight traffic from the roads of Great Britain, equating to 235-270,000 journeys saved. The chart below shows the percentage distance saved by different numbers of operators on the trial.



Distribution of % distance saved using LSTs, by operator

- These results now reflect actual journey/distance savings, where as in previous reports an adjustment was made for potential increases in fuel use (and hence emissions) when pulling an LST. Emissions are now addressed in a separate model.
- The average percentage distance saving is 7%, which **equates to 1 in 14 journeys**.
- The most efficient LST operations are saving up to 1 in every 8 journeys, close to the theoretical maximum (excluding the fuel use adjustment).
- Individual company LST utilisation results were checked with operators in 2016/17, and were confirmed as being consistent with their understanding of performance.

Trial outcomes 1b: Emissions saved

- The results of modelling described in Section 6 provides results not just for Carbon Dioxide, but for six separate emissions, with spatial analysis by road type and a selection of areas for which emissions are of particular interest.
- The results are presented both for the trial to date and projected forward to the nominal trial end point(s) and are shown in full in the summary table below.
- The emissions savings are expressed as a tonnage saved compared to a counterfactual of moving the same quantity of goods on 13.6m trailers rather than LSTs. The results are, as might be expected, around 7% overall, close to the average saving in distance noted above.

LST TRIAL EMISSIONS SAVINGS SUMMARY

FLEET SCENARIO:		**S2: WHOLE FLEET TO 15 Yr**		
ASSUMED ADDITION RATE - TRAILERS PER PD:		**114**		
RESULTING PROJECTION - PERIOD ALL ON ROAD:		**2020-P2**		
(All figures rounded)	units	**To Date**	**10yr Trial**	**Extended Trial**
		End 2017	**End 2021**	**End 2026**
Trial fleet stats (Actual/projected)				
LSTs on road		1,939	2,800	2,800
Total journey legs	million	4	8	15
Total distance covered	million km	443	1,055	1,889
SAVINGS:	tonnes			
Carbon Monoxide	CO	17	40	71
Carbon Dioxide equivalent	**CO2e**	**28,180**	**67,030**	**120,066**
Oxides of Nitrogen	**NOx**	**141**	**336**	**602**
Particulate Matter (Exhaust)	PM Exhaust	2	4	6
Volatile Organic Compounds	VOC	3	8	14

- If we consider the key metrics of CO2(e)[3] (as a dispersed emission) and NOx (as a localised emission) we estimate:
  - **A net reduction from TRIAL TO DATE of around 28,000 tonnes of CO2(e) and 141 tonnes NOx, as well as other emissions**.
  - **A PROJECTED net reduction if the trial were to run to the original 10 year end point of around 67,000 tonnes of CO2(e) and 336 tonnes NOx, as well as other emissions**.
- In terms of impact on geographic areas of particular interest, the analysis shows that for the trial:
  - **15% of the emissions savings noted above are being made in Air Quality Monitoring Areas (AQMAs)** where air pollutant concentrations already exceed or are likely to exceed relevant air quality objectives defined by Defra
  - **6.2% of the emissions savings noted above are being made within 200m of one or more Designated Areas (SAC, Ramsar, SSSI, SPA)** – areas which have cited features that are sensitive to changes in ambient NOx, nitrogen deposition and acid deposition that can be brought about by changes in traffic emissions of NOx – particularly from roads within 200m.

[3] Carbon dioxide equivalent" or "CO2e" is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO2e signifies the amount of CO2 with an equivalent global warming impact

Trial outcomes 2: Safety impact (Injury incidents)

Safety benefit from saved journeys

- **There is a direct safety benefit of around 5% reduction in collisions in delivering a fixed quantity of cargo using LSTs rather than standard 13.6m trailers due to the reduction in the number of journeys.**
- This is in addition to the safety comparison discussed below on a 'per km' basis.
- This is equivalent to around 2-3 collisions and 3-4 casualties saved during the period of the trial.

Incident collection and categorisation

- All incidents involving LSTs on the road or in public places, whether or not an injury took place, must be reported to the trial as part of the undertaking signed by operators. Injury incidents in depots/private land must also be reported.
- There have been no fatal accidents involving LSTs in 443 million km of operation.
- The injury events reported on the trial are broken down by location and severity in the table below. Events are also classified by whether it was judged to be LST related (i.e. it would not have happened with a regular 13.6m trailer). However, all injury analyses presented in the report are based on the figures for ALL incidents occurring on the road or in other public places.
- In each year, we review the incidents not only for the statistical calculations, but to explore events of special interest, perhaps because they occurred on minor roads or in built up areas, or because the behaviour of the trailer was unusual.
- There were four additional incidents in 2017. None were judged to be LST related and all occurred on major public roads (A roads or motorways).

Injury Collisions from Trial Logs	Total Collisions	Total Casualties	Fatal	Serious	Slight
All Injuries (inc depots etc.)	**27 (23)**	**36 (28)**	0	10 (7)	26 (21)
All Injuries in Public Road/Place	**22 (18)**	**31 (23)**	0	10 (7)	21 (16)
All Injuries judged LST-related (any location)	**7 (7)**	**7 (7)**	0	0	7 (7)
All injuries – LST-related AND in public place	**3 (3)**	**3 (3)**	0	0	3 (3)

Figures in (brackets) show the totals at the end of 2016. The injury incident analysis in this report is based on all public incidents, i.e. the figures in the row outlined in RED

Injury incidents involving LSTs reported on the trial (2012-2017)

Injury incidents comparison to other semi-trailers - NATIONAL

- **When measured across all road types, the LSTs on the trial are being operated as safely if not more safely per km, than the trailers they replace.**
- Nationally, LSTs have been involved in around 70% fewer personal injury collisions and casualties, compared to the average for GB articulated HGV Injury incidents (based on STATS19 data) operating over the same distance (based on DfT Data), at a 95% confidence level.

Injury incidents comparison to other semi-trailers – URBAN / MINOR

- A key question for the trial has always been whether an acceptable safety record overall might mask an increase in risk on the relatively small proportion of distance on urban operations, which we first reported on last year, or on roads other than the main motorway/trunk/principal network.
- We have now updated the route modelling done last year, validating its choice of route against a large sample of real GPS data for articulated HGVs (including, but not limited to LSTs) operating on actual LST routes.

Urban

- By mapping the LST routes against the ONS Urban Areas – the same basis used in all DfT freight statistics, the model estimated that in 2017 the LSTs ran on roads in urban areas (excluding motorway) for 13.1% of their total operating distance, compared to an average of 5.8% for the GB articulated HGV fleet as a whole.
- There have been 3 injury incidents involving LSTs on roads in ONS urban areas reported on the trial to the end of 2017.
- **Based on 13.1% urban operation our analysis suggests that the LSTs on the trial are being operated as safely, if not more safely, than the trailers they replace, when considering running only on roads in ONS defined urban areas (excluding motorways).**
- This result is statistically robust at a 95% confidence level.
- This conclusion remains statistically valid for all cases where the proportion of LST operation on urban roads (excluding motorways) is assumed to be the same as or greater than that for the wider GB semi-trailer fleet.
- This urban% is higher than the 8-9% calculated last year. This is largely due to the incorporation of a substantial set of data from two operators whose most frequent routes use large sections of major roads (including dual carriageways) which happen to fall within the ONS Urban Area of the towns they are bypassing. This demonstrates the weakness of using the ONS Urban Areas as a proxy for the area of real interest, which is the operation of large vehicles away from the Trunk/principal road network. (see below).

Minor Roads

- In the updated route modelling in 2017, the Ordnance Survey Integrated Transport Network (OS ITN) data on road type and class for every link in every route is collected, allowing us to re-analyse the routes by road type. This has two benefits:
  - It addresses the problem of the inclusion of major roads in Urban Areas, noted above, since Minor Roads are much better proxy for looking at roads where an HGV would be most likely to encounter other roads users in confined spaces, confined lanes, vulnerable road users, or be making sharp turns.
  - It allows us to calculate the injury rate by road type (Motorway, Trunk/Principal, Minor) in the same detail as DfT publishes data for HGV traffic (TRA3105)
- When viewed by road type, the route modelling estimates that:
  - 85.4% of the LST distance covered was on Trunk Roads (Motorways and A roads operated by Highways England or the equivalent in Scotland and Wales)
  - 12.6% was on Principal Roads (A roads operated by local authorities) and
  - 2.0% was on Minor Roads

- There have been 2 injury incidents involving LSTs on Minor Roads reported on the trial to the end of 2017.
- **Based on 2.0% operation on Minor Roads, our analysis suggests that the LSTs on the trial are being operated as safely, if not more safely, than the trailers they replace, when considering running only on Minor Roads.**
- This result is statistically robust at a 95% confidence level.
- This conclusion remains statistically valid for all cases where the proportion of LST operation on Minor Roads is assumed to be the same as or greater than that for the wider GB semi-trailer fleet.

Trial outcomes 3: Property damage

- Estimates of damage events, where an LST was involved and the trailer's design has not been explicitly ruled out as a contributory factor, are:
  - 1 reported damage only event for every 2.5 million km travelled by the LSTs
  - 1 reported damage only event for every 20,000 journey legs operated by LSTs

Damage incident rates for LSTs vs other trailers

- In the last year's annual report we noted the challenges of comparing damage incident rates of LSTs to other trailers, since there is no national dataset for the non-LSTs. A small scale comparison of damage incident rates across their LST and non-LST fleets for 7 operators showed that in a small number of cases, the LSTs might be experiencing a higher incident rate than the fleet as a whole.
- As a result of our recommendation last year, the incident log template used to gather data was replaced as from 1 January 2018 and now incorporates more narrative evidence of the severity of damage to the trailer and any objects hit in the collision and, crucially, a requirement to report summary figures for incidents and total distance for the non-LST trailers in the fleet where the LSTs are being used.
- Results from this new-format incident data will not be available until we have gathered and analysed the 2018 data.
- The other area of interest here is whether there is any correlation of damage events with specific trailer design elements, in particular the kick-out, which is itself related to the choice of steering design (self or command steer).
- Although only very weak statistical correlations to any design feature were found in work undertaking in 2016, we still believe this is an important area that DfT will need to take into account when considering any wider roll-out of LSTs. This is because they will need to decide whether the same range of design features permitted on the trial should continue to be allowed, or perhaps, whether operational restrictions would be applied to certain designs.
- We anticipate the rationale for adopting certain designs of trailers to be one of the topics discussed in the industry and stakeholder engagement in Autumn 2018.

B Status of the trial

- As the trial has progressed, the nature of the questions the Department has wanted to pose has changed slightly and in 2016 we re-articulated the issues above in seven questions, published in the 2016 Annual Report Summary. They are shown in the table below, with a summary of the status of the trial in terms of generating sufficient evidence to inform a future impact assessment in each area.

Q1 What do operators use LSTs for?	**Q1-Q4: STATUS: READY** While the trial continues to gather data in other areas, we believe the evidence we have already gathered in this area would be sufficient to inform a future impact assessment
Q2 What are the savings realised in HGV journeys?	
Q3 What are the resulting reductions in emissions?	
Q4 What about safety – will LSTs cause more injuries?	
Q5 What about damage and the associated costs – will LSTs cause more damage on the roads?	**STATUS: ONGOING** While we have damage data for all operators, comparative data for non-LSTs has only been gathered for a sample of operators. Further data for all operators is being gathered in 2018 and will be required to inform a future policy impact assessment
Q6 Might any special operational requirements be appropriate for LSTs?	**STATUS: ONGOING** Some qualitative data and suggestions are available. A series of conversations with industry and stakeholders is planned to inform a future policy impact assessment.
Q7 What proportion of the existing GB fleet of semi-trailers might be replaced by LSTs, were numbers not restricted?	**STATUS: ONGOING** Initial estimates from the operators on the trial are available. We need to expand this data to include a range of operators who have not participated in the trial, in order to fully inform a future policy impact assessment

C Recommendations (Ongoing)

- We have no completely new recommendations arising from the work in 2017.
- We do have some updates to recommendations made last year, where work has started but is still ongoing and we are reporting on progress against each one.
- A more detailed version of this table is shown in Annex 1.

2016 Recommendation	2017 Progress / Update
2016-1 Industry Engagement	Discussions took place mid-2017 but for a number of reasons it was not possible to arrange an event in 2017. Engagement webinars (20) around the new data framework took place in Jan-Feb 2018. Further engagement is now being planned for Autumn 2018 - see Section 9 of the report.
2016-2 Understanding low efficiency use of LSTs .	We have some insights from the QSF2 data (presented in this report). The most common causes are intermittent demand, lack of control over loading density (e.g. third-party logistics companies or general hauliers on per-load contracts) or simple inertia in decisions to sell unproductive LSTs. Further discussion of these issues may arise in the engagement noted above.
2016-3 Technical appraisal of LST 'course correction at speed'	This action lies with DfT who have stated that: "DfT officials are reviewing the behaviour of LSTs when they are subjected to a sudden course correction at speed as part of a review of the performance of the whole range of axle steering options in operation on the trial."
2016-4 Understanding the underlying basis for LST design variation	We have had some initial discussions with manufacturers on this topic and it is planned to be a primary topic for the consultations planned for Autumn 2018.
2016-5 Increasing data on the relative rate of LST damage incidents to those of all trailers in the fleet of each operator	The new data framework launched from January 2018 has been designed to increase the flow of data on damage incidents, including their nature and severity along with non-LST incident totals for the same fleets. Analysis of this new data will be carried out once we have 2-3 periods of data. The issues of route familiarity etc. will be addressed by the planned selected operator visits in 2018 and the consultations noted above.
2016-6 Increasing data on the nature and severity of damage incidents involving LSTs	
2016-7 Preliminary assessment of future impact of LSTs – scaling up and emissions assessment	The first step in this process has been completed with the projections of emissions savings to the end of trial presented in this report (See Section 6). The second stage, scaling up to a hypothetical roll out of LSTs is scheduled to start in August 2018 and should be completed in early 2019.
2016-8 Preliminary exploration of possible post-trial requirements or guidance for operating LSTs	Risk Solutions and DfT have had some initial discussions with FTA, RHA and SMMT in this area and have further stakeholder meetings planned which will consider options. We plan to test some of those options in wider consultation beginning in the Autumn of 2018, following publication of this report.

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PROJECT NOTES

Separate technical papers published alongside this report.

- **Project Note E1: LST Routing and Operational Analysis by Road Type**
  September 2018 SPATS 1-403 PN-E1-v4-2
- **Project Note E2: LST Emissions Savings**
  September 2018 SPATS 1-403 PN-E2-v4-1
- **Project Note E3: LST Intermodal Effects**
  September 2018 SPATS 1-403: PN-E3-v4-1

TABLES

FIGURES

1 INTRODUCTION

1-1 The LST Trial

The original GB longer semi-trailer trial launched in 2012

1.1 The Department for Transport (DfT) is running a trial of the operation of longer semi-trailers (LSTs) on roads in Great Britain (GB). These trailers are permitted to be up to 2.05m longer than the standard 13.6m units commonly seen on the roads in this country.

1.2 A trial was created to gather evidence about the operational performance of LSTs in terms of safety, environmental impact and economics.

1.3 The trial was scheduled to last for 10 years from its launch in 2012 and allowed up to 1800 LSTs to be built and operated. The first semi-trailers were granted Vehicle Special Orders (VSOs)[4] early in 2012 and data collection began on 1 May 2012

1.4 In order to participate in the trial, hauliers sign an 'Operator Undertaking'. Submitting data to inform the trial evaluation is a key condition in this undertaking.

1.5 The outputs from the trial will feed into a decision about whether to permit an increase in the length of semi-trailers authorised for operation on roads in GB under normal regulatory requirements (i.e. without a VSO).

1.6 More broadly, subject to acceptable outcomes in terms of safety and property damage, the trial will contribute to DfT's work to:

- identify de-regulatory measures to reduce burdens on business; and
- identify measures to reduce carbon emissions from HGVs.

1.7 Further details about the trial can be found on the DfT website[5].

DFT extended the trial from 1 May 2017

1.8 In January 2017, DfT agreed to extend the number of semi-trailers in the trial by 1000 trailers and extended the prospective trial length by 5 years, to 2026/7. This followed an industry consultation during 2016.

1.9 In March 2017, DfT invited operators to bid for a share of this additional allocation. This new allocation of LSTs entered service from 1 May 2017.

1.10 Details of the trial extension and consultation can be found on the DfT website[6].

1.11 For the first six years of the trial the data collection requirement was quite onerous, with details of each journey made by each trailer reported and analysed in detail. The datasets collected have provided a rich picture of the performance of LSTs, and this is reported here. The stability of the datasets generated in this way, and the level of detail collected, enabled DfT to reduce the burden of data collection on operators at the end of 2017.

1.12 From the start of January 2018 (2018-P1) a new data collection framework has been introduced. This framework reduces the emphasis on capturing the detail on every journey made by each trailer, requiring only summary data on overall trailer operation. Instead the focus has shifted to capturing an increased level of detail on any incidents

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[4] A VSO grants permission for a specific operator to operate specific special trailer(s) on GB roads for the duration of the VSO. All LSTs require a VSO to operate. The operator must apply to the Vehicle Certification Authority (VCA) for a VSO before the trailers are used on the road, citing all the trailer Vehicle Identification Numbers (VINs). This is often done as soon as the VINs are fixed by the manufacturer during build

[5] Trial general information: https://www.gov.uk/government/collections/longer-semi-trailer-trial

[6] Trial extension 2017: https://www.gov.uk/government/publications/longer-semi-trailers-guidance-and-application-form

that have occurred and requires operators to provide more comparable details about non-LST incidents and vehicle-kilometres in the period for their non-LST fleet.

1.13 **This report concerns the performance of the LST fleet on the road up to the end of 2017, reported under the old data framework. Data from January 2018 onwards will be available in 2019.**

1-2 The evaluation of the trial

The trial is being evaluated independently

1.14 In December 2011, the Freight, Operator Licensing and Roadworthiness Division (FOLR) of the DfT commissioned Risk Solutions to:

- Design a process to collect data to support the evaluation of LST operational performance
- Set up the initial systems for data collection
- Initiate the process and support participants during the first year of the trial (2012)
- Report on progress achieved during the year.

1.15 Having an independent evaluator serves two purposes:

- The raw operational data remains confidential – it is not seen by or available to DfT or any party other than the originating company and Risk Solutions. The details of individual operations are commercially sensitive to operators and without this arrangement many of them would not have been willing to participate or would have only agreed to provide summary data.
- The analysis of the data and the conclusions are being made independently of DfT. While it is the case that Risk Solutions are commissioned by DfT, we are clear that our role is to bring forward only analysis and conclusions that can be reasonably supported by the data. We provide an effective challenge function for DfT, helping ensure, as far as possible, that press releases and department briefings are fully consistent with, and supported by, the evidence. Our experience has been that DfT has always responded well to this aspect of our role as independent evaluators.

1.16 Risk Solutions was re-commissioned to continue in the role of independent evaluation consultant for the trial in 2013, 2015 and 2017. The company was re-appointed for the period 1 January 2018 to 31 December 2019, via a competitive process.

The evaluation framework follows broad HM Treasury principles

1.17 The primary objective of the trial is to provide evidence to DfT to support long term policy decisions on **"…. the most socially beneficial length of Heavy Goods Vehicle semi-trailers"**[7]. The specification of the trial, to allow trailers of the two length categories (up to 14.6m and up to 15.65m) that otherwise match all existing regulatory standards, flowed out of the impact assessment and the analyses done to support it.

1.18 The evaluation process needs to operate at two levels:

- Primary evaluation of outcomes – analysis that can inform the response to core questions:
  - Do longer trailers carry at full capacity?
  - Do longer trailers result in fewer vehicle trips or vehicle kilometres?
  - Do longer trailers result in more or different types of accidents? Is there potential for using extra safety devices on longer trailers?

[7] 'Impact Assessment of Longer Semi-Trailers', DFT00062 15/12/2010.

- What kind of operations are longer trailers used for? For example, what routes, trips, commodities and roads are they used on?
- Does the pattern of usage differ significantly from the assumptions made in the original Departmental Impact Assessment?
- Can the existing infrastructure (including roads, delivery depots and parking) cope with longer trailers? Does existing infrastructure limit their potential use?
- Do real world operations identify any additional operational issues, risks, costs or benefits not identified in the Department's original research?

- Secondary evaluation – analysis to assess
  - The extent to which the trial process and the resulting data have produced a robust data source, and
  - The issues that will need to be considered in applying the results to any impact assessment of the wider use of LSTs, beyond the trial.

1.19 The HM Treasury Magenta Book ('Guidance for Evaluation')[8] recommends use of a programme logic model (PLM) for all policy evaluation. The PLM provides a structure for evidence gathering, collation and analysis, mapping how the inputs, key activities and outputs are used to deliver the desired outcomes.[9]

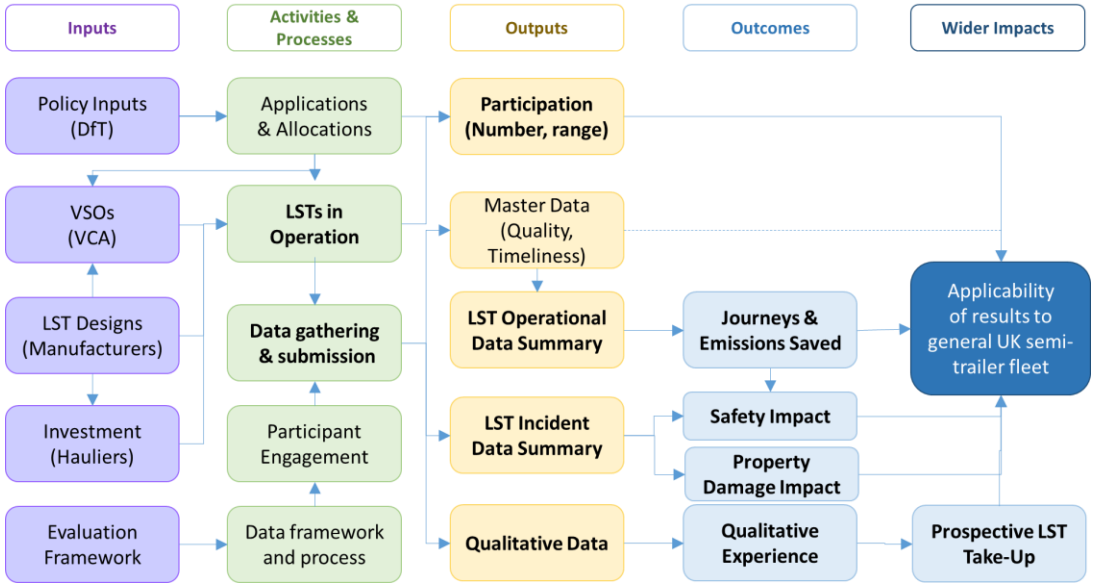


Figure 1: LST Trial Evaluation Programme Logic Model

1.20 Figure 1 shows the PLM for the LST trial evaluation. Some elements of the model, and the progress being made on them, can be expressed as metrics (e.g. How many operators have been signed up? How many LSTs are operating compared with the planned total?). Others may only be expressed qualitatively as no numeric target was set at the start of the trial (e.g. Has the trial attracted a broad range of operator types and sizes as was hoped?).

1.21 Where metrics were explicit in the original formation of the trial (e.g. 1,800 LSTs on the road), they are clearly identified in this report and progress against them will be

[8] 'The Magenta Book: Guidance for Evaluation' HM Treasury April 2011 (available from .GOV) See also 'Logic Mapping: hints and tips for better transport evaluations' Tavistock Institute for DfT October 2010.

[9] An expanded explanation of PLMs as outlined in the HMT guidance is given in Appendix B of the 2014 Annual Report.

evaluated as the trial continues. Where no quantitative measure can be established, progress is reported qualitatively.

1.22 Annex 2 summarises the extent to which the evaluation to date covers the PLM.

1-3 This (sixth) trial annual report

Evaluation updates are published annually

1.23 Results from the LST operations have been reported annually for the first five years of the trial, 2012-16[10]. Terminology used in the trial and data collation is also defined in those earlier reports. Major terms appear in a glossary at the end of this report.

1.24 This **sixth** annual report largely follows a similar structure to previous years. Previous reports described the trial data collection and analysis methodology in detail. The core processes have not changed significantly since 2013, so this information will not be repeated and can be found in 2015's report[10].

1.25 The report has been structured to align with the evaluation stages as follows:

Part 1: Trial inputs, activity and outputs

1.26 **Section 2**: Discusses **inputs** to the trial, including progress on the allocation of places on the trial and the process of collecting data for the evaluation

1.27 **Section 3**: Discusses progress on the **activities and processes** of bringing participants into the trial and managing the data collection and submissions.

1.28 **Section 4**: Presents and discusses trial **outputs**, including the key raw results.

1.29 Section 4 also contains a summary of the results from the qualitative surveys of the operators' experience of using LSTs.

Part 2: Trial outcomes

1.30 At the start of Part 2, we discuss the new work done this year on the relationship between **LSTs and the intermodal** (mainly road/rail) freight market, and the relevance of this to the calculation of trial emissions and safety impacts.

1.31 Section 5 presents the analysis of **potential savings in journeys and distance travelled**. This is important as it provides the basis for analysing carbon savings being realised on the trial and is an important contributor to reductions in personal and non-injury accidents.

1.32 Section 6 discusses the new work done this year to calculate the **emissions savings arising from the LST Trial,** including carbon and other pollutants.

1.33 Section 7 presents the analysis of **personal injury incidents**. This is vital to establish whether there are any indications that LST operations are increasing **safety risk** (relative to other traditional trailers), particularly to other road users and vulnerable groups.

1.34 Section 8 presents the analysis of **non-injury incidents**. This seeks to assess the **damage to property** (infrastructure or other vehicles) caused by LSTs, in comparison with other trailers. This work has been expanded since the 2015 report.

1.35 Outcomes in terms of **qualitative experience**, based on qualitative surveys of operators, have been inserted into relevant sections throughout this report rather than in a separate section. The most recent qualitative survey (carried out in 2016-17) was also designed to check our understanding of the data in different areas of the analysis.

[10] Evaluation of the high volume semi-trailer trial: annual reports for earlier years https://www.gov.uk/government/publications/longer-semi-trailer-trial-evaluation-annual-report-2015

Part 3: Wider impact and conclusions/recommendations

1.36 Section 0 discusses **wider impact** issues relating to the future use of LSTs.

1.37 Section 0 brings together **the key conclusions** from the work to date and **recommendations for the next stages of the evaluation**.

1-4 New analysis in this report

This report introduces a number of new or extended evaluation analyses

1.38 The data sources, collection and analysis methods have been fully described in earlier annual reports. In this report we have only included notes of any amended or new methods or processes.

1.39 We have highlighted specific sections of this report that cover new or extended analysis compared to the 2016 report in Table 1.

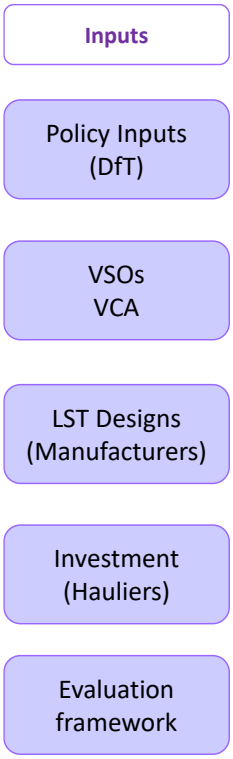
1.40 The full details of three major 'Special Topic Analyses' are being made available as separate documents alongside this report and can be found on the DfT website.

Table 1: New or extended analysis since the 2016 annual report

	Special topic analysis	Location in report
STA E1	Updated LST operational analysis by road type, following validation and refinement of the routing model using GPS samples *[Risk Solutions]*	Section 4 Page 21 and relevant parts of safety and emissions discussions. **Full Document:** Project Note E1: LST Routing and Operational Analysis by Road Type September 2018 SPATS 1-403 PN-E1-v4-2
STA E2	Analysis of emissions savings from the trial *[WSP and Risk Solutions]*	Section 6 Page 38 **Full Document:** Project Note Note E2: LST Emissions Savings September 2018 SPATS 1-403 PN-E2-v4-1
STA E3	Study of the actual and likely future effects of LST availability on intermodal freight *[WSP]*	Annex 3 Page 97 Full Project Note: E3: LST Intermodal Effects September 2018 SPATS 1-403: PN-E3-v4-1
QSF2	An extension of the data reported from the Qualitative Survey 2, including initial responses from operators on the trial regarding their prospective take up of LSTs if they were more widely available.	Section 4 Page 27

PART 1: TRIAL INPUTS, ACTIVITY AND OUTPUTS

2 TRIAL INPUTS



2-1 Policy inputs

The policy framework for the trial is currently as defined in 2011

2.1 The framework for the trial, established by DfT at the end of 2011, has remained largely unchanged. Full details are on the DfT website.[11]

The 2017 additional allocations have almost all been assigned

2.2 Around 80-90% of the latest batch of 1000 LSTs announced in 2017 has, at the end of May 2018, been allocated, with around 70 new operators among those taking up these newly available trailer options. Proof of order is required, although there is often some delay between orders being placed and trailers entering service on the road.

We expect the remaining LSTs to enter service during 2018-19

2.3 A steady flow of new trailers has entered service during the latter part of 2017 and we expect this to continue throughout 2018. Estimated projections of the fleet growth are presented later in the report as part of the emissions calculations (Section 6, Figure 26).

A few trailers have been transferred between participants or left the trial

2.4 Operators have transferred a few LSTs to other companies on the trial. The main movements have been between companies where there was already a relationship, for example between subsidiaries of a parent company, or between a client company and their contract haulier who was already running the trailers. There have also been a small number of sales of manufacturers' demonstration trailers to hauliers.

2.5 A small number of trailers have been taken out of service due to manufacturing faults, or damage through incidents that was beyond repair.

2-2 Vehicle Special Orders (VSOs)

The system of Vehicle Special Orders (VSOs) is largely robust

2.6 The Vehicle Certification Agency (VCA) issues the VSOs under which the LSTs are permitted to run on GB roads. For new designs, this involves rigorous testing by VCA at Millbrook Proving Ground, or at the manufacturer's site. This results in production of a 'Model Report' that records the design parameters of the design being approved, and its performance in the tests. For further builds of an existing design, each new trailer is subject to a simple conformance test.

[11] https://www.gov.uk/government/collections/longer-semi-trailer-trial

2.7 The VCA provides advice to DfT, operators and Risk Solutions on matters relating to LST operations under VSOs and on errors found in the recording of vehicle identification numbers (VINs) in the data.

2.8 There have been a small number of cases where the operator has not obtained a VSO, usually because they believed the manufacturer did this. These errors have been picked up when they start to submit data, or when they have initiated contact about doing so.

2.9 Risk Solutions and VCA have codified key data from the VCA model reports[12] so that we will be able to match operational data back to design features, such as tail-swing distance, used in the analysis discussed in Section 8.

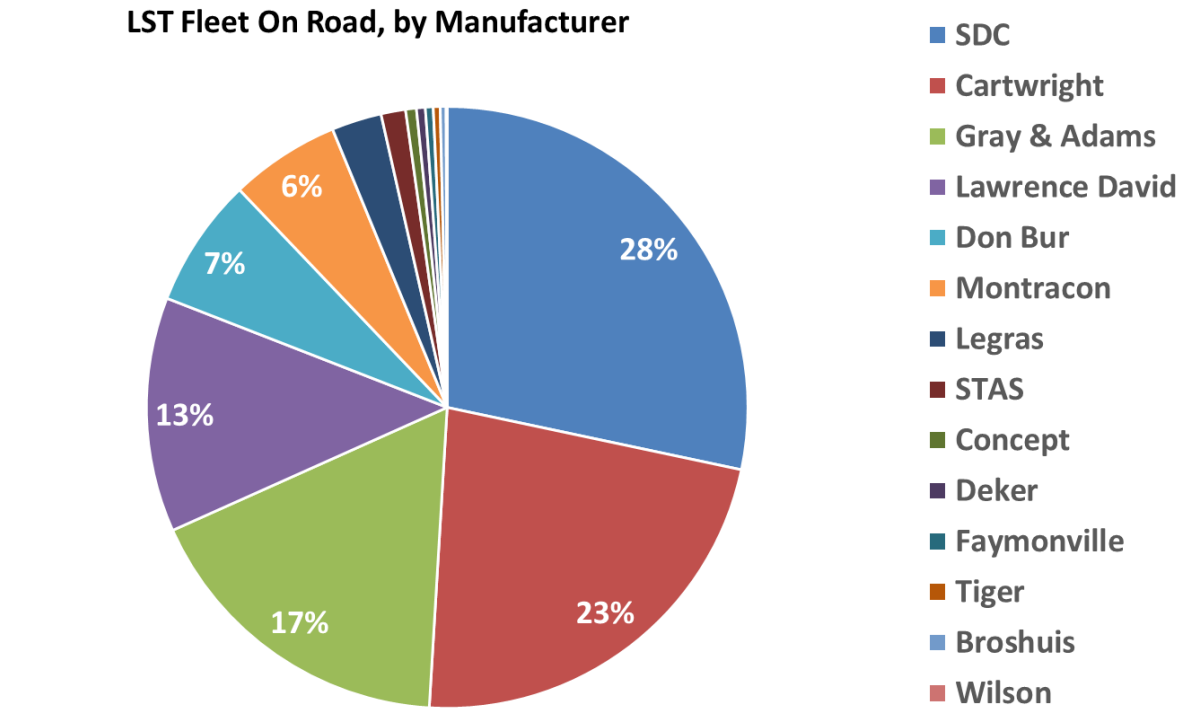
2-3 Manufacturers

Operators have commissioned LSTs from 14 manufacturers

2.10 At the time of writing, 14 manufacturers have constructed LSTs – see Figure 2.

2.11 The main UK manufacturers have been responsible for construction of most LSTs. Thirty-one LSTs came from manufacturers who have built fewer than ten LSTs each.

2.12 LST designs have emerged from manufacturers or bespoke requirements of users. The numbers of each design have been driven by market demand. Most LSTs are single deck box/curtain sided designs. More detail is given in Section 3.



Source: LST Trial data

Figure 2: LST fleet by manufacturer (at end Dec 2017)

[12] Each LST design is tested by VCA to ensure it conforms to the requirements laid down for the trial by DfT. This includes a practical test of the turning circle requirements, on-the-road tests of performance and stability, and measurements such as the cut-in and kick-out (tail swing) of each design under a pre-defined set of turning and speed conditions.

2-4 Investment in the trial

Both DfT and operators continue to invest in the LST trial

2.13 DfT's financial commitment under the trial covers: project management of the trial; the time required by VCA for the testing of LST designs prior to issue of a VSO; and the contract with Risk Solutions for independent evaluation support.

2.14 The decision that the trailers would be funded by the market, without any subsidy from public money, was one of the drivers for setting the trial up as a ten-year programme.

2.15 While the take up of allocations was initially slower than DfT anticipated, take up during 2012-13, and the oversubscription of the later allocation processes, suggest that many operators see a good business case to justify investing in the trailers. Qualitative research carried out during 2016/17 confirms this (see para 4.105 onwards), as does the quantitative analysis of efficiency gains discussed in Section 5.

2-5 Evaluation framework

The core evaluation framework has been stable since 2013, detailed requirements have evolved to meet the changing needs of the evaluation

2.16 A major policy input by DfT was definition of the original data requirement, which was first drafted in December 2011. Risk Solutions and DfT rationalised the data requirements to just those data elements for which DfT could see value[13]. This formed the first version of the data submissions to be completed by operators and, with two minor changes, this remained the basis for data collection up to the end of December 2017 – the period covered by this report.

2.17 The data gathering processes provide for collection of some basic company information when a company enters the trial and then reporting of trial statistics after each four-month data collection period. The key submission files and processes were summarised in the 2015 Annual Report[14]. The MS Excel templates and user instructions for use by operators to collate the data are available on the DfT website[15].

2.18 In 2016 an additional qualitative and semi-quantitative survey was run (called the QSF2 survey). This collected information to provide a deeper understanding of the way in which operators are making use of the trailers, a check on our analysis of their individual company efficiency in using the trailers, and a focus on their plans for the future.

2.19 The general data analysis carried out at the end of each data collection period and annually has been expanded and refined as the trial dataset grows, as the larger dataset permits finer segmentation and cross-referencing of findings. Where appropriate, analyses draw on experience from outside the project team or from special topic studies involving deeper dives into the general dataset, or work with selected volunteer companies from among the trial participants.

2.20 The annual reports contain the publishable analysis of the data, providing the results needed for DfT policy development. They maintain the confidentiality of the data from individual operators, since this is commercially sensitive.

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[13] DfT's rationale and justification for each data item is described in Appendix A1 of the 2014 Annual Report.

[14] https://www.gov.uk/government/publications/longer-semi-trailer-trial-evaluation-annual-report-2015

[15] The latest trial data process templates, user guide and management summary are available on the DfT website at https://www.gov.uk/government/publications/longer-semi-trailers-trial-data-guidance-and-documentation.

LST data submissions and process to 31 December 2017

Company Information File (CIF)

This is submitted once only, when the operator enters the trial (when their first VSO is granted). The CIF includes information about the size and nature of the operator's business and their non-LST semi-trailer fleet.

Qualitative Survey File (QSF)

This is submitted when the operator enters the trial and then optionally at later times. The QSF contains open questions about the experience of the company, its staff and clients in operating the new trailers.

From time to time we may run additional surveys to collect qualitative and semi-quantitative information from operators using a modified QSF process. Such surveys may seek for example: feedback from operators once they have been on the trial for more than an agreed number of periods, to capture the longer-term experience; information to support validation of data collected by other methods; and data to support deeper analyses.

LST Data Submission File (DSF)

This is submitted every data period and covers their LST operations in that period, including:

- An aggregated **journey log** of all LST journeys on the public road network in the period. The log includes details of locations and times, the nature of the journey, load and mode of appearance (MOA) types, load weight and two measures of utilisation.
- A set of **trailer reference information** relating trailer IDs to their vehicle identification number (VIN), basic design details and numbers of days 'off the road' in the period.
- An **incident log** covering all LST incidents on the public highway and certain types of incident on private property (e.g. in depots, at client sites).

Second Quality Survey File (QSF2)

In 2016-17, with the agreement of DfT, we carried out a second qualitative survey.

Data checking and compliance management

All files submitted are checked for basic errors and inconsistencies by Risk Solutions:

- comments and requests for revisions are sent back to the operator, **OR**
- an 'Accepted' email is sent, signifying the completion of the process.

All three sets of data are collected using MS Excel templates provided by Risk Solutions.

The submission process and all communication with operators is managed using a CRM (Customer Relationship Management) system called 'Gold-Vision' that is only accessible to the project team. members in Risk Solutions. The company contact data and some summary submission progress charts are accessible to the DfT trial project team.

A full description of the data requirements and framework, including DfT's original rationale for each data field is available in the 2015 annual report published on the DfT website.

Figure 3: LST Trial - data submission framework and process summary

3 TRIAL ACTIVITY AND PROCESSES

3-1 Establishing the LST fleet

The LST trial fleet on the road, or on a VSO, is now larger than originally envisaged

3.1 We track the growth of the fleet in two ways:

- The number of LSTs known to be on the road by the date on which they appear in the journey logs submitted by the operators.
- The number of LSTs on VSOs. VSOs are granted before or during manufacture, some time before they appear on the road.

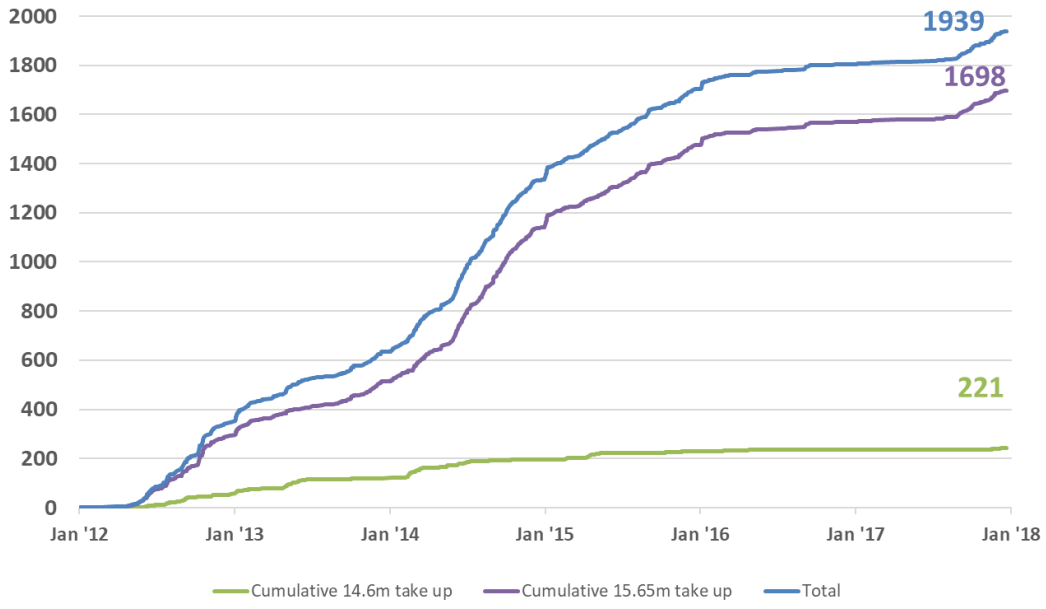
3.2 Table 2 shows the size of the fleet at the end of December 2017 (the trailers in the data analysed by this report).

Table 2: LSTs on the road/VSO

	On the road	On VSO
At end Dec 2017	1,939	2,073
Source	*LST Trial Data*	*DfT/VCA Data*

3.3 Note that the figure of 1,939 'on the road' is an underestimate as it counts only those trailers for which we had data submitted. A small number of operators had not submitted data for all their trailers and some new operators were waivered from submitting data in 2017-P3 because of the imminent change in the data collection process. Any trailers on the road after 31 December 2017 will not be included in the current dataset although they may already be included on a live VSO.

3.4 Figure 4 shows the growth of the LST fleet from the start of the trial to the end of 2017.



Source: DfT trial data

Figure 4: Growth of the LST fleet 'On the Road' (from journey logs)

The projected LST fleet is now large enough to meet the data analysis requirements of the trial

3.5 When the trial was launched, DfT set a goal of 1,800 LSTs – around 2% of the UK semi-trailer fleet at the time - based on an estimate of the minimum number of trailers that would be needed to generate data to ensure the findings were sufficiently robust to inform policy. This has now been exceeded as shown in Table 2.

3-2 LST designs in operation

The most common LST design is 15.65m box or curtain sider.

3.6 Figure 5 to Figure 8 show a summary of the LST fleet mix by major design features[16].

Figure 5: LST body design mix

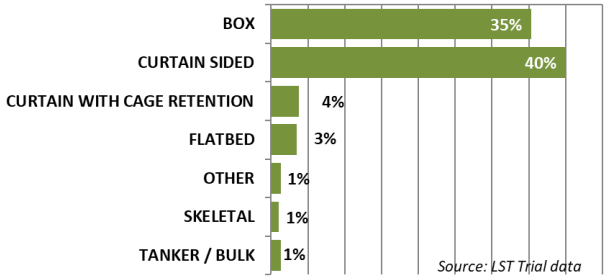


Figure 6: LST deck layout mix

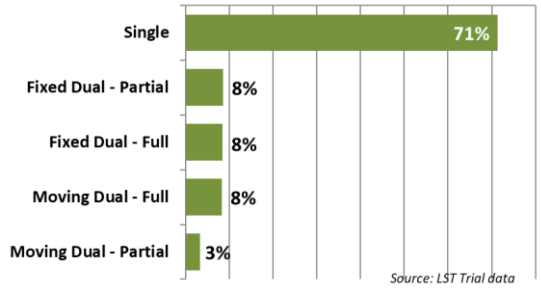


Figure 7: LST steering design mix

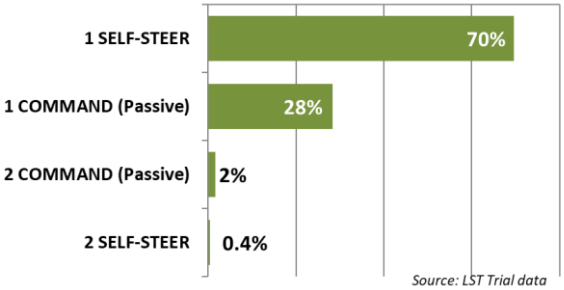
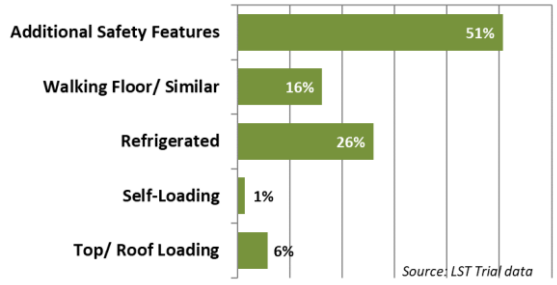


Figure 8: LST other features mix



[16] Further details of the design mix categorisation and the history around the choices of steering arrangement can be found in earlier trial annual reports – see footnote 10.

The most common steering arrangement is a single moving axle (98%)

3.7 When the trial was first launched, some designers suggested that to pass the required turning circle test, two steering axles might be required. Early in the trial, manufacturers demonstrated that this was not the case and most of the trailers produced have either a single self-steer or command steer axle. The few LSTs with more than one steering axle are a handful produced at the very start of the trial, or flatbed 'heavy haulage' trailers.

The fleet includes some dual deck, flatbed & ISO container carrier designs

3.8 Just over 30% of the LST fleet are of more specialised designs.

- Dual Deck LSTs (both flat and step-frame) are carrying low-density goods that cannot be stacked without damaging them, such as parcels or FMCG[17] pallets. There is one Triple Deck LST, designed to carry very low-density products (toilet rolls).
- LST ISO carriers have been developed by a single operator for use on their road-rail operation. They also designed a matching '50 foot' ISO container. These designs have been widely reported in the trade press[18].
- LST flatbeds / low loaders are largely being used for specialist heavy haulage or vehicle transport. They are generally telescopic with a 'pin' that fixes them at 'LST length'. They often make their return leg 'retracted' to 13.6m, these legs do not therefore appear in the trial data. On other occasions, they might be extended beyond 'LST length' in which case they would operate as specialist loads with a journey specific VSO outside of the trial.

3.9 While the results from the dual deck trailers might give a usable sub-set of data for analysis, the numbers of flatbed and ISO carriers mean that we can only elicit qualitative insights into the potential for such vehicles, as the numbers of journeys will not yield statistically meaningful insights for these specific designs.

Around 60% of the LSTs can be tracked using GPS/Telematics data

3.10 We updated our information on the number of LSTs with GPS tracking as part of the 2016 QSF2 survey. Based on the operators who have responded to the survey (126), 35% of operators representing **62% of the LST fleet are now able to track the location of their LSTs**, either with a GPS on the trailer itself or linked to a GPS on the tractor unit.

3.11 This is a lower figure that cited last year (up to 70% of the LST fleet tracked) which may reflect the fact that the operators who took longer to respond to the survey (and were not included in last year's data) might also be from the smaller size companies with lower levels of GPS tracking.

3.12 The 62% figure is also probably optimistic, since we know from other engagement with operators regarding GPS data that linking of trailer IDs to tractor GPS data is far from perfect in many systems, often involving a manual process step where the trailer ID is entered for the individual job code to which the tractor is assigned.

3.13 However, this is much higher than was declared by the earliest trial participants in their initial QSF submissions from 2012 onwards. From conversations with operators we know that the expansion in the use of GPS, particularly on trailers, reflects later LST orders being fitted with GPS at manufacture. We also know of some larger and mid-sized operators back-fitting GPS to LSTs or to their entire trailer fleet.

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[17] FMCG – Fast Moving Consumer Goods

[18] The skeletal trailers built to carry a 50 foot ISO container have been reported on several times by Commercial Motor and Motor Transport during the past

Table 3: Information on operators use of GPS for tracking from the QSF2 survey

LST QSf2 Question Q3-2a. Do your LSTs have…	No. of ops	No. of LSTs	No. of legs	Total mvkm	% of operators	% of LSTs	% of km
GPS on the trailer itself	22	668	1,600,923	171.6	17%	43%	51%
GPS on the tractor unit with a trailer reference (allowing trailer locations to be tracked)	22	300	628,770	62.4	17%	19%	20%
Total Tracked	**44**	**968**	**2,229,693**	**233.9**	**35%**	**62%**	**72%**
GPS on the tractor unit, but not able to link to trailer ID	61	454	667,648	101.4	48%	29%	21%
GPS tracking not currently used in our company	14	46	95,188	7.7	11%	3%	3%
Totals for those responding to survey	**126**	**1,555**	**3,117,779**	**364.6**	% values expressed as % of the 126 ops, % their LSTs and % of their km		
No response to survey	35	384	471,511	78.8			
Totals	**161**	**1,939**	**3,589,290**	**443.4**			

3.14 Higher levels of GPS data usage to generate the journey logs gives us greater confidence that the legs are being properly recorded. In checking the data, we can clearly see the improvement in data quality where it is derived from GPS downloads. Increased GPS usage also helped many operators with the requirement to report full postcodes for start and end locations from January 2016.

3.15 We would emphasise that while the use of GPS has benefited the trial by providing better data quality, **we do not in general have access to the GPS raw data**. Provision of such data was not part of the operator undertaking signed by the participant because when the trial started in 2012 separate GPS tracking of trailers (as opposed to tractor units) was not widespread and DfT judged that to have placed such a tracking requirement on the operators would have been considered an unreasonable burden on the industry and may have excluded smaller operators from participating, limiting the coverage and value of the trial.

3.16 For this report however, we have been able to obtain a substantial sample of GPS raw data for LST legs to support and refine the modelling of LST routes described in last year's annual report (Annex 3) and updated here in section 4 (para 4.40 onwards).

3-3 Data submission process participation and compliance

Most operators are submitting journey data of reasonable quality and largely on time

3.17 The compliance to the end of 2017-P3 was very good – strong efforts were made by both Risk Solutions and DfT to ensure that all missing or late data was followed up because this was the final period of data collection under the existing template. Our in-house tools include automated checks of data submissions for consistency and completeness allowing us to go back to the operator for corrections while the data was still current and fresh in their minds.

3.18 **These measures resulted in a comprehensive and good quality dataset for the whole of 2017, and also some back filling of missing data for 2016**.

Raw data submitted by operators remains confidential

3.19 All datasets submitted by trial participants contain commercially sensitive data and are held securely on Risk Solutions' servers or the encrypted computers of the project team. The data files are only accessible by members of the team who have a project-related reason to do so. Risk Solutions does not make raw data available to DfT or any third parties.

Participant engagement remains high

3.20 Risk Solutions continues to support trial participants in setting up efficient data processes and advising on possible improvements, based on good practice across the trial.

3.21 In general, engagement with operators continues to be positive with both managers and direct data contacts demonstrating good intent and a conscientious approach to data gathering. Where problems have arisen and more senior staff have become involved, this has also been done efficiently and without loss of relationships in almost all cases.

3.22 The Freight Transport Association (FTA) has generously organised three LST trial industry forums since 2012, with 30-40 operators attending each event. The events have been open to all companies participating in the trial (not just FTA members) and include input from DfT, VCA and Risk Solutions.

3.23 DfT, FTA and RHA are now discussing the timing and nature of further industry engagement, which may take the form of smaller seminars during the latter half of 2018, as part of the industry engagement workstream. This industry engagement was a recommendation of last year's annual report.

Recommendation 2016-1: Industry Engagement

We recommend that DfT liaise with FTA, RHA and other stakeholders to arrange a further LST Trial industry forum, ideally during 2017, to communicate with the operators and retain participant engagement, as the trial enters its sixth year and the trial community is extended.

3.24 Further details of the engagement being planned are given in Section 9.

4 TRIAL OUTPUTS: LST FACTS AND FIGURES 2017

4.1 This chapter provides an overview of the key statistics for:

- The number and range of participating companies
- The extent and nature of LST operations
- The number and nature of incidents involving LSTs.

4.2 This is followed by a summary of Qualitative Survey (QSF2) results.

Outputs

Participation (Number, range)

Master Data (Quality, Timeliness)

LST Operational Data Summary

LST Incident Data Summary

Qualitative Data

4-1 Trial participants summary

4.3 The data on who is participating in the trial and the nature and size of their operations is drawn from the company information file (CIF) completed by each trial participant, usually in their first data period.

4.4 The CIF data provides background information used to group companies for analysis. It also provides a data source for later comparison of the operational patterns of LSTs with those of the existing fleet of an operator.

Table 4: Company Information File (CIF) Status

CIF Status	Finalised	Draft/Missing
At end Dec 2017	141	25
Source	*LST Trial Data*	

4.5 The status of CIF submissions is shown in Table 4. We have not devoted too much effort on collection of company information during 2017, focusing more on obtaining comprehensive and detailed leg and routing data. During 2018 we will be collecting a comprehensive set of new company information from all operators as part of the new data collection process.

There is a broad range of company types on the trial

4.6 One of DfT's stated intentions was that the trial should be accessible to operators of all sizes – not just large operators. Figure 9 summarises the range of companies (based on their CIFs[19]) by size, Figure 10 by the nature of their primary operations.

4.7 Figure 9 shows that the trial does include a significant number of small and very small operators. Figure 10 shows the balance between a small number of own operation fleets (retailers, parcel companies) with larger numbers of LSTs, and a large number of general hauliers with fewer LSTs each.

4.8 We note that while a large proportion of the companies are general hauliers, some of their operations are associated with long term contracts for major retailers.

4.9 The 'Other' category includes cases with very few data points or specialist trailers.

Many operators applied special LST operational measures to LST operations

4.10 One of the earliest questions to be considered by all participants is the extent to which they would constrain the use of LSTs within their operation, at least during early use.

4.11 Figure 11 shows operator responses (again based on CIFs) to a series of possible special arrangements that could have been put in place, with operators selecting as many as applied.

[19] Further details of the categorisation of companies and all other data gathering in the CIFs can be found in earlier trial annual reports – see footnote 10

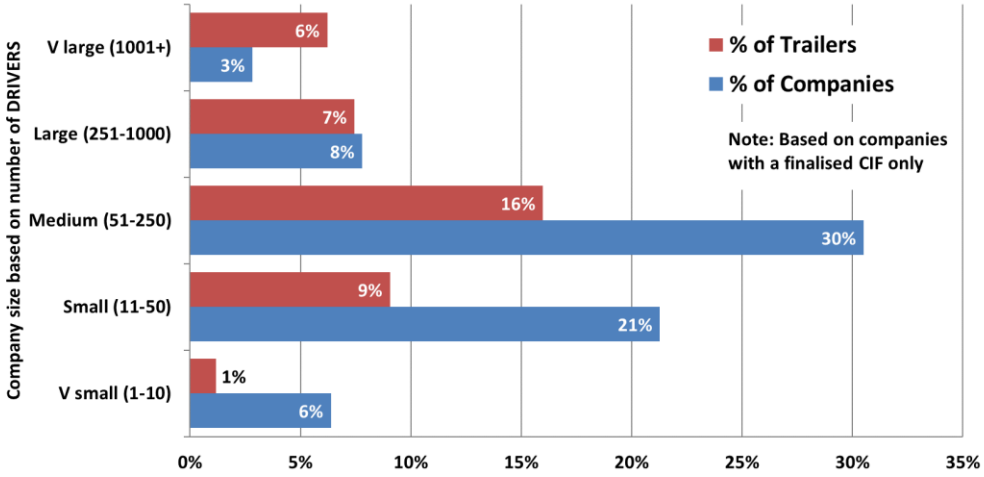


Figure 9: LST trial participants and fleet by company size

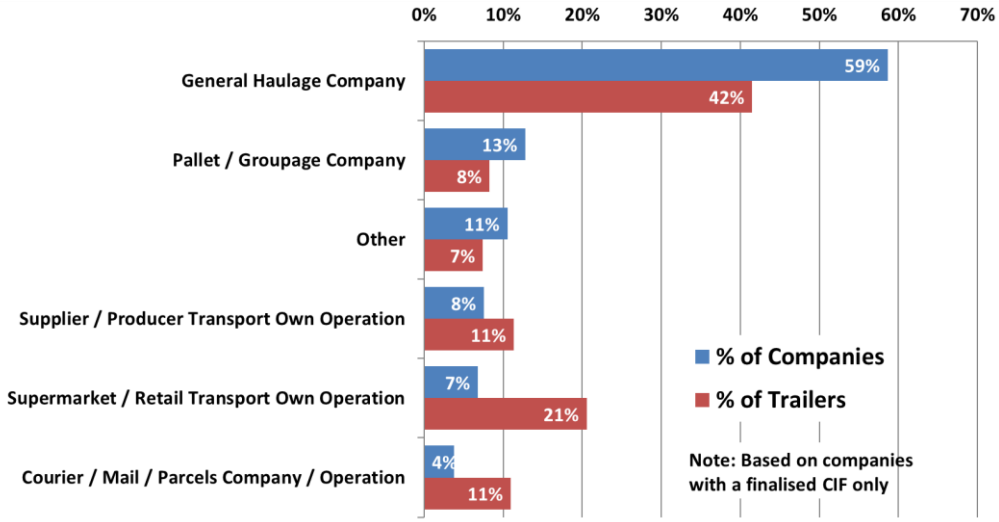


Figure 10: LST trial participants by nature of operation

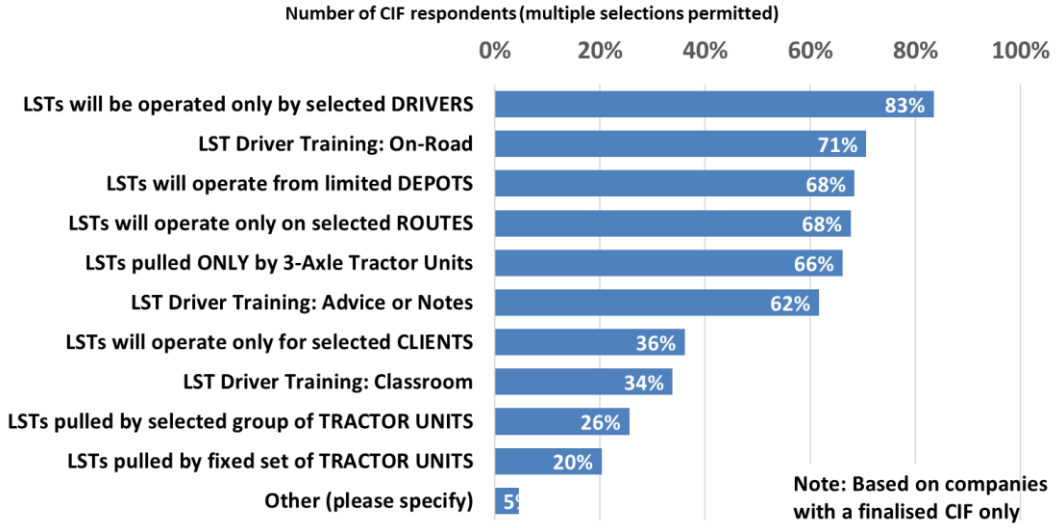


Figure 11: Special arrangements made for LST operations

Source for all charts- LST Trial data

4-2 Operational data summary

4.12 The outputs below give an overview of the operations of LSTs from the start of the trial to the end of 2017 based on the journey leg data submitted by operators.

4.13 Journeys are expressed as legs in the data, meaning a single point-to-point trip without loading or unloading stops en-route. Any multi-drop journeys with fewer than five loading/unloading points are recorded as individual legs for each part of the trip. Where there were five or more drops, the journey is recorded as a single record in the data, with the number of drops noted.[20]

Distance covered by LSTs

LSTs had travelled 443 million km by the end of 2017

4.14 The summary figures for LST operations to the end of 2017 are shown in Table 5.

4.15 The equivalent figures to the end of 2016 show that during 2017, with around 160 more vehicles on the road by the end of the year than at the start, the total mileage covered by the trial increased by almost 40%.

Table 5: LST total km and legs

LST distance & leg count totals	To end 2017	To end 2016	To end 2015
Total vehicle km recorded	443 million	319 million	202 million
Number of recorded legs	3,589,290	2,647,018	1,727,559
Average leg distance	124 km	121 km	117 km

4.16 The fleet currently stands at slightly above the size originally envisaged for the trial, and a further 500-700 vehicles are now anticipated to join the trial during 2018 due to the trial extension announced by the DfT in January 2017, with the remaining new allocations being delivered in 2019.

More than half of the distance covered by LSTs is between industrial locations.

4.17 Figure 12 shows that the primary uses of the LSTs continue to be in the areas anticipated in the DfT Impact Assessment[21].

4.18 The categories '3) Supplier to Distribution Centre (DC)', '4) DC to DC', '6) To/from industrial site' and '7) Palletised trunking' all relate to journeys between sites that might be considered industrial - based on site access and the location of such sites in areas with lower public movement or limited public access. These legs represent 67% of all loaded distance covered and, we can assume, a proportion of all the empty distance.

4.19 In contrast, '5) To/from Retail Site' is the only leg type where we might expect operations in areas of high public movement and potential public access (on entry routes to the site). This leg type represents 13% of the loaded distance, but by the nature of retail delivery operations, many of the return legs will be empty.

4.20 **The vehicle km are dominated by FMCG goods and other goods moved in cages or on pallets**

[20] This approach is the same as that used in the DfT Continuing Survey of Road Goods Transport.

[21] Op Cit. Page 31 and Page 40 Table 5 of the impact assessment lists the categories of journeys which were assumed to see transfer of loads from regular 13.6m trailers to LSTs were the longer trailers to be generally available. This is a direct comparison of the percentage swaps since the table relates to assumed transfers of loads across the entire market.

4.21 The nature of the transported goods is shown in Figure 13 and the mode of appearance (MOA) is shown in Figure 14. These are dominated by fast moving consumer goods (FMCG) and other goods moved in cages or on pallets.

Figure 12: LST km by journey type

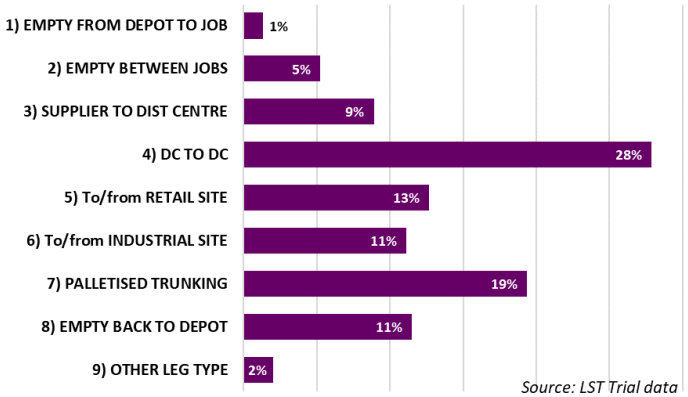


Figure 13: LST km by goods type

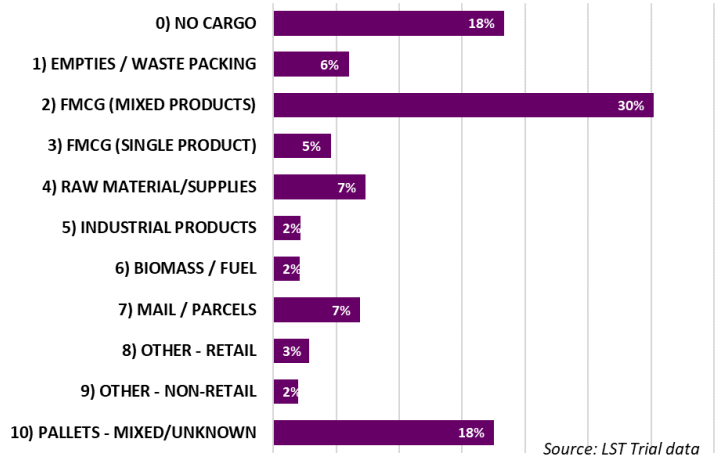
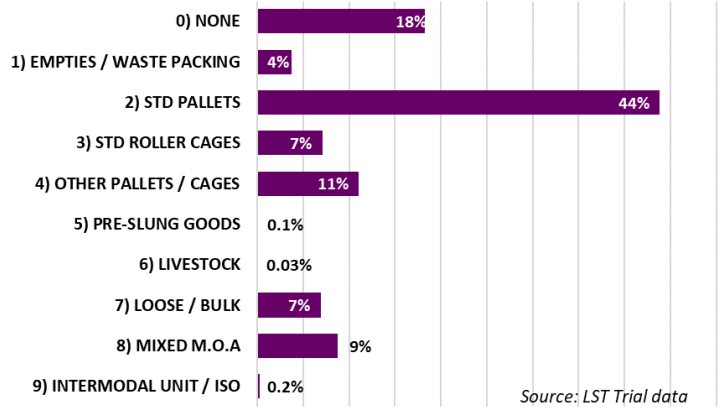


Figure 14: LST km by mode of appearance (M.O.A.)



Empty running of LSTs is two thirds that for regular semi-trailers in the same period

4.22 The LSTs ran empty for around 18% of the total distance they covered, considerably lower than the figure of around 29-30% for all GB articulated HGVs in 2017[22].

[22] Source – Road Freight Statistics for 2017 Table RFS0117 Percentage empty running and loading factors by type and weight of vehicle and mode of working DfT July 2018.

4.23 The lower empty running rate reflects the extent to which the trial participants are placing the LSTs on operations where empty running is less common, such as trunking and depot to depot routes. These are the operations where the routes are familiar to the planners and drivers, are most easily pre-assessed as being suitable for LSTs, and where the return on investment for the additional cost of an LST can be most clearly demonstrated.

4.24 The reduced empty running is evidence that many of the trial operators have suitable work available where they can deploy the LSTs efficiently, making use of the additional length on both outbound and return legs.

Utilisation

4.25 Utilisation data is gathered by both deck % and volume %[23] used, to give both perspectives on how well the total load potential of the trailer is being used.

4.26 We also record whether the load was 'weight limited' so that we can identify cases where the deck or volume is not being used because no additional weight can be added, rather than because no further goods were available. Only 2.6% of legs are noted as being weight limited, which is consistent with the view that LSTs are primarily of interest to those hauling lower density – higher volume goods.

4.27 If a significant proportion of a company's LST legs were to be weight limited and showed low deck % figures, it would call into question the value of using LSTs for that operation.

LSTs have been 100% full for 37% of their distance travelled

4.28 Figure 15 shows the utilisation by deck space covered.

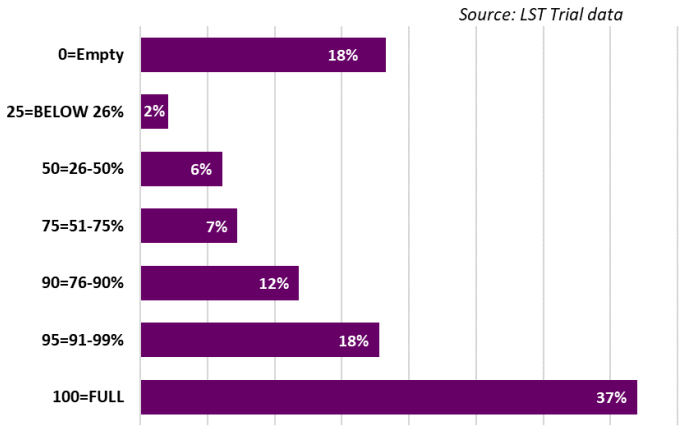


Figure 15: LST km by Deck% covered

4.29 The operators are instructed that they may record a trailer as 100% full if they could not load another 'unit' of goods (i.e. 1 more cage, 1 more pallet etc.)

4.30 The figures for 100% full journeys contain some conservatism as data for 2012-2013 did not include a distinct 100% category and so for those journeys any 100% full legs would fall in the 91-99% band.[24]

[23] The values are expressed as % of the total deck space or volume, in many cases calculated by the operator using the number of standard pallets of cages loaded compared to the maximum possible.

[24] See Annual Report 2014 (footnote 1) Appendix E, paras 22-30 for explanation of the changes made in 2014. Para 28 and 29 explain the conservative assumptions made in back-fitting the revised rules to earlier data for some operators.

The additional length of the LSTs was in use for around 55% of the total distance covered

4.31 As a rough measure, any journey with Deck % > 90% is making some use of the additional trailer length, i.e. the bottom two categories on Figure 15 giving a total of 55%.

4.32 Section 5 includes a detailed analysis of the deck % utilisation data and what it might mean in terms of a reduction in vehicle km compared with the same work being done on 13.6m trailers. The calculations also take into account the potential saving of empty legs where some entire 'round trip' journeys are saved by using LSTs.

4.33 Figure 16 shows the utilisation by volume filled, which although important is not the primary focus of the analysis.

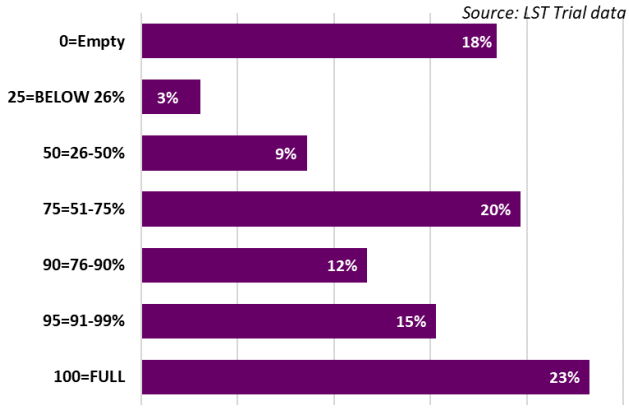


Figure 16: LST km by Volume% filled

4.34 We have not carried out any analysis by volume %. This would require consideration of different types of operation and trailer type to be meaningful. For example, an assessment by volume needs to consider the trailer design:

- For refrigerated trailers, a free space of perhaps 20-30% of the volume may be required to permit circulation of the air and hence for such trailer designs, a figure of 70% may be regarded as 'full' by volume in analysis.
- For flatbed trailers, volume fill is not measurable in a meaningful way and so volume analysis will need to exclude these units.

Utilisation results check

4.35 As part of the QSF2 survey we sent out individualised summaries of our utilisation analysis to each operator, presenting them with their own results to check whether they broadly agreed with the summary. The options given in the survey (Question 4-1a) were whether our utilisation summary was:

- *More optimistic (higher utilisation) than you would have expected*
- *Broadly in line with what you would expect to see*
- *More pessimistic (lower utilisation) than you would have expected*

4.36 At the time the data for this annual report was frozen we had received QSF2 responses from 126 operators. Of these, 112 agreed that our data was "broadly in line with what they expected to see" – with a few operators checking our results precisely matched their internal analysis.

4.37 No operator judged our analysis to be overly optimistic. Where the operator judged our data was pessimistic – just six cases - we have discussed the causes with them. In one or two of these cases, further conversation showed that they were being overly conservative in their submission estimates of utilisation and plans were made to adjust their approach to estimation.

4.38 The survey question also invited a narrative comment. In a few cases this revealed that the operator interpreted the question as comparing the results with their initial expectations at the start of the trial. Where possible we contacted the operator and explained the question, resulting in some amended submissions.

4.39 In summary, we are confident that the utilisation estimates are sufficiently robust to be used in the calculation of LST operational efficiency and the numbers of journeys saved on the trial, as reported in Section 5.

LST Operations by road type

4.40 We also need to know the types of roads used by LSTs to inform the analysis of safety and emissions impact. To do this we needed to know the routes used between the origin and destination of every LST journey, as a series of road links, for which we can then extract information about road type or overlay on GIS areas.

4.41 The routes taken by trial LSTs were not included as part of the core data submission required from operators, but for 2016 and in particular 2017, we did require full start and end postcode information for each individual journey leg. A routing model was then used to generate likely, credible routes taken by trial LSTs. The LST journeys were analysed to determine distances travelled by road type and through areas of particular environmental significance and validated against a sample of routes where we had detailed GPS data.

Route modelling approach

4.42 The route modelling process is described in full Project Note E1[25].

4.43 In summary the process estimates routes for LSTs in 2 stages.

- The first stage creates a partial network consisting of local roads that might be taken from the origin and the destination of each LST journey, to a trunk road or part of the 'Primary Route Network' (PRN) (see Table 8) plus the whole of the trunk road network itself. This partial network does not contain all possible roads that HGVs can take, but only the roads that they are likely to use to get to and from a trunk road, and to travel across the trunk road network. This significantly speeds up the second stage of routing, and at the same time, removes roads that HGVs are not permitted to travel on due to documented restrictions.
- The second stage finds the quickest complete route from the origin to the destination for all LST journeys, using this partial road network. An example route is shown the yellow highlighted route in Figure 17. Local roads are light blue, and trunk roads are darker blue, the SRN is darkest blue.

4.44 We were able to estimate the proportion of LST journeys by road type by modelling LST routes over the Ordnance Survey Integrated Transport Network (ITN). This representation of roads contains detailed information about road types (Motorway, A roads, B roads and minor roads) as well as carriageway types such as dual carriageways, single carriageways, and restrictions to routing such as one-way streets, and turning restrictions at junctions and weight restrictions. Figure 18 shows an example of the detail available and how the model has chosen a route through a number of junctions for an LST journey (in yellow).

4.45 The road class / type information is applied in Section 5 to give the analysis of distances and in Section 7 in the assessment of injury incident rates, on different road types.

[25] Project Note E1: LST Routing and Operational Analysis by Road Type September 2018 SPATS 1-403 PN-E1-v4-2

4.46 We were also able to determine the distances LSTs travelled through sensitive areas (urban areas and areas sensitive to emissions) by mapping all ITN road links to areas of particular interest. This process is explained further in the discussion of the emissions analysis in Section 6.

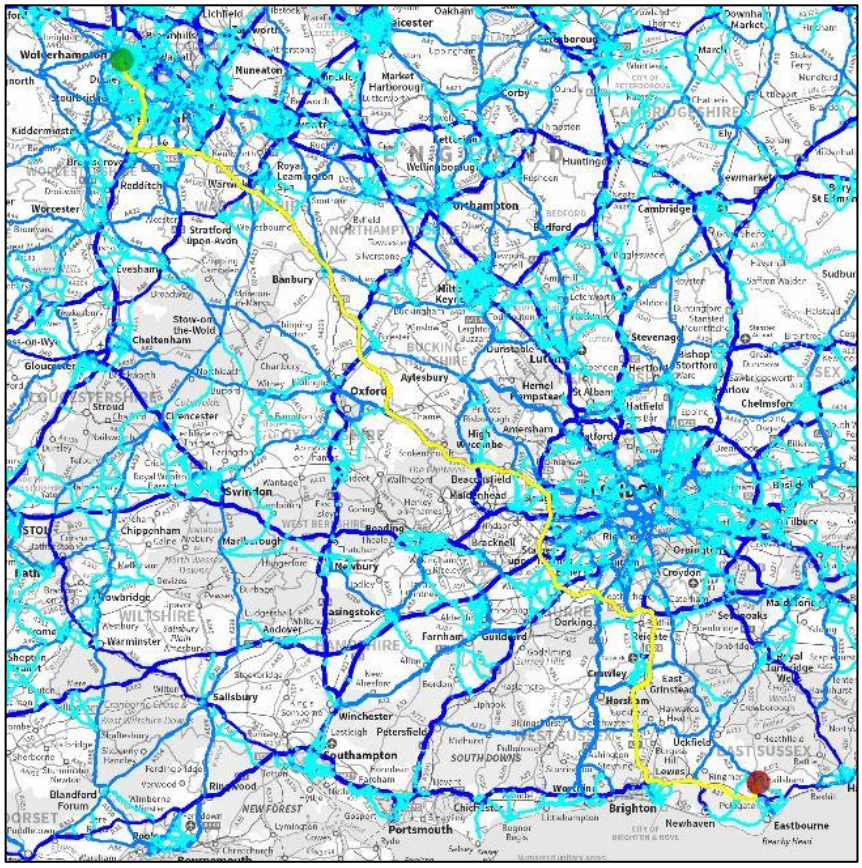


Figure 17: Example LST modelled route from Wolverhampton to Eastbourne

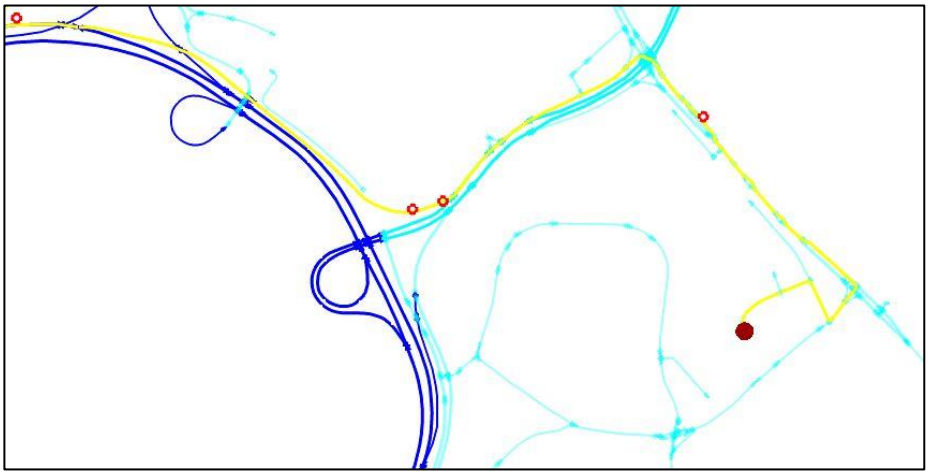


Figure 18: Integrated Transport Network road links, with an LST route (yellow) and GPS tracking points (red circles)

4.47 To ensure that the routes chosen by the model were a reasonable representation of the real routes taken by LSTs, we calibrated the routing model so that the routes it chose were equivalent to real routes taken by HGVs from a number of the operators involved in

the LST trial. This was done by comparing 260,000 GPS tracked journeys with an equivalent set of modelled routes, and modifying the route modelling algorithms to more closely follow the real GPS tracked journeys. The small red dots in Figure 18 are the GPS positions from a tracked HGV, used to calibrate the routing algorithms.

Comparison to published data (DfT TRA3105 - 2017)

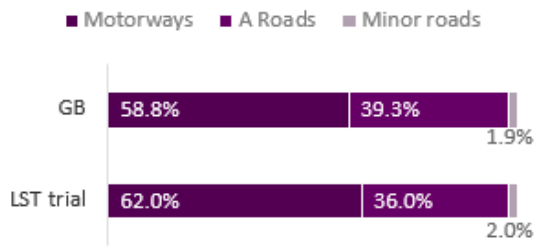
4.48 We were able to successfully model routes for 830,000 (93%) of the LST trial journeys made in 2017. Our analysis revealed that the proportion of vehicle km by road type matches well with that reported by the DfT for the national articulated HGV fleet in England, Scotland and Wales (DfT TRA 3105). The LST distances by road type are detailed in Table 6, the comparisons are shown in Table 7.

Table 6: LST modelled journey distance (2017) by road type

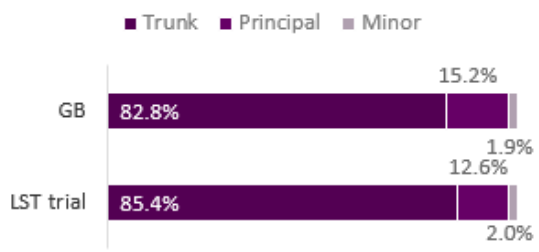
	Non-urban	% of total vkm	Urban	% of total vkm	Total vkm	% of total vkm
Motorway	**63,313,108**	**62.0%**	**0**	**0.0%**	**63,313,108**	**62.0%**
Major (A Road)	**24,679,735**	**24.2%**	**12,140,096**	**11.9%**	**36,819,831**	**36.0%**
Trunk (SRN)	18,232,075	17.8%	5,685,598	5.6%	23,917,673	23.4%
Principal	6,447,660	6.3%	6,454,498	6.3%	12,902,158	12.6%
PRN	4,987,807	4.9%	4,751,508	4.6%	9,739,315	9.5%
Other	1,459,853	1.4%	1,702,990	1.7%	3,162,843	3.1%
Minor roads	**798,842**	**0.8%**	**1,261,164**	**1.2%**	**2,060,006**	**2.0%**
PRN	496	0.0%	41	0.0%	538	0.0%
Other	798,346	0.8%	1,261,123	1.2%	2,059,469	2.0%
Grand Total	**88,791,685**	**86.9%**	**13,401,260**	**13.1%**	**102,192,945**	**100.0%**

Table 7: LST comparison with national HGV fleet by road class and road type

Road class	LST trial	GB
Motorways	62.0%	58.8%
A Roads	36.0%	39.3%
Minor roads	2.0%	1.9%



Road type	LST trial	GB
Trunk	85.4%	82.9%
Principal	12.6%	15.2%
Minor roads	2.0%	1.9%



Principal vs Primary Route Network (PRN)

4.73 There are two slightly different approaches commonly used in discussing classification of GB roads, which can make a single discussion of data expressed in the two different formats problematic. The two most commonly used structures are:

- **MAJOR (split into TRUNK and PRINCIPAL) vs. MINOR** – used in the national traffic flow statistics and data sources such as STATS19
- **PRN vs OTHER** – as defined by DfT in the 2012 "Guidance on Road Classification and the Primary Route Network"[26]. Broadly, the PRN consists of all of the strategic road network (including motorways) and the 'green' roads on maps and road signs.

4.74 In introducing analysis by road type in this year's report (especially in Sections 5, 6 & 7, we have had to refer to BOTH these systems and so Table 8 clarifies the difference.

Table 8: GB Road classification systems

MAJOR/MINOR

- **Major** roads are made up of the **Trunk** and **Principal** roads
- **Motorways** are defined as part the MAJOR road group, (and are almost always Trunk roads) but in other presentations they are separated out.
- The **Trunk Road** network consists of the Strategic Road Network (managed by Highways England), and the equivalent trunk roads in Wales and Scotland. It is made up of Motorways and the trunk A roads.
- **Principal roads** are the remaining A roads that are managed by Local Authorities (i.e. not part of the Trunk road network).
- Principal roads include a range of road size and quality and may go through urban areas where there is no alternative local route.
- **Minor roads** are B roads, C roads and unclassified roads.

PRN/OTHER

- The Primary Route Network (PRN) extends the Trunk network to connect a specific group of towns and cities, and provides a road network for longer distance journeys but it is not actually a 'class' of road.
- The PRN consists of a defined set of towns in the country which are defined as **"Primary' Destinations"**. The list of primary destinations is maintained by DfT.
- PRN routes are the agreed/suggested route between two of these destinations.
- Local Authorities have a role in defining the specific roads to be flagged as PRN where such a route passes through their geographic area.
- **The roads making up the PRN are NOT the same as Principal roads**
- The PRN only includes the more significant A roads, reaching and including city centre ring roads, but not through the centres of towns and villages. The PRN is often coloured green on a road map, other A roads are coloured red.
- **All roads on the SRN form part of the PRN** (according to 2012 guidance).

[26] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/315783/road-classification-guidance.pdf

LST operation on appropriate roads

4.75 Figure 19 shows the modelled LST distances broken down by Urban/Rural and then by the two road classification systems described above.
(Note that while 'SRN' technically only refers to the English SRN, managed by Highways England, it is sometimes used, as here, as a shorthand to include the equivalent networks managed by the Scottish and Welsh governments.)

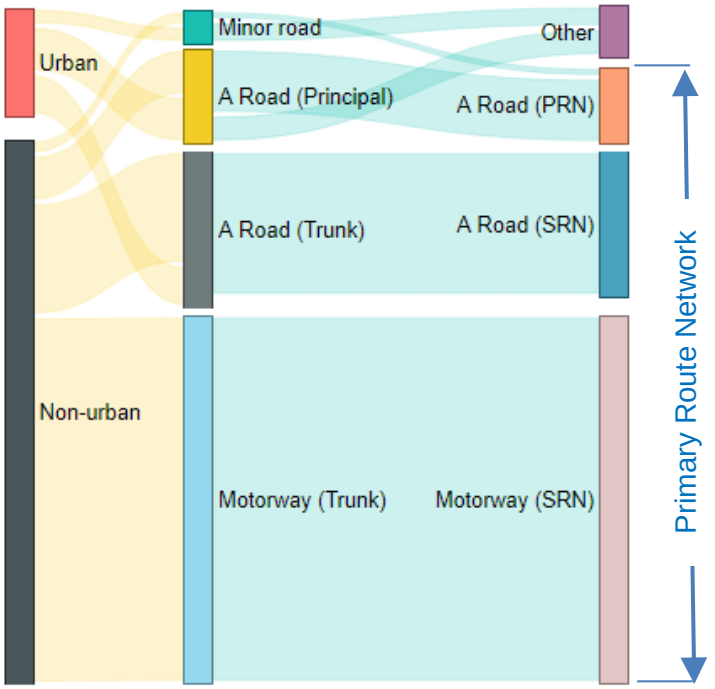


Figure 19: LST distances by different road classification systems

4.76 In early trial annual reports we used 'Urban' as a simple proxy for roads where we might find LSTs operating alongside vulnerable road users or making sharp turnsturns.

4.77 Table 6 indicates that for 13.1% of their distance, LSTs are travelling on roads passing through ONS 'urban' areas. This figure is higher than the 8-9% average presented last year with the prototype routing model.

4.78 However, using the urban definition as a proxy for higher risk areas is a very blunt approach as most of the vehicle km classified as 'urban' were in fact driven on major A-roads rather than minor roads, and in many cases this will include dual carriageways or roads where motor vehicles are well separated from other road users or pedestrians. For this reason, the safety analysis this year presents the data by road class as well as by urban/rural split, with a particular focus on minor roads. Only 2.0% of the LST operation by distance is on minor roads.

Operation on 'other' (not PRN) roads

4.79 The other perspective is to consider the '**Other'** roads in Table 9 - those that are not part of the SRN or PRN networks that run through urban areas.

4.80 We estimate that only 5.1% of the LST trial vehicle km were on roads which were not part of the SRN or PRN networks. Of the distance travelled by LSTs on these 'other' roads, only 2.9% was in urban areas. Table 9 shows the proportion of total LST distance travelled in 2017 in urban and non-urban areas, and for the Trunk network, the additional roads included in the Primary Route Network, and on the 'other' smaller roads.

4.81 A sense of the scale of each segment of the data can be seen in the alternative presentation as a weighted area chart in Figure 20.

Table 9: LST distances by SRN/PRN/Other network

Road network	Non-urban	Urban	Total
Strategic Road Network (SRN)	79.8%	5.6%	85.4%
Primary Route Network (PRN)	4.9%	4.6%	9.5%
Other roads	2.2%	2.9%	5.1%

Figure 20: LST distances by road network (weighted area)

4-3 Incident data summary

The analysis of incidents involving LSTs is a primary objective of the trial

4.98 The low incidence of road traffic collisions involving LSTs on the public highway (both anticipated and actual) is one of the reasons the trial needs to collect data for an extended period of time. This is necessary to allow us to analyse trends or contributory factors to risk in a statistically meaningful way to inform future policy decisions

4.99 The primary focus of incident data analysis throughout the trial is to assess whether or not there is any emerging evidence about the relative safety risk performance of LST operations compared with standard length trailers.

4.100 Figure 21 provides a summary of the incidents involving LSTs, reported by operators

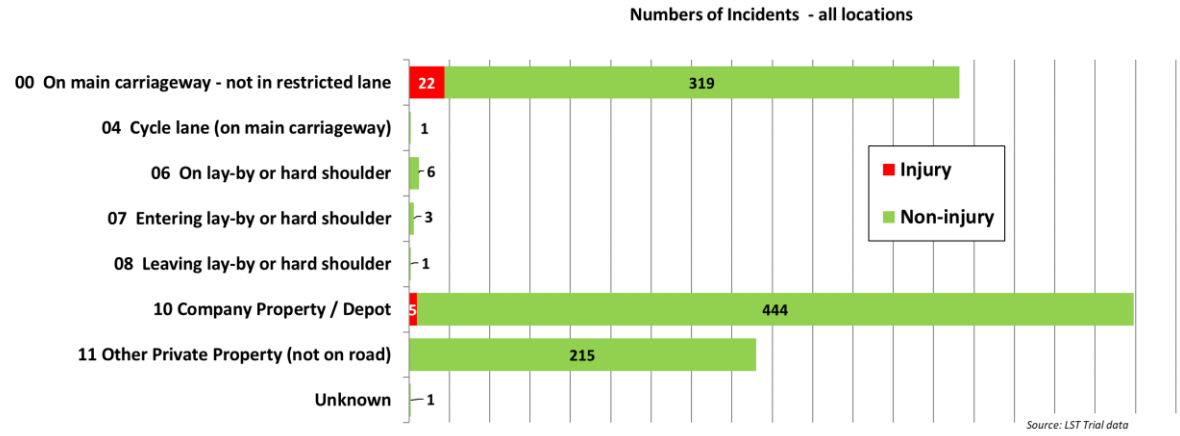


Figure 21: Incidents reported involving LSTs (Summary to end 2017)

There have been 27 injury incidents involving an LST reported of which 22 took place on the public highway

4.101 A detailed analysis of the incident data and resulting casualty figures is reported in Section 7, along with a review of the circumstances of each injury incident (Table 22).

4.102 Also in Section 7, we will discuss the question of whether incidents were 'LST Related', i.e. was the fact the trailer was an LST a factor that influenced either the occurrence or outcome of the event.

There are have been 990 non-injury incidents reported of which 246 were on the public highway and caused damage

4.103 As in previous years, the quality of damage only incident reporting in depots and on other private land is highly variable. This is not surprising as it is not a requirement of trial participation. Some operators simply take the approach of reporting everything – others just the minimum required.

4.104 Of the 990 non-injury events reported, 333 were identified by the operator as occurring in areas they considered public and 246 were reported as resulting in damage. As with the safety incidents, more detailed analysis is presented later (see Section 8).

4-4 Qualitative surveys (1 & 2) summary

4.105 Since the start of the trial, all operators have been asked to complete a Qualitative Survey File (QSF1) which covers their overall experience of introducing LSTs into their operations and their subsequent use. It allows space to record both the benefits they are realising from running the LSTs as well as any challenges they have faced. It therefore provides evidence that can contribute to 'lessons learned', which might benefit future companies who decide to operate LSTs.

The qualitative comments from newer LST operators remain consistent with those found early in the trial

4.106 We continue to receive QSF1 responses and find that the comments from the latest operators reiterate the broad themes seen in earlier years of the trial. The text here is broadly the same as was reported in last year's annual report, but has been included again as the points it raises will continue to be important in preparing for further engagement with the industry later in 2018.

4.107 The QSF1 was usually completed by operators at the end of their first or second period on the trial and so was a snapshot of their 'early' experience. It contains six open questions about the experiences of company participants in the trial, their staff or clients. In the 2015 annual report we presented analysis based on the first 111 QSF1s received. As a relatively small number of operators joined the trial in 2016 and 2017, the results of the QSF1 survey completed as companies join the trail have not been updated since the 2015 annual report was published. Full details of the results of the survey can be found in the 2014 and 2015 reports[10] and are summarised here:

- Most operators reported no problems incorporating LSTs into their existing operations - Operators reported no significant issues in loading or driving. A small proportion of operators reported issues around negotiating **client** depots and a few noted 'other' issues.
- Most operators provided or insisted on LST specific driver training in advance of operating LSTs.
- The majority of operators stated that they did not make any special preparations (other than the driver training) in advance of operating the LSTs. Outside the QSF1 process, we are aware of operators who have made operational adjustments once

they have gained some initial experience of using the LSTs, in particular, by arranging for them to be placed at the end of a line of loading bays at a depot.

- Just over half of respondents noted some self-imposed restrictions for LSTs, the most common being approved routes only and certain client depots. Others said they would not have to impose additional constraints as the nature of their general operation (for example, palletised trunking) is already suited to LSTs.
- It is worth noting that some of the companies who did impose some restrictions, did not see this as a problem, but simply a reflection of choosing to operate the LSTs in the most efficient or cost-effective way.
- Feedback received by respondents from their key stakeholders (mainly drivers) was positive.
- Asked about the overall impact on their business replies were again positive:
  - Increased commercial returns
    "Excellent - an additional benefit to the operation and reduced costs and maintenance"
  - No problems-excellent
    "Overall the new trailers are ideal for the trunking work we do on the pallet network"

    "Excellent, they drive like any other trailer and even better than a wagon and drag"
  - Reduced carbon footprint
    "Extra revenue for carrying goods and lower CO_2"

4.108 In December 2016, we launched a new qualitative survey (QSF2). We issued 157 invitations and received 92 useable responses by the time the data was 'frozen' for the 2016 report. Since that date we have received a further 34 useable returns, so the analysis presented in this report is now based on 126 operators.

4.109 The survey was designed to

- help validate information and analyses carried out using other sources of information, and to inform further analyses – the results of this element are reported at the appropriate points in the report
- provide an opportunity for operators to feedback some narrative about their experience of operating the LSTs from the perspective of a range of staff and the business as a whole - there is a small overlap between some of the areas covered in the QSF and those noted in the CIF.

4.110 The responses to this second element were consistent with those received in response to the QSF1. Specifically:

- A clear majority of operators (over 70%) reported positive experiences with the LSTs. Of these many mentioned the extra carrying capacity being cost effective.

  "we have seen a significant benefit by using the longer trailers both in overall operational efficiency and as a pure cost saving. If the opportunity arose, we would be interested in adding more of this type of trailer to our fleet"

  "Overall positive experience, increased capacity which in turn has reduced costs and given us greater flexibility."
- Other positive comments included: ease of handling and helping to meet corporate CO_2 targets.

  "on normal road driving the feedback I have received is that the trailer follows the tractor unit better that a standard trailer."

- Almost two thirds of the operators said that they restricted operations to set routes, either to maximise utilisation of the trailers (e.g. by running them on routes where they could use the extra space on all legs) or to avoid destinations where there were known access problems.

  "Good value for money once dedicated routes are formed"

- A number noted that the trailers were not suitable for ad hoc, or general operations because of access problems. A small number said they had carried out risk assessments and discussed operations with clients to make sure they could maximise utilisation.

  "They don't suit deliveries to a changing customer base (due to the various nature of the delivery site dimensions for example)."

  "General experience is good - not experienced any great operational issues provided routes, loading and unloading points are surveyed for suitability in advance."

- Where operators reported problems these mainly related to the access difficulties. Other issues raised included: the capital cost of the trailers, experience of, or fears of increased maintenance costs due e.g. to rear axle steering leading to extra tyre wear, and driver training requirements restricting their operation.

  "We have experienced issues with delivery areas for these vehicles and also manoeuvring them."

- Two operators noted negative experiences because of the data requirements of the trial and two because the type of work they had purchased the trailers for had reduced.

  "cut backs in local authority spending and customer load profile changes has meant the trailer has become almost redundant. We do try and use it on our general haulage operation but find it very difficult to utilise. The main problems are the weight carrying penalty of a standard trailer and manoeuvrability in tight spaces, although on normal road driving the feedback I have received is that the trailer follows the tractor unit better that a standard trailer."

  "No regrets in having our three LSTs as part of a mixed fleet. They have come in good use. Would not plan to expand the number at present due to hassle of buying and supplying data."

PART 2: TRIAL OUTCOMES

Journey reduction, emissions, safety and damage

We are interested in four anticipated outcomes of the trial, which we have explored through analysis of size measures under the main outcomes in the programme logic model.

Outcomes 1: (A) Journeys (B) Emissions Saved

The analysis of potential savings in journeys and distance travelled being realised in real operations is important as this is what drives the economics of adopting LSTs and the societal benefits in terms of safety gains and emissions savings. The analysis of journey/distance savings is covered in Section 5.

Section 6 contains the results of the detailed emissions modelling we have carried out since last year, showing the estimates of emissions saved on the trial to date and projected to the current planned trial end point.

Outcomes 2: Safety Impact

The analysis of **personal injury incidents** is vital to establish whether there are any indications that LST operations are increasing **safety risk** (relative to traditional trailers), particularly to other road users and vulnerable groups. This analysis is reported in Section 7. This year the analysis includes more refined segmentation of the results by road type/class, based on improved and calibrated route modelling.

Outcomes 3: Property Damage Impact

The analysis of **non-injury incidents** seeks to assess the **damage to property**, (assets or other vehicles) caused by LSTs in comparison to other trailers (Section 8.

Outcomes 4: Qualitative Experience

The outcomes in **qualitative experience** are based on the original QSF1 responses and the more recent QSF2 survey. These have been used to inform analyses throughout the report (rather than in a single, separate section).

Note: Intermodal effects of LST availability

We have carried out new analysis of the impact of LST availability on the intermodal (mainly road/rail) market. Any major change in the road/rail balance of freight movement would need to be considered in the journey savings, emissions and safety analysis.

The study – summarised in Annex 3 – concluded that:

1. Overall where routes operating LSTs (during the trial) might have competed with rail at a limited level, **rail has been able to respond effectively and integrate LST operations into its business model**.
2. This LST+Rail option **will not allow rail to increase its forecast volume, but is effective enough to avoid rail losing potential traffic to LSTs**.
3. The effect of introducing **LSTs can be regarded as neutral or at least a second order influence on operator's modal choice**

Therefore, there is no material intermodal market adjustment due to the trial and it does not need to be taken into account the various savings calculations in sections of Part 2.

5 TRIAL OUTCOMES 1A: DISTANCE / JOURNEYS SAVED

5.1 This section of the report deals with the analysis of distance and journeys saved from using LSTs compared with delivering the same goods using standard length trailers. The analysis of potential savings in journeys and distance travelled is important as this is what drives the economics of adopting LSTs and the societal benefits (safety gains and emissions savings).

5-1 Expressing the extent of use of the additional deck length

5.2 The fundamental measurement in the analysis of how efficiently the LSTs are operating is whether the additional length is being used, based on the declared 'Deck%' data reported by operators in their data submissions.

5.3 There are two main categories of semi-trailer operated in the trial, trailers up to 14.6m in length and trailers up to 15.65m in length. The additional length in each case is used to assess the extent of the additional loading as a percentage of a 13.6m trailer load. Of the trailers put into operation during the trial to date 88% have been 15.65m length.

5-2 Distance and journeys saved by using LSTs

Since the start of the trial, the use of LSTs has removed between 29 and 33 million vehicle kilometres of freight traffic from the roads of Great Britain. This equates to removing around 235-270,000 journeys by the 13.6 metre trailers (the longest standard articulated HGVs currently allowed on our roads).

5.4 Table 10 shows the cumulative vehicle kilometres saved during the trial. More detail is shown in Table 11 and Table 12 for 2017. The savings calculation process is described in detail in our previous Annual Reports[10] (Specifically, the 2014 report, Annex E).

5.5 The most important elements of the calculation are:

Distance saved based on use of additional deck space on LSTs

- The distance saving is estimated by comparing the actual distance travelled by the LSTs to an estimate of the distance that would have been travelled if the same quantity of goods (measured by the Deck% utilised) had been transported using standard 13.6m trailers, because they would have needed to make more journeys.
- Savings are 'claimed' only for legs where some/all of the extra trailer length is used.

Empty legs saved – upper/lower bound

- The upper bound takes account of some empty return journeys also being saved due to saving of whole round trips – loaded out and empty returns.
- The lower bound represents the basic calculation, considering only loaded legs and is therefore a more conservative estimate.
- Prior to 2016 we used the proxy of retail leg types to calculate this additional saving. During 2016 we improved the quality of the data and also created an algorithm to enable us to identify individual return empty legs matched to outward fully-loaded legs and assign round-trip savings to these whole trips.
- We have been prudent in our calculation of empty legs saved, only claiming those where our search algorithm can directly connect the empty leg back to a related loaded leg in a simple A>B>A or A>B>C>A pattern. More complex patterns are ignored in the savings calculation.

Table 10: Cumulative vehicle km saved by using LSTs

Distance saved (million vehicle km)	At end 2017	At end 2016	At end 2015	At end 2014	At end 2013
Lower bound	29.3	20.9	12.3	6.0	2.1
Upper bound	32.9	23.5	14.2	7.1	2.4

Summary of data from below in Table 11 and Table 12 for 2017 figures. Earlier years from past annual reports, recalculated without adjustment for additional fuel consumption.

Table 11: Distance savings to end 2017, lower bound

Source: LST trial data – Lower bound - loaded Legs Only Trailer Length:	14.6m	15.65m	Total
Total vkm for LST legs where additional deck length was reported in use	33,661,513	215,624,351	249,285,865
Total vkm operated by all LSTs	63,595,389	374,360,399	437,955,788
Percentage of vkm operated by LSTs where additional deck length was reported in use	53%	58%	57%
Range of potential saving for vkm operated by LSTs (additional load carried)	0-7%	0-15%	
Estimated net vkm saved (lower bound)	1,898,610	27,485,939	29,384,550

Table 12: Distance savings to end 2017, upper bound

Source: LST trial data – Upper Bound includes some empty legs Trailer Length:	14.6m	15.65m	Total
Total vkm for LST legs where additional deck length was reported in use	33,661,513	215,624,351	249,285,865
Vkm for legs where additional deck length was reported in use and to/from retail site (to end 2015)	1,667,706	17,110,711	18,778,417
Vkm for legs which represent return empty leg of an LST where additional deck length was reported in use outward bound round trip (2016 onwards)	696,861	5,377,112	6,073,973
Percentage of vkm operated to/ from retail sites where additional deck length was reported in use	5%	8%	8%
Vkm saved in non-retail operations	1,823,706	25,671,487	27,495,193
Vkm savings for outward retail journeys where additional deck length was reported in use	74,904	1,814,453	1,889,357
Total Vkm saved in retail operations (to end 2015)	149,809	3,628,906	3,778,714
Total Vkm saved in return legs of round trips (2016 onwards)	106,060	1,564,089	1,670,149
Estimated net vkm saved (upper bound)	2,079,574	30,864,482	32,944,056

Return legs with 'Empties/Waste Packaging'

- We have also been prudent in ONLY claiming a saved return leg when the journey is out full and back 100% empty. It would have been legitimate to also include return journeys carrying a partial load of 'Empties and Waste Packaging', since the operational pattern is the same and if using 13.6m trailers, the only difference would have been that the empties would have filled a slightly larger percentage of the trailer than for an LST.
- Including these legs with the 'empty' runs would have further improved the savings results but we decided that the prudent approach was to treat them as 'part loads'.

Additional fuel used when pulling LSTs is now reflected in the emissions work, not as a suppressing factor on the distance saving figures

5.6 In previous annual reports we modified the distance savings calculated from the journey logs and loading data by a fuel consumption factor (1.8%)[27] reducing the distance savings. This factor was introduced because in the earlier years of the trial, the distance saving was seen, by some, as a proxy for emissions savings. This fuel factor was used to reflect the increased fuel consumption and hence environmental impacts of the LSTs on all the legs travelled. The value of 1.8% was that assumed in the original impact assessment.

5.7 We have now carried out a more comprehensive analysis of the energy and emissions impacts of the LSTs (see Section 6) and this factor has therefore been removed from the vehicle-kilometre and journey saving calculation.

5.8 **The values now reported here reflect actual journey and distance savings**.

Distance saved

5.9 Reading directly from the tables above, **we estimate that 29 (lower bound) to 33 (upper bound) million articulated HGV km were removed from GB roads as a result of the trial to the end of 2017**.

Journeys saved

5.10 The vehicle kilometres saved shown in the tables above can be converted into a simple estimate of the number of journeys saved by dividing by the 123km average leg length recorded by vehicles in the trial, and rounding the results.

5.11 On this basis, **we estimate that 235,000 (lower bound) to 270,000 (upper bound) journeys were removed from GB roads as a result of the trial to the end of 2017**.

5-3 Proportion of distance and journeys saved by using LSTs

5.12 The analysis above calculates total distance savings. We also analyse savings as a percentage of distance operated and from this calculate an expression of the number of journeys saved compared with using standard length trailers to deliver the same goods.

5.13 Expressing the results in this form is, we have found, useful in articulating the benefit gained from operating LSTs to a wider audience.

[27] The 1.8% was the factor for increased energy consumption and hence tailpipe emissions in the original LST Impact Assessment.

Over the whole fleet and across the trial we estimate that the average percentage distance saving by operators is 7%, which equates to 1 in 14 journeys.

5.14 We arrive at this figure by dividing the distance saved from Table 10 by the total distance travelled by LSTs from Table 5. Both the lower and upper bound figures from Table 10 give the same percentage savings after rounding i.e. 7%.

Behind this average figure there are considerable differences in efficiency of operation and levels of loading across the range of operators taking part in the trial

5.15 Figure 22 illustrates the distribution of percentage distance savings by operators participating in the trial.

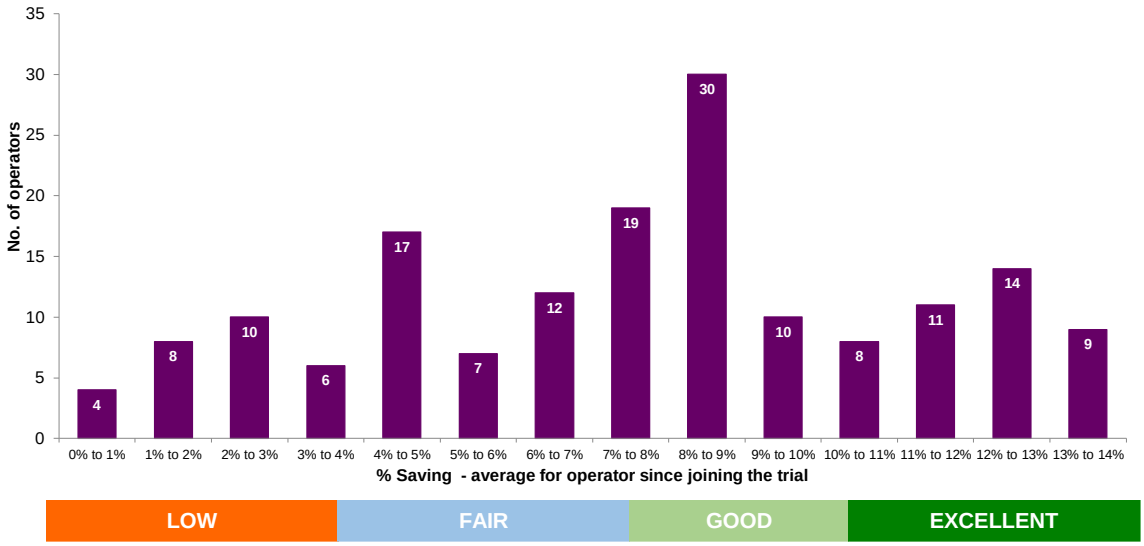


Figure 22: Distribution of % distance saved using LSTs, by operator

The theoretical maximum benefit

4.111 While the longest LSTs (15.65m) are often referred to as giving a "15% gain", this is actually a statement of the additional length (vs 13.6m. When calculating the reduction in journeys as a percentage of the number of 13.6m journeys to deliver a given number of pallets, the maximum 'saving' is just over 13%, for a standard single deck trailer.

4.112 There is a special case in which the **percentage** deck space gained by adding the additional length is greater than that for a single decker. Some of the dual deck trailers (both regular and LST lengths) have a profiled front edge to their roof, to offset the drag from the increased height required to make use of the dual decks. This reduces the loading space at the front of the upper deck, meaning that the total usable deck space is not double that of an equivalent single deck trailer. This means that as a **percentage**, the gain resulting from extending a trailer with a profiled front roof is greater than for an equivalent square fronted trailer, since the whole additional length is at the rear where the load area is full height. This potential further gain is noted, but no special additional benefits have been claimed for such trailers in the utilisation calculations in Section 5.

Confirmation of savings by operator experience

5.16 To help validate these findings, we asked operators (as part of the QSF2 survey described elsewhere) to consider whether our estimates of their savings from use of the longer trailers agreed with their own experiences and expectations.

5.17 This work, reported in the 2016 Annual Report, found that in the clear majority (90%) of cases the operators considered our estimates of percentage distance saved for their

operations to be in line with their own experiences. In several cases the operators who considered our assessment more pessimistic than they were experiencing on the ground realised they were under-reporting the utilisation of their trailers in the journey log returns. They agreed to modify their data collection processes to improve the quality of the data.

5.18 We also asked operators whether our assumptions about round trips made with empty return legs were in line with their actual operation. In almost all cases, the operator's own estimate band is the same as or higher than the calculated savings estimate.

5.19 **This confirms that in calculating savings in this way we do not appear to be over-estimating the savings compared to the operator's own experience**.

Number of LSTs by operator efficiency level

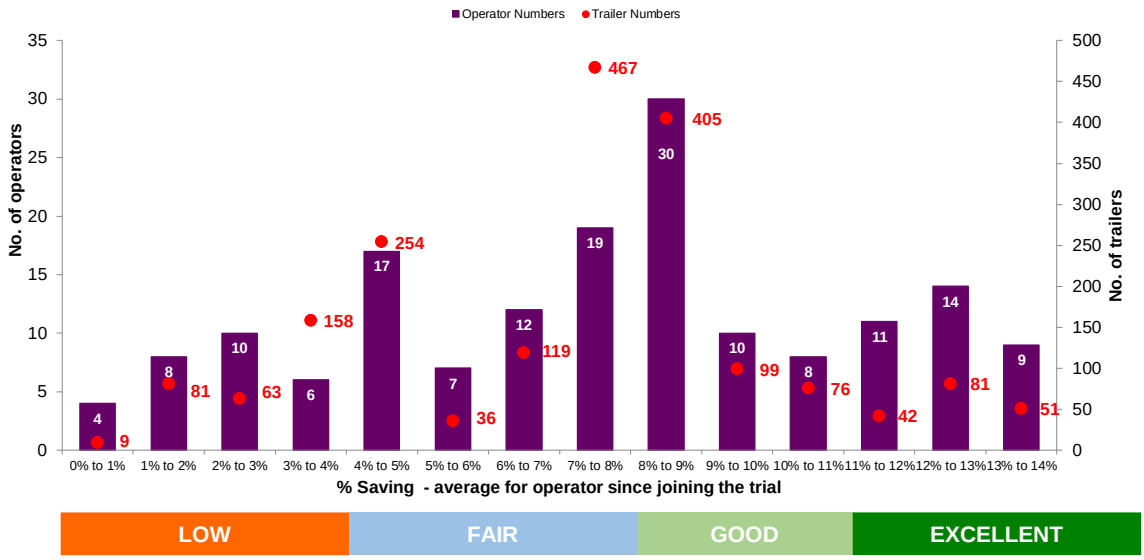


Figure 23: Distribution of % distance saved using LSTs, by operator and number of trailers

5.20 Figure 23 above shows the average savings by operator together with the number of trailers operated by each of those operators. This shows that at the very lowest efficiency end of the scale there are four operators, but they are only operating nine trailers, less than half of one percent of the total fleet. At the top end of the scale there are nine operators, operating 51 trailers, accounting for around 2.5% of the fleet.

5.21 The uneven distribution of trailers across the intervals can be explained by the distribution of larger and smaller fleets amongst the operators within the trial. There are a small number of larger fleets operating within the 3-4% and 4-5% efficiency ranges.

5.22 It is also notable that the two largest fleets are operating within the 7-8% efficiency range according to our calculations.

There are a number of cases where little or no benefit from LSTs is being reported

5.23 Figure 22 shows that some operators are making very low savings, and given that LSTs are expected to use more fuel per kilometre than standard trailers, this may translate into dis-benefits in terms of both environmental and economic impact. Figure 24 shows the impact of re-applying the fuel consumption factor (explained in paragraph 5.4) to the estimate of distance savings.

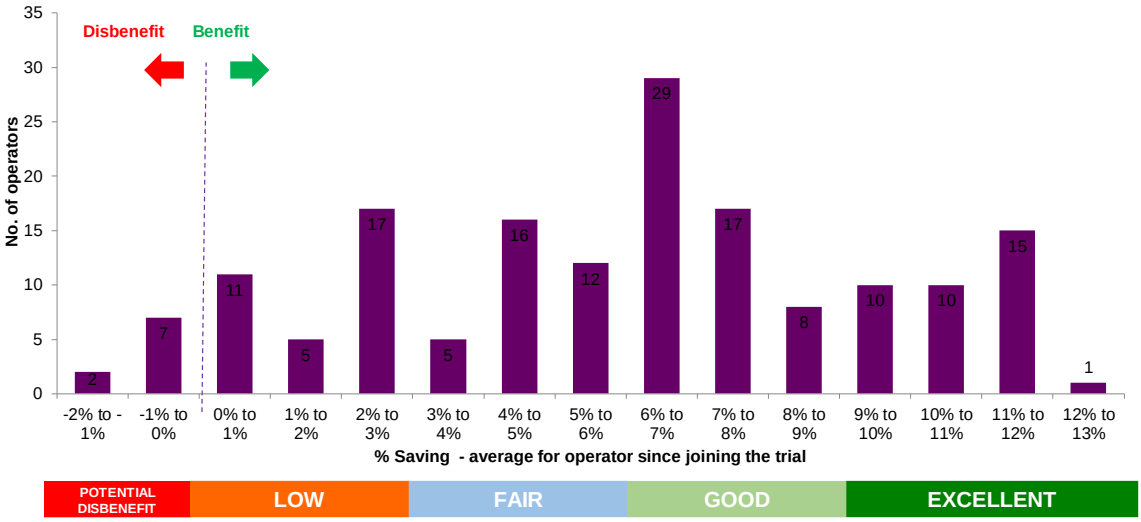


Figure 24: Distribution of % benefit using LSTs, by operator showing impact of applying a 1.8% fuel comsumption factor

5.24 A more detailed study of the operators appearing at the lower end of the range of benefits shows that there are possibly two groups.

Operators with complex operational patterns

5.25 The first group are operators where the data shows that their operation involves large numbers of 'out-full/back-empty' but we have not included these in our savings calculation as they are part of more complex operation patterns and so are not picked up by the algorithm described in paragraph 5.4. They are therefore not included in the 'upper bound' result which takes credit for the savings in numbers of return legs as well as outbound ones.

5.26 A more refined analysis of the operational patterns of operators could allow the upper-bound calculation to be applied to these operators. This would move them 'up' the savings range and the peak of the distribution in Figure 22 would move to the right.

Operators unable to operate the trailers efficiently in some periods

5.27 This leaves the second group, those operators who do not appear to be making use of the additional length of their LSTs very often. A small number fall in the 'Dis-benefit' section of the chart. Dis-benefits arise due to the assumed additional fuel used to operate the longer trailer, while not using any of the additional length available in loading.

5.28 In last year's report we said that we would investigate this further once we had collected all the remaining QSF2 results. Therefore, we have looked at the qualitative comments made by the 11 operators who completed the survey and who also appear in the three leftmost bars in Figure 24 (showing an average saving of less than 1% once the fuel penalty is taken into account). We found that five expressed a positive opinion of their LST experience anyway; five were broadly neutral; and only one expressed a negative opinion of their experience to date.

5.29 The reasons for the positive opinion, despite the perceived low average benefits, included the operational flexibility of having the extra capacity available when required, and the fact that for some operators the nature of their business means that they don't have full control of their loading levels:

> *"whilst on face value we are not getting the most from our LST's on a consistent basis we do get the value of the additional space as and when required. We are looking at opportunities within the group to fully utilise by gaining additional work"*

5.30 One operator with a positive opinion also said that they believed their utilisation had been under-estimated in the data recording.

5.31 The operators with a neutral opinion often said that operational issues were restricting the benefits that could be achieved, for example access limitations in customers' yards. They also often said that if they had more LSTs in their fleet and if more yards could accept them, then they would expect to see their utilisation benefits increase.

> *"not having a complete fleet gives operational issues hence they have to generally stay on round trips which reduces their impact and load fill savings. Not all retailers allow them on site due to yard size and axle configuration. . . Value would increase again if we had more and all sites / depots accepted them"*

5.32 The operator who expressed a negative opinion found that the extra loading space on a single deck LST gave them little benefit compared with the double deck standard trailers that make up the majority of their fleet.

Recommendation 2016-2: Understanding low efficiency use of LSTs

Now the QSF2 analysis has been completed, the consultation planned for autumn 2018 should include further enquiry with operators whose results suggest limited benefits from using LSTs to better understand the range of factors involved.

6 TRIAL OUTCOMES 1B: EMISSIONS SAVINGS

6.1 In this section we report the results of emissions modelling, carried out to estimate the potential emissions savings from using LSTs in place of standard length trailers when carrying the same cargo over the same duty cycle, particularly in terms of carbon dioxide (CO_2e) and oxides of nitrogen (NOx), important environmental pollutants.

6.2 In previous trial reports, emissions savings arising from using the trailers have been expressed as a simple metric of distance saved (compared with carrying the same goods on 13.6m standard trailers) as a proxy measure. The distance saved was reduced by applying a factor to account for additional fuel use (the fuel consumption factor), taken from the pre-trial estimates. As noted earlier (para 5.4) the fuel consumption factor has now been removed from the simple distance saving calculations presented in Section 5 as effects of any additional fuel use on emissions are now covered by the emissions modelling described here.

6-1 Approach adopted to emissions modelling

6.3 The emissions modelling carried out for this report differs from that performed in the pre-trial modelling in 2010-11, since that work was necessarily a forecast of the potential emissions savings from a fairly wide range of possible, but as yet un-built, LSTs designs, operating over theoretical duty cycles. The current modelling generates a much more refined analysis based on the actual LST designs that have emerged once the trial was launched and the actual operational patterns and duty cycles recorded in the trial data during 2017.

6.4 The emissions model takes as input the 2017 LST journey leg dataset of 830,000 individual legs, with defined start and end points and modelled routes, specified at the Integrated Transport Network (ITN) road link level, derived from the LST route modelling described earlier in Section 4.

6.5 The initial runs used input data from both 2016 and 2017, however, in the final analysis, the data was restricted to 2017 only, because we found that it was much more complete (in terms of routes that could be modelled) than 2016. Our judgement was that using this single year alone would produce better quality results than the two years combined, due to the data gaps (missing postcodes) in the 2016 information.

6.6 The 2017 sample year savings were then used to estimate:

- Emissions savings in previous years, based on the number of trailers and distances covered recorded by the trial, and
- Projections of emissions savings into the future based on a range of fleet growth scenarios.

6.7 Two types of results have been produced:

1. Savings as a percentage of the emissions that would be produced if the same goods were carried in standard length trailers:
   a. Total
   b. Segmented by Road Class/Type
   c. Segmented by a selection of defined air quality areas
2. Total emissions savings for the trial in tonnes:
   a. Actual savings to end 2017
   b. Projected savings to end 2021 – the original 10-year trial period
   c. Projected savings to end 2026 – the notional end of the 2017 trial extension

6.8 A summary of the emission modelling approach and key assumptions is given in this section. A complete explanation of the modelling is available in Project Note E2[28] (referred to throughout this section).

6.9 This work was carried out by a combined team of experts from Risk Solutions and specialists from WSP Air Quality team.

6-2 Emissions modelling

Emissions model selection

6.10 The key parameters considered in the emissions calculations are:

- Vehicle type (Euro category of the tractor unit pulling the trailer)
- Unladen weight
- Vehicle loading from unladen to 44 tonnes gross vehicle weight (gvw)
- Vehicle speed.

6.11 Without undertaking further modelling to create emissions functions specifically for LSTs, the most suitable emissions functions are provided by the **European Monitoring and Evaluation Programme (EMEP) \ European Environment Agency (EEA)** air pollutant emission inventory guidebook, chapter '1.A.3.b.i-iv Road transport', 2017. Emissions data within Defra's current Emissions Factors Toolkit (version 8) are based on these EMEP and EEA functions.

6.12 A full discussion of the choice of this model and its suitability for application in this analysis is given in Project Note E2, where we address the main questions around:

- using existing emissions functions where there are no LST specific emissions factors and coefficients available
- using the EMEP/EEA functions (adopted by Defra) which do not take into account the wider range of factors in a model such as PHEM (such as Aerodynamic Resistance and Rolling Resistance

6.13 The discussion in the Project Note has been reviewed in conjunction with DfT's specialists from the Vehicle Environment Team (part of DfT International Vehicle Standards) and we have agreed that for the analysis for which the model is being applied in this study, the functions used are fit for purpose.

6.14 This approach does not preclude DfT from commissioning an update of the pre-trial work using PHEM[29] to generate emissions functions for LSTs[30] specifically if it is believed that this would add further value or if further data were to be generated that would inform LST-specific function coefficients that were materially different to those for the equivalent 13.6m trailers.

Vehicle weights

6.15 Unladen LSTs are by their nature heavier than unladen standard trailers due to their increased length as well as other design features that may add weight such as steering axles. The functions in the emissions model have therefore been further developed to distinguish between conventional articulated HGV and LST vehicle types with an

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[28] Project Note E2: LST Emissions Savings September 2018 SPATS 1-403 PN-E2-v4-1

[29] PHEM (Passenger car and Heavy-duty Emission Model) is a vehicle emission model developed by the TU Graz since 1999. PHEM is based on an extensive European set of vehicle measurements and covers passenger cars, light duty vehicles and heavy-duty vehicles from city buses up to 40 ton semi-trailers.

[30] TRL (2010). *The likely effects of permitting longer semi-trailers in the UK: vehicle specification performance and safety*. Final Report LP0807 for DfT.

unladen load penalty for LST vehicles, and to calculate the emissions relative to an equivalent journey using a standard (13.6m) trailer.

6.16 The final results have been refined to take account of both

- Linear load penalties associated with design features that will scale directly with trailer length, such as deck layout (single, dual) and body design (flatbed, box, skeletal etc), and
- Design features that will add a fixed load penalty irrespective of trailer length such as number and type of steering axles.

6.17 All trailers have a base weight assumed to be the weight of the equivalent 13.6m trailer of similar type (deck layout, body design and with a single, non-steering axle) and all trailers are assumed to be pulled by an identical tractor unit of fixed weight (the same weight used in the pre-trial work).

For every trailer in the fleet, the overall **unladen vehicle weight** is obtained by adding the base trailer weight to the tractor weight, the steering axle weight and the additional length of the trailer greater than 13.6m multiplied by the factor for that design of trailer. Full details of the values used are in Project Note E2 (see Annex B of the note).

6.18 The **Gross Vehicle Weight**, required for the emissions function, is then derived by adding the recorded goods weight as declared by the operator for each leg to the calculated unladen vehicle weight for the specific trailer operating that leg. (Capped at 44 tonnes, as we assume that operators have been operating legally on the roads, and any excess is likely to have been generated by our calculation assumptions.)

6.19 Further work is planned during 2018 with SMMT to obtain the latest actual values for the marginal weights of individual LST designs, compared to their 13.6m equivalent. This will be used to update the results in later trial reporting.

Engine type

6.20 At this stage, the modelling has been based on EURO V engines, although the actual fleet will have been mixed. This starting position has been taken because:

- It was also the assumption made in the pre-trial emissions estimates
- For the majority of the trial to date, EURO V would probably be the most common engine type in use.

6.21 An increase in EURO VI engines would reduce the emissions across all fleets and hence the absolute savings would be reduced in proportion to the uptake of the newer engines and reduction in the fleet using EURO V or older equipment.

6.22 Future work could be conducted to nuance the results by using variable fleet engine mixes. This adjustment may be important in estimating the emissions impact of LSTs were they to be made more widely available following the trial, since they would appear in larger numbers in the fleet and the analysis would be over the longer period, during which EURO VI adoption would increase.

Speed

6.23 Two sets of speed scenarios have been modelled.

6.24 **The first is a simple reference table of vehicle speeds based on the road class**. These are related to the vehicle speeds used in the route modelling to influence route choice, but they need not be so.

6.25 These vehicle speeds are not the speed limits (but are always within them) so they do account for some normal speed variations and on minor roads are set quite low. These speeds have been set by experimentation with both the routing and emissions model

with the intention of giving route journey times that are **broadly representative of an uncongested flow scenario**.

6.26 The second scenario has the speed used for a link moderated by any difference between the modelled journey time and that declared by the operator for the specific journey leg. This is treated as a bounding case which is closer to the real-world scenario but which we have reason to believe it more likely to overestimate the journey time than to underestimate it. This is explained in more detail in Project Note E2.

6.27 **For our primary results, we have used the uncongested flow scenario.**

6.28 This might seem counter-intuitive, but the reasoning is that for the specific purpose of this modelling, it is the prudent choice. The absolute emissions impact for a vehicle is higher in congested traffic, but here we are interested in the saving between the emissions from an operation running LSTs (with fewer journeys) than moving the same goods using 13.6m trailers.

6.29 **Since the dominant factor in the saving is the reduced journey count, the results assuming uncongested flow yield relatively modest (and hence conservative) savings compared to those with congested traffic.**

Emissions model implementation

Calculating emissions

6.30 The full technical description of the model is given in Project Note E2 for those wishing to review the method at that level.

6.31 In simple terms, the emissions are calculated at a road link level applied during the processing of every unique A>B journey in a single database connecting the emissions model to the results of the routing model.

LST vs non-LST Emissions

6.32 The model generates two separate estimates of the emissions, one for the actual LST legs and the other for a hypothetical set of non-LST legs moving the same goods. This is done by calculating the modelled emissions twice for every leg in the dataset:

- For the LST leg: Using the calculated gross vehicle weight as noted above
- For the non-LST leg: Using,
  - An increased length for each road link in the journey, representing the additional journey legs that would be necessary to transport the same goods using a standard length trailer. This additional link length is calculated using the existing leg by leg distance saving factors already produced in the main trial evaluation of utilisation levels (see Section 5)
  - A non-LST vehicle weight based not on the LST trailer type but the standard 13.6m trailer length and axle configuration
  - A re-distribution of the weight carried on the LST leg across the hypothetical non-LST legs to ensure that the same total goods are carried by the LST and non-LST journeys.

6.33 The result is that for every leg, for every ITN link, in 2017 the model returns emissions values for both the LST and the hypothetical non-LST equivalent. While these should not be taken as accurate emissions estimates for any individual leg (which would be influenced by other environmental factors), when aggregated up we believe this is a reasonable modelling approach.

Emissions modelling spatial analysis

6.34 By linking the emissions model to the routing model, we have been able to estimate not just the overall scale of emissions savings from the trial LSTs, but also the location:

- By the proportion saved on each road type
- By the proportion of the savings occurring in a number of spatial areas of interest.

6.35 The areas of interest for which we have produced results are show in Table 13 (overleaf). The results for each area were produced by analysing every road link on each of the 56,000 unique LST routes and calculating the proportion of each link that falls into each of these spatial areas. The emissions analysis can then be segmented to show the savings that occurred within each area.

6.36 Sites with SAC, SSSI, Ramsar and SPA designations are commonly referred to as 'Designated Sites'. These sites may have cited features that are sensitive to changes in ambient NOx, nitrogen deposition and acid deposition that can be brought about by changes in traffic emissions of NOx – particularly from roads within 200m. We have also therefore calculated the emissions savings in any of the Designated Sites.

6.37 We calculated the proportion of each ITN road link that falls inside each area of interest by comparing every ITN road link shape with GIS shape files for the areas of interest. For Designated Sites we added a 200m buffer zone to each shape, to ensure we included road links that are on the boundary of an area. PCM areas are lines (roads), so we added a 100m buffer zone to each shape to allow for slight variations in road shapes. AQMA areas contain a mixture of shapes and lines (roads), so we added the 200m buffer zone. Figure 25 shows examples of SSSI (red) and PCM (blue) areas with a 200m and 100m buffer zone near the M25. Roads used by LSTs are shown in black. Road links that have a proportion of their length inside sensitive areas are coloured.

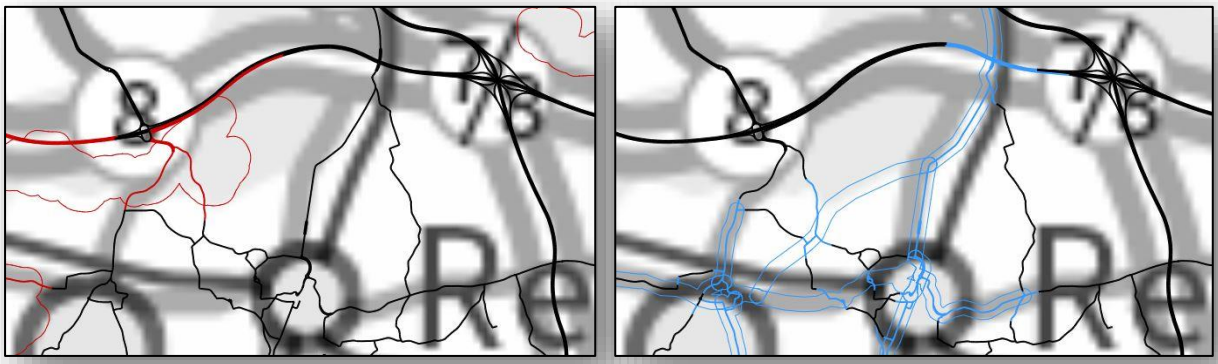


Figure 25: SSSI (red) and PCM (blue) areas of interest with road links used by LSTs (black)

Table 13: Emissions modelling spatial areas of interest

	Area of interest in emissions modelling
AQMA	Air Quality Management Areas are areas where air pollutant concentrations exceed or are likely to exceed the relevant air quality objectives. AQMAs are declared for specific pollutants and objectives. [Definition: Defra LAQM.TG(16)] https://laqm.defra.gov.uk/technical-guidance/
PCM Links	The Pollution Climate Mapping model is a collection of models designed to fulfil part of the UK's EU Directive (2008/50/EC) requirements to report on the concentrations of particular pollutants in the atmosphere. These models are run by Ricardo Energy & Environment on behalf of Defra. There is one model per pollutant (including NO_x, NO_2, PM_{10}, $PM_{2.5}$ and other pollutants) each with two parts: a base year model and a projections model. The PCM provides outputs on a 1x1 km grid of background conditions plus representative roadside values for around 9,000 links. PCM is also used for scenario assessment and population exposure calculations to assist policy developments and also provides model runs to support the writing of Time Extension Notification (TEN) applications for PM_{10} and NO_x. [Definition: Defra] https://uk-air.defra.gov.uk/research/air-quality-modelling?view=modelling
SAC	Special Areas of Conservation are strictly protected sites designated under the EC Habitats Directive. Article 3 of the Habitats Directive requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the 189 habitat types and 788 species identified in Annexes I and II of the Directive (as amended). The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds). [Definition: JNCC] http://jncc.defra.gov.uk/page-23
Ramsar	Ramsar sites are wetlands of international importance designated under the Ramsar Convention. [Definition: JNCC] http://jncc.defra.gov.uk/page-161
SSSI / ASSI	Sites of Special Scientific Interest (England, Scotland and Wales) and Areas of Special Scientific Interest (Northern Ireland). [Definition: JNCC] http://jncc.defra.gov.uk/page-1527
SPA	Special Protection Areas are strictly protected sites classified in accordance with Article 4 of the EC Birds Directive, which came into force in April 1979. They are classified for rare and vulnerable birds (as listed on Annex I of the Directive), and for regularly occurring migratory species. The European Commission's website hosts a full copy of the Directive 2009/147/EC on the conservation of wild birds (Birds Directive) (the codified version of Council Directive 79/409/EEC as amended), within which all the Articles and Annexes (including amendments) are given, along with useful interpretation information. [Definition: JNCC] http://jncc.defra.gov.uk/page-162

6-3 Projecting whole trial emissions savings

Trial to date

6.38 The modelling has been applied to the most recent year of data, 2017, as described above.

6.39 Data for previous years is derived for each previous year by:

- First calculating for each type of emissions an emission saving factor – which is the emissions saving per LST km derived from the 2017 results
- Then calculating total emissions for each previous year as:

  Total Emissions =
  No of legs in year ***x*** *average leg distances* ***x*** *emissions saving per LST km*

6.40 This approach assumes that previous years have operational patterns that are not grossly different to 2017. Risk Solutions wider analysis of the trial data provides assurance that this is a reasonable assumption, based on the fact that key indicators such as the average journey leg length, loading percentages and calculated savings have been stable for all years, at least once the first 1-2 trial data periods were completed.

6.41 In this way emissions savings generated by using LSTs instead of standard length trailers have been estimated for all the years of the trial up to the end of 2017.

Remaining trial years

6.42 In order to extend the modelling to future years, we need first to estimate the number of LSTs likely to be on the trial in each year, which is done by considering how many LSTs might join the trial in each period from 2018-P1 onwards.

6.43 We have considered **three LST trial fleet growth scenarios** for the remainder of the trial, as described in Table 14.

Table 14: LST Trial fleet growth scenarios

Fleet Scenario	Description
S0: ORIGINAL 10yr trial with 1800 LSTs	The closest scenario to the original trial plan, where there would be only 1800 LSTs and a duration of 10 years. The original trial plan and modelling assumed all 1800 trailers were on the road by the end of the first year, whereas in fact this was only achieved at the year of 2016, year 5 of the trial.
S1: EXTENSION FLEET ONLY TO 15yr	This may not be a real scenario, but at the present time, it is unclear whether, if the trial were to continue past year 10, the original 1800 trailer allocations would be extended alongside the additional 1000 trial places released in April 2017. This theoretical option models a scenario in which DfT decides NOT to adopt a policy allowing LSTs to be used beyond the trial, but fulfils its commitment to the 'new' 2017 allocations which appear to be valid for a further 5 years.
S2: WHOLE FLEET TO 15 Yrs	**This is the more realistic scenario, where the WHOLE LST fleet would remain on the road until year 15**. (In reality, this refers to the allocations remaining valid, with many of the actual trailers being replaced when they reach end of life)

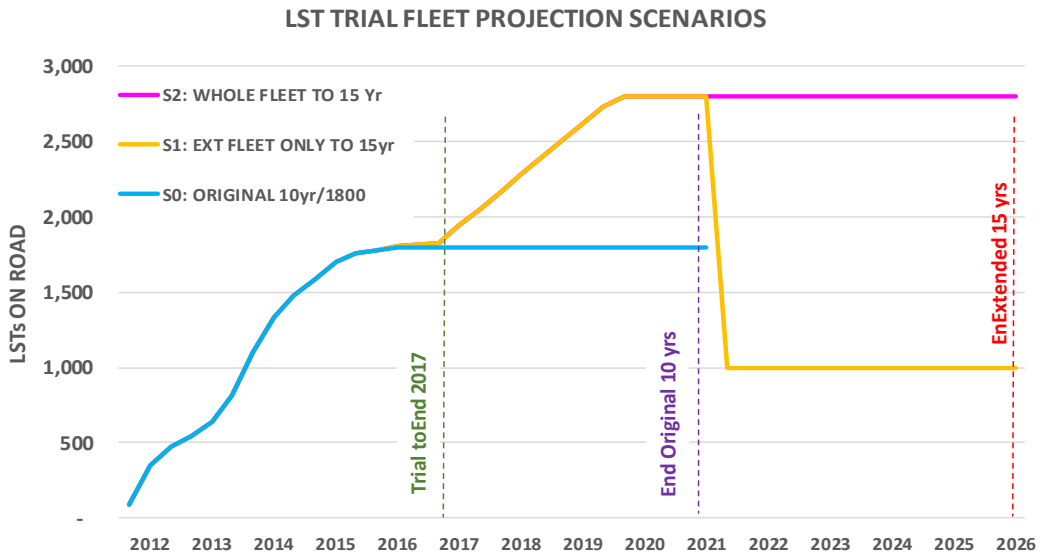
6.44 The final variable to be considered is how fast the remaining trial trailer allocations are finalised (during 2018) and those trailers come onto the road. Our current modelling has assumed that 114 new trailers enter service in each 4-month period – the number we saw added in 2017-P3 and the average of the past 2-3 periods. By modelling with a fairly conservative assumption about fleet growth we are bring prudent in that this will produce commensurately conservative emissions savings results.

6.45 **The resulting fleet growth curves for each scenario are shown in Figure 26**.

6.46 For years up to 2017 we have data for the actual leg count and total distance covered by the LSTs. For 2018 onwards we have projected values based on the number of trailers in the fleet growth curve, combined with estimates for average numbers of legs and leg length per trailer, from 2017 (as the most recent year).

6.47 For the current report, we have used Scenario 2 (above) for these calculations, as it covers all the LSTs so far built or allocated by DfT. Alternative results for other scenarios can be produced if DfT requires.

6.48 **The resulting fleet annual distance curve for Scenario 2 is shown in Figure 27.**



EXTENDED FLEET GROWTH

ASSUMED ADDITION RATE - TRAILERS PER PD	**114**	Actual trailers added in 2017-P3
RESULTING PROJECTION - PERIOD ALL ON ROAD	**2020-P2**	We may expect higher rates in 2018
		Rate for 1000 on road by 2019-P1 would be 225

Figure 26: LST Trial cumulative fleet growth curves

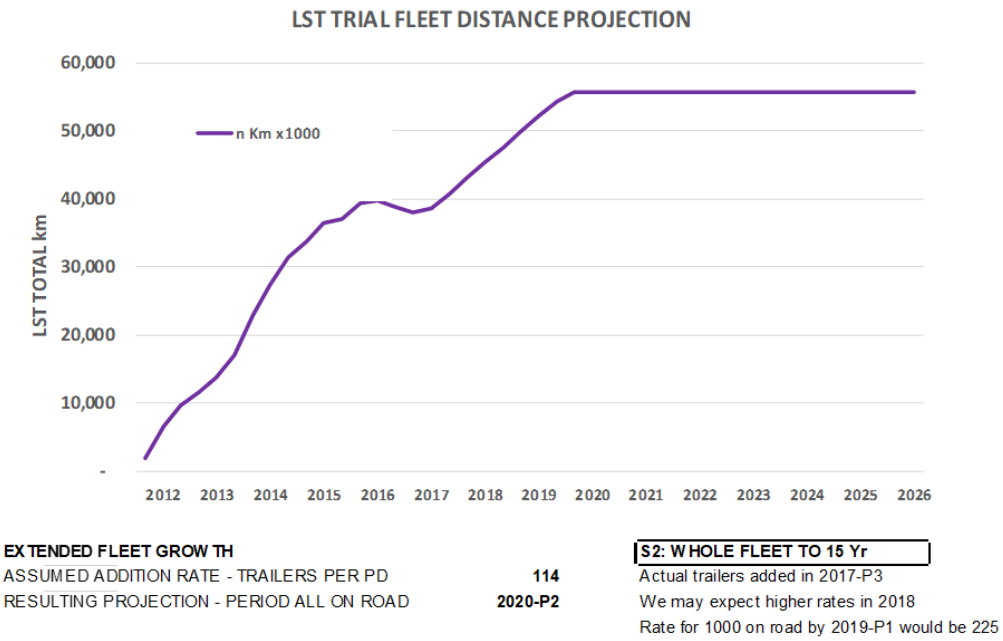


Figure 27: LST Trial fleet annual distance projection (Scenario 2)

6.49 The slight 'dip' in the centre of the curve arises from an unusual set of data for a small number of operators who appear to have operated 10-20% fewer legs /km with their fleet of LSTs in 2017, compared to 2016. We are in touch with the operators to see what caused this change as it does not appear to be the result of missing data legs, nor a reduction in their LST fleet size. In at least one major case, they have streamlined their use of LSTs to focus on shorter routes where they can be used most effectively for operational reasons.

6-4 Emissions results - reference year (2017)

6.50 The total emissions results for the reference year (2017) are shown in Table 15. Overall savings for all pollutants of approximately 7% are indicated for the trial.

Table 15: Total savings assuming uncongested flow (2017)

[tonnes emissions]	CO	CO2e	NOx	PM Exhaust	VOC
LST	49.8	81,278	412	4.44	9.60
Non-LST	53.7	87,772	445	4.79	10.35
Saving	**3.9**	**6,494**	**32.6**	**0.038**	**0.744**
% Saving	*7.2%*	*7.4%*	*7.3%*	*7.3%*	*7.2%*
Saving per LST mkm	***0.038***	***63.6***	***0.32***	***0.0034***	***0.0073***

6.51 The total mass emission saving for NOx of 32.6 tonnes can be put in the context of total UK emissions for articulated HGVs in 2016 of approximately 16,000 tonnes (the latest available data) – or approximately 0.2% of total sector emissions. Likewise, the CO2e emissions saving of 6,494 tonnes compares to total UK emissions for articulated HGVs

in 2016 of approximately 12,114,667 tonnes – or just less than 0.05% of total sector emissions. These figures are of course quite a small proportion of the total, since the number of trailers on the trial is only a small percentage of the total GB fleet. A more meaningful comparison will come with the scaling up work to be carried out in the coming year (see Section 9).

6.52 The bottom row of Table 15 gives the emissions savings expressed as a factor in tonnes per LST km, calculated from the 2017 data. This is used later to apply these reference year results to both actual LST distances covered in earlier trial years and the projected distances for future years.

6.53 The breakdowns that follow show the emissions results by road type (Table 16) and areas of specific interest regarding emissions (Table 17), with the further breakdown of emissions saved in 'Designated Areas' into the sub-areas (which overlap) in Table 18.

Emissions by Road Class

6.54 When broken-down by road class, the percentage savings remain around 7% for all classes, the small variations reflecting minor variations in the savings of journeys with differing road class proportions.

6.55 The most substantial savings in total tonnes are with LSTs operating on motorways, with savings of 3,921.7 and 19.4 tonnes of CO2e and NOx respectively, reflecting the high proportion of operations that take place on Motorways. However, these have a lower saving per km, due to the more efficient engine performance on these roads.

6.56 The most notable savings in tonnes per LST million kilometre (mkm) for CO2e and NOx are those for Trunk A and minor roads.

Emissions by Areas of Interest

6.57 **In considering the emissions in 'areas of interest' the focus is on the impact of emissions on health, where the main emissions of interest are NOx and Particulates**. In looking specifically at the Designated Sites, the only emission of interest is NOx. The other emissions are still calculated by the model and so are included for completeness, but are de-emphasised in the remaining results tables.

6.58 The results for areas of interest indicate potential benefits in particular with savings in NOx emissions which complements initiatives to reduce emissions in AQMAs and Designated Sites, and on PCM links with non-compliance with the annual mean limit value for NO_2 at roadside.

6.59 **15% of the emissions savings are in Air Quality Monitoring Areas (AQMAs)** where air pollutant concentrations already exceed or are likely to exceed relevant air quality objectives defined by Defra

6.60 Sites with SAC, SSSI, Ramsar and SPA designations are commonly referred to as **Designated Sites**. These sites may have cited features that are sensitive to changes in ambient NOx, nitrogen deposition and acid deposition that can be brought about by changes in traffic emissions of NOx – particularly from roads within 200m.

6.61 **A specific location can fall within the geo-spatial areas of more than one type of Designated Site, since their definitions allow them to overlap**. The values given in Table 17 remove this duplication and show the results for emissions savings made on road links falling in ANY designated site. The values in Table 18 note the savings for road links falling in each individual designated site, calculated separately, irrespective of whether those savings ALSO appear under other sections of the table.

6.62 **6.2% of the emissions savings are being made within 200m of one or more Designated Areas (SAC, Ramsar, SSSI, SPA)**

Table 16: Emissions savings by road class (uncongested flow - 2017)

By Road Type[tonnes]	CO	CO2e	NOx	PM Exhaust	VOC
Motorway					
LST	28.7	48,961.7	245.0	2.6	5.6
Non-LST	31.0	52,883.4	264.5	2.8	6.0
LSTSAVING	**2.2**	**3,921.7**	**19.4**	**0.2**	**0.4**
% Saving vs non-LST	*7.2%*	*7.4%*	*7.3%*	*7.3%*	*7.2%*
% of total 2017 saving	**58.2%**	**60.4%**	**59.7%**	**59.5%**	**58.5%**
Saving per LST mkm	*0.04*	*61.95*	*0.31*	*0.00*	*0.01*
Major (A Road)					
Trunk A Road					
LST	11.3	18,527.7	93.8	1.0	2.2
Non-LST	12.2	20,086.8	101.6	1.1	2.4
LST SAVING	**0.9**	**1,559.0**	**7.8**	**0.1**	**0.2**
% Saving vs non-LST	*7.5%*	*7.8%*	*7.7%*	*7.6%*	*7.6%*
% of total 2017 saving	**23.9%**	**24.0%**	**24.0%**	**24.1%**	**23.9%**
Saving per LST mkm	*0.07*	*120.87*	*0.61*	*0.01*	*0.01*
Principal A Road					
LST	6.9	10,697.2	55.1	0.6	1.3
Non-LST	7.4	11,478.4	59.1	0.6	1.4
LST SAVING	**0.5**	**781.2**	**4.0**	**0.0**	**0.1**
% Saving vs non-LST	*6.5%*	*6.8%*	*6.7%*	*6.6%*	*6.6%*
% of total 2017 saving	**12.6%**	**12.0%**	**12.2%**	**12.3%**	**12.5%**
Saving per LST mkm	*0.02*	*32.68*	*0.17*	*0.00*	*0.00*
Minor Roads					
LST	2.9	3,091.8	18.5	0.2	0.5
Non-LST	3.1	3,323.5	19.9	0.2	0.6
LST SAVING	**0.2**	**231.6**	**1.4**	**0.0**	**0.0**
% Saving vs non-LST	*6.7%*	*7.0%*	*6.8%*	*6.8%*	*6.7%*
% of total 2017 saving	**5.3%**	**3.6%**	**4.2%**	**4.1%**	**5.1%**
Saving per LST mkm	*0.10*	*112.46*	*0.66*	*0.01*	*0.02*

Table 17: Emissions savings for areas of interest (uncongested flow - 2017)

[tonnes]	CO	CO2e	NOx	PM Exhaust	VOC
AQMA					
LST	7.67	12,568	63.7	0.69	1.48
Non-LST	8.25	13,548	68.6	0.74	1.59
Saving	**0.58**	**979**	**4.9**	**0.052**	**0.112**
% Saving vs non-LST	*7.0%*	*7.2%*	*7.1%*	*7.1%*	*7.0%*
% of total 2017 saving	***15.0%***	***15.1%***	***15.0%***	***15.0%***	***15.0%***
Saving per LST mkm	*0.036*	*61.8*	*0.31*	*0.003*	*0.007*
PCM Links					
LST	6.39	10,242	52.3	0.57	1.23
Non-LST	6.86	11,021	56.2	0.61	1.32
Saving	**0.47**	**780**	**3.9**	**0.042**	**0.090**
% Saving vs non-LST	*6.8%*	*7.1%*	*7.0%*	*6.9%*	*6.8%*
% of total 2017 saving	***12.2%***	***12.0%***	***12.0%***	***12.1%***	***12.1%***
Saving per LST mkm	*0.04*	*61.2*	*0.31*	*0.003*	*0.007*
Designated Sites					
LST	3.27	5,340	27.1	0.29	0.63
Non-LST	3.51	5,742	29.1	0.31	0.68
Saving	**0.24**	**403**	**2.0**	**0.021**	**0.046**
% Saving vs non-LST	*6.8%*	*7.0%*	*6.9%*	*6.9%*	*6.8%*
% of total 2017 saving	***6.2%***	***6.2%***	***6.2%***	***6.2%***	***6.2%***
Saving per LST mkm	*0.036*	*60.2*	*0.30*	*0.003*	*0.007*

Table 18: Emissions savings for Designated Sites (uncongested flow - 2017)

[tonnes]	CO	CO2e	NOx	PM Exhaust	VOC
Ramsar					
LST	0.28	440	2.27	0.02	0.05
Non-LST	0.30	472	2.43	0.03	0.06
Saving	**0.02**	**32**	**0.16**	**0.002**	**0.004**
% Saving	*6.4%*	*6.7%*	*6.6%*	*6.5%*	*6.5%*
Saving per LST mkm	***0.04***	***58.0***	***0.29***	***0.003***	***0.007***
SAC					
LST	1.74	2,892	14.59	0.16	0.34
Non-LST	1.87	3,102	15.64	0.17	0.36
Saving	**0.12**	**211**	**1.05**	**0.011**	**0.024**
% Saving	*6.5%*	*6.8%*	*6.7%*	*6.6%*	*6.6%*
Saving per LST mkm	***0.03***	***57.9***	***0.288***	***0.0031***	***0.0065***
SPA					
LST	0.75	1,164	6.01	0.06	0.14
Non-LST	0.80	1,250	6.45	0.07	0.15
Saving	**0.05**	**86**	**0.44**	**0.005**	**0.010**
% Saving	*6.7%*	*6.9%*	*6.8%*	*6.8%*	*6.7%*
Saving per LST mkm	***0.04***	***61.0***	***0.311***	***0.0033***	***0.0073***
SSSI					
LST	2.10	3,448	17.45	0.19	0.40
Non-LST	2.26	3,721	18.81	0.20	0.44
Saving	**0.16**	**273**	**1.37**	**0.015**	**0.031**
% Saving	*7.1%*	*7.3%*	*7.3%*	*7.2%*	*7.1%*
Saving per LST mkm	***0.04***	***62.8***	***0.314***	***0.0033***	***0.0071***

6-5 Emissions results - whole trial

6.63 The final row of Table 15 gives the emissions savings expressed as a single factor in tonnes (of emissions) per million LST km, calculated from the 2017 data.

6.64 The total emissions at three key time points in the trial are shown in Table 19, derived by applying the factors above, pro-rata, to the total LST distances covered in each year from the total fleet distance curve in Figure 27.

Table 19: Total trial emission savings projection

LST TRIAL EMISSIONS SAVINGS SUMMARY				
FLEET SCENARIO:		**S2: WHOLE FLEET TO 15 Yr**		
ASSUMED ADDITION RATE - TRAILERS PER PD:			**114**	
RESULTING PROJECTION - PERIOD ALL ON ROAD:			**2020-P2**	
(All figures rounded)	units	**To Date**	**10yr Trial**	**Extended Trial**
		End 2017	**End 2021**	**End 2026**
Trial fleet stats (Actual/projected)				
LSTs on road		1,939	**2,800**	2,800
Total journey legs	million	4	**8**	15
Total distance covered	million km	443	**1,055**	1,889
SAVINGS:	tonnes			
Carbon Monoxide	CO	17	**40**	71
Carbon Dioxide equivalent	CO2e[31]	28,180	**67,030**	120,066
Oxides of Nitrogen	NOx	141	**336**	602
Particulate Matter (Exhaust)	PM Exhaust	2	**4**	6
Volatile Organic Compounds	VOC	3	**8**	14

6.65 If we consider the key metrics of Carbon Dioxide (as a dispersed emission) and Oxides of Nitrogen (as a localised emission) we estimate:

- **A net reduction from TRIAL TO DATE of around 28,000 tonnes of CO2(e) and 141 tonnes NOx, as well as other emissions**.
- **A PROJECTED net reduction if the trial were to run to the original 10-year end point of around 67,000 tonnes of CO2(e) and 336 tonnes NOx, as well as other emissions**.

6.66 In terms of where the emissions have been reduced, the analysis shows that for the trial

- **15% of the emissions savings noted above are being made in Air Quality Monitoring Areas (AQMAs)** where air pollutant concentrations already exceed or are likely to exceed relevant air quality objectives defined by Defra
- **6.2% of the emissions savings noted above are being made within 200m of one or more Designated Areas (SAC, Ramsar, SSSI, SPA)** – areas which have cited features that are sensitive to changes in ambient NOx, nitrogen deposition and

[31] Carbon dioxide equivalent" or "CO2e" is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO2e signifies the amount of CO2 with an equivalent global warming impact

acid deposition that can be brought about by changes in traffic emissions of NOx – particularly from roads within 200m.

6.67 These results related to the trial conditions, fleet and operational patterns. They will be segmented by operator type and used to estimate the results at GB level post-trial in the 'scaling up model' (See Section 9.

6.68 **The cumulative tonnes saved for each emission is shown in the curves at the end of this report section.** These are all for LST fleet growth scenario 2 in Table 14, where both the original 1800 LST allocations and the extended trial 1000 trailers are permitted to continue on the road to year 15.

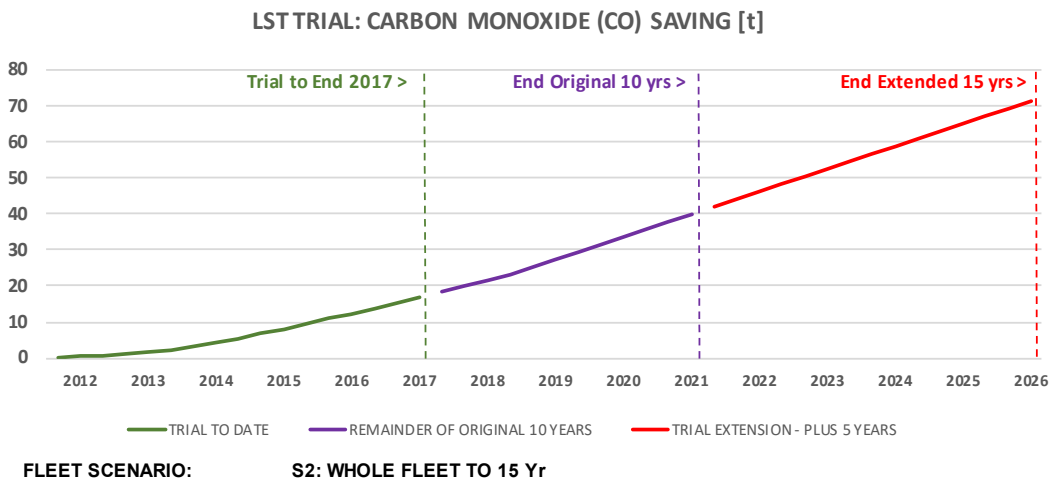


Figure 28: Emissions savings - whole trial projection: CO

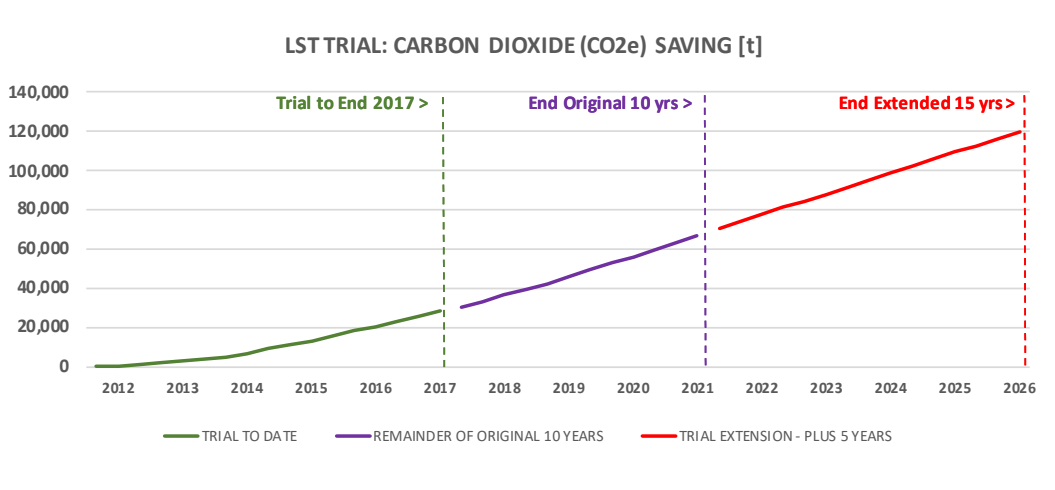


Figure 29: Emissions savings - whole trial projection: CO2(e)

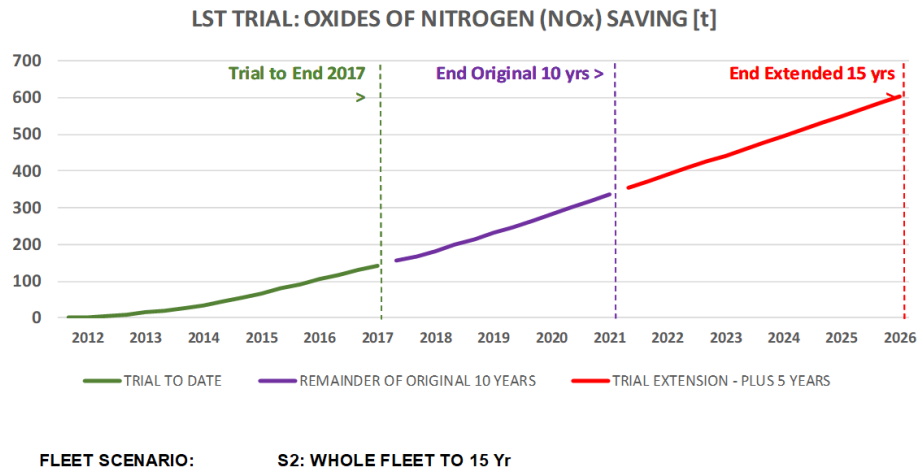


Figure 30: : Emissions savings - whole trial projection: NOx

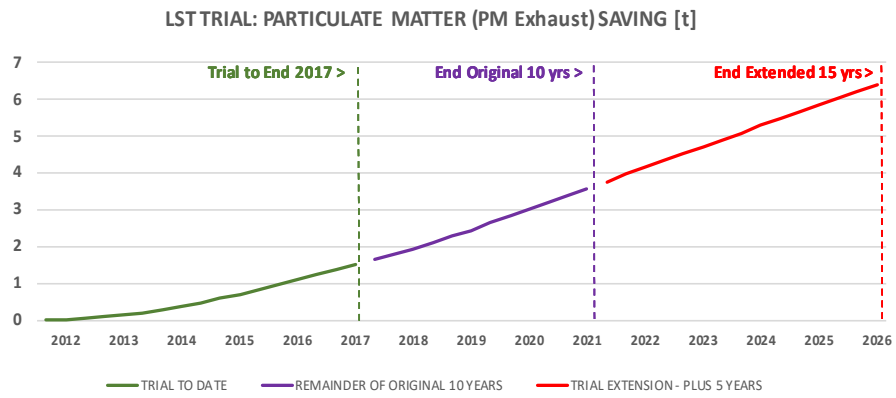


Figure 31: Emissions savings - whole trial projection: PM (Exhaust)

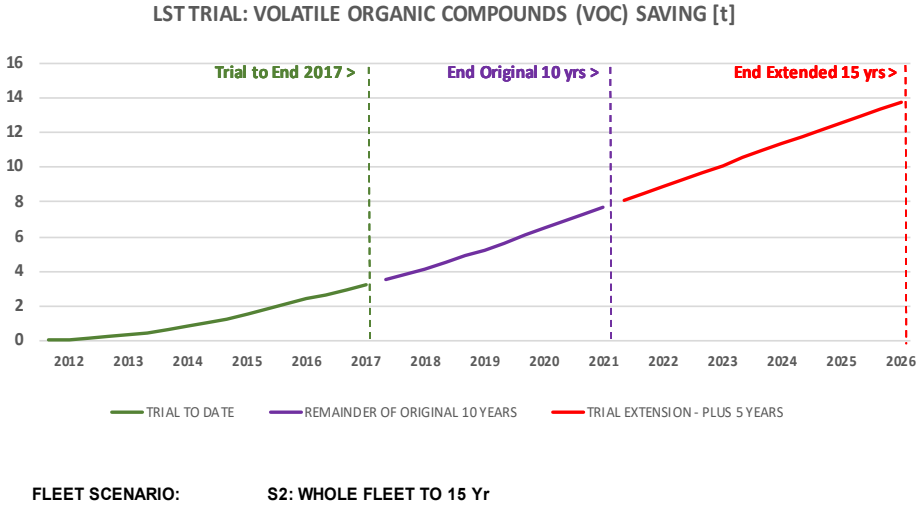


Figure 32: Emissions savings - whole trial projection: VOC

7 TRIAL OUTCOMES 2: SAFETY IMPACT

7.1 As in past reports, we analyse the safety impact of the LSTs in the trial by:

- Estimating the absolute saving in injuries arising from the reduction in journeys
- Comparing the per km incident and casualty rates for LSTs with that published for the GB fleet of articulated HGVs as a whole. We analyse the incident rates nationally and then also for 'urban operations' and by road type.

7.2 We present the data on injuries that occurred in all locations, whether on the road or on private land (depots etc). However, the primary analysis focuses on incidents which took place on the public highway or in areas with public access, such as service stations.

7.3 We also review the LST injury incidents qualitatively. We examine not only the narrative given by the operator in their submission file, but in many cases, we ask for further information or documents from the operator to ensure we understand the circumstances of the incident. We use this to form a view on the degree to which the incident may have been related to the trailer being an LST. However, this judgement is purely used for discussion – events that may not have been related to the presence of an LST are still included in all the primary analysis and statistical significance checks.

7-1 Safety benefit from saved journeys: National

7.4 As described in Section 5, the additional capacity of the LSTs has been calculated to have removed between 29.3 and 32.9 million vehicle kilometres from GB roads.

7.5 These vehicle kilometres would have otherwise been operated by the standard length HGV articulated fleet. It is therefore reasonable to calculate the additional incidents and casualties that would have been expected to occur if the trial had not taken place, by considering how many incidents and casualties the standard length fleet would have incurred over 29.3 and 32.9 million vehicle kilometres. Table 20 shows the calculation.

Table 20: Collisions and casualties removed from GB roads over the trial period 2012-2017 through reduction in vkm operated

Injury incidents Public access locations	GB Artic HGV rate per million vkm	Million vkm removed from operation	Calculated incident reduction
Collisions	**0.160**	**29.3 – 32.9**	**4.7 – 5.3**
Casualties	**0.228**	**29.3 – 32.9**	**6.7 – 7.5**

Sources: LST utilisation and vkm reduction from trial data. GB rate from STATS19 and TRA3105.

Broadly speaking, if you save (on average) around 1 in 14 standard length articulated HGV journeys (7%) by using LSTs, you also eliminate 1 in 14 collisions, if all other factors remain the same

7.6 The reduction in numbers of collisions and casualties reported in Table 20 is small compared with the hundreds of collisions involving articulated HGVs on GB roads over the trial period. However, it will become important in any future impact assessment of LST use beyond the numbers on the trial. This potential saving in collisions would apply to the proportion of the national fleet that was replaced with LSTs.

7.7 Note that savings in incidents from saved trips is independent of the actual number of LST incidents or whether the LST per km incident rate (discussed in the next section) post-trial remains at the low levels seen on the trial, or rises to the same level as the general fleet. However, if the LST injury incident rate ever rose higher than that for the

GB fleet as a whole, then it could offset this gain from making fewer journeys. It is important that in considering any wider use of LSTs, beyond trial conditions, that DfT have plans for maintaining the elements of the trial conditions that have led to the current good performance in terms of injury incidents per km.

Removing the fuel consumption factor on absolute incident savings has removed some conservatism

7.8 As noted earlier (see 5.4) in past reports the calculations in Table 20 were slightly more conservative since the distance saved figures used were reduced by a small factor to reflect additional fuel use. We have not made this adjustment this year since effects of additional LST fuel use is addressed in the emissions modelling in Section 6.

7-2 LST injury incident data high level outcomes

Injury incident and casualty numbers

7.9 In Figure 21 earlier, we noted 27 injury incidents involving LSTs since the trial began. Table 21 expands on this to show the casualties associated with these events, classified by injury severity, the nature of the location, and whether the event was judged to be LST-related[32] - a judgement discussed later in this section.

7.10 From this table and the data that underpins it, we can note the following headlines.

There have been no fatal accidents involving LSTs in 443 million km of operation.

Since the last annual report, there have been 4 additional personal injury incidents involving LSTs, resulting in 3 serious and 5 slight injuries. None of these were judged to be LST related.

Table 21: Casualties from 27 incidents involving LSTs reported to the trial: 2012-17

Injury Collisions from Trial Logs	Total Collisions	Total Casualties	Fatal	Serious	Slight
All Injuries (inc depots etc.)	**27 (23)**	**36 (28)**	0	10 (7)	26 (21)
All Injuries in Public Road/Place	**22 (18)**	**31 (23)**	0	10 (7)	21 (16)
All Injuries judged LST-related (any location)	**7 (7)**	**7 (7)**	0	0	7 (7)
All injuries – LST-related AND in public place	**3 (3)**	**3 (3)**	0	0	3 (3)

Figures in (brackets) show the totals at the end of 2016. The injury incident analysis in this report is based on all public incidents, i.e. the figures in the row outlined in RED

[32] An incident is judged to be LST-related if it is judged that the incident occurred because the trailer was an LST and would not have occurred had the trailer been a standard length.

7-3 All injury incidents in public locations - discussion

7.11 The personal injury incidents in public locations are summarised in Table 22. Note that:

- Identification of location is made by the operator, but is then checked manually using google maps.
- Casualty severity is determined by the operator, based on the STATS19 (police data) injury classes but are reviewed by Risk Solutions and, on occasion, adjusted based on further information provided by the operator.
- Whether the incident is LST-related or not is a judgement made initially by the operator. Where appropriate (e.g. to clarify certain details), we have reviewed specific event records with the operator and, in the light of better information, adjusted the original classifications UPWARDS i.e. classified an incident as LST-related where the operator had formerly identified it as not LST-related. No incidents have yet been reclassified 'down' to be not-LST related.
- The incident summary shown here is a simplified and cleansed version of events designed to convey the main points without identifying the operator.
- In around 70% of cases, the STATS19 record for the same event can be identified from the event details the year after it occurs, allowing us to further inform our understanding of the events and to compare incident locations to the STATS19 location data.
- The national STATS19 data for 2017 has not yet been published by DfT, so we cannot yet confirm that the 2017 LST events shown appear in that data.[33]

Our statistical analysis conservatively includes events that may not have been LST-related and would still have happened with a standard 13.6m trailer

7.12 All the statistical analysis that follows is based on all of the events listed in the table above, whether or not they are judged to be LST-related. This is a prudent approach adopted because whether an incident would have occurred at all, or developed in the same way if the trailer had not been an LST, is a matter of judgment. For example:

- In incidents 3,4,6,13 and 16 - a **3rd party vehicle ran into the back of the trailer** due to poor judgement by the 3rd party driver. The LST length is probably not relevant and the incident would almost certainly have happened with a 13.6m trailer.
- In incidents 11,12,14,15, 18, 20 and 21, where the **LST driver ran into the rear of another vehicle**, usually in slow moving traffic, the operators see no effect from the trailer length. Operators, so far, have not reported any issues with braking or slowing instability when pulling LSTs compared to other trailers.
- In incidents 7,9,10, 17, 19 and 22 the **cause was driver fatigue / loss of concentration**, which would not be related to trailer length, unless it is argued that the trailers might be less stable when the driver makes a sudden steering or braking adjustment as a result of the lapse. Operators have not, so far, reported any increased braking instability related to LSTs compared to other trailers. Operators believe these collisions would still have occurred with a standard 13.6m trailer.
- In general, if the LST was manoeuvring and the impact is with the rear corner of the trailer, the default assumption was to classify it as LST-related.

7.13 While not used to filter the quantitative analysis, discussing whether incidents were LST-related does give us an indication of the level of conservatism in our calculations.

[33] The raw STATS19 data collected by police forces across the country are checked and validated centrally to ensure they meet a consistent set of criteria. Only the validated events are included in the national published statistics.

Table 22: Description of all reported LST injury incidents in public locations

Inc. No. [#] Year	Road type & urban / rural	Casualties (FATal, SERious, SLIGHT based on STATS19 police category definitions)			
		Fat	Ser	Slight	Incident summary [LST-related judgement]
[1] 2012	Minor (urban)	0	0	1	LST driver turning left on mini-roundabout. A taxi entered the roundabout during the LST manoeuvre struck the trailer. Taxi driver slight injury. **Not LST-related.**
[2] 2012	Trunk (rural)	0	0	1	Early in the trial, LST being delivered from manufacturer to VCA for testing, before delivery to operator. Agency driver misjudged roundabout at motorway junction and overturned trailer. Driver slightly injured - no other vehicles involved. Agency drivers generally not used on the trial. **Maybe LST-related.**
[3] 2013	Motorway	0	1	0	LST slowing down on motorway. Driver behind failed to brake and hit back of trailer and was injured. **Not LST-related.**
[4] 2014	Trunk (rural)	0	0	1	LST travelling on rural section of A-Road at night. Another road user ran into rear of the LST at high speed and was injured. **Not LST-related.**
[5] 2014	Motorway	0	1	0	LST encountered previous incident on motorway that had resulted in a jack-knifed vehicle partially blocking lane 1. It was night, motorway section unlit and damaged vehicle was unlit. LST driver was unable to avoid hitting it and was injured. **Not LST-related.**
[6] 2014	Motorway	0	1	0	LST travelling in lane 1 of motorway at night. Car driver approached from behind and hit the trailer. Car driver injured. **Not LST-related.**
[7] 2014	Trunk (rural)	0	0	1	LST travelling on rural section of A-Road when he lost control - vehicle left the road and overturned, injuring the driver. No other vehicles involved. Investigation attributed event to driver fatigue resulting from stress factors outside work. **Not LST-related.**
[8] 2015	Minor (urban)	0	0	1	LST on driver assessment route making a turning manoeuvre in an urban location reported to have hit a pedestrian with the tail end of the trailer. Police did not attend scene but gathered information from pedestrian report and interviews with operator involved. The route is no longer used for driver assessment. **LST-related (see discussion in 2015 Annual Report page 27 para 5.12-5.18)**

Inc. No. [#] Year	Road type & urban / rural	Casualties (FATal, SERious, SLIGHT based on STATS19 police category definitions)			
		Fat	Ser	Slight	Incident summary [LST-related judgement]
[9] 2015	Motorway	0	0	1	LST travelling on motorway in middle of the day. Vehicle left the road on nearside but did not overturn. No other vehicle involved. Investigation attributed event to driver fatigue. **Not LST-related.**
[10] 2015	Motorway	0	0	1	LST travelling on motorway mid-morning. Vehicle left the road on offside and overturned. No other vehicle involved. Investigation attributed event to driver fatigue. **Not LST-related.**
[11] 2015	Motorway	0	1	5	LST travelling on motorway in middle of the day. Traffic congestion resulted in a stationary queue. LST driver failed to react quickly enough and collided with the rear stationary vehicle. There were 1 serious and 5 slight injuries. **Not LST-related.**
[12] 2016	Principal (urban)	0	1	0	Driver hit cyclist from behind when moving from slip road to dual carriage way. **Not LST-related.**
[13] 2016	Motorway	0	0	1	LST travelling on inside lane of motorway when a third-party vehicle crossed from outside lane and hit rear offside of the trailer at speed. **Not LST-related.**
[14] 2016	Motorway	0	0	1	LST travelling on motorway, collided with rear of another vehicle which then ran into a second vehicle. **Not LST-related.**
[15] 2016	Motorway	0	1	0	LST following another HGV in roadworks on motorway. The HGV made an emergency stop to avoid another vehicle swerving across the lanes. LST unable to stop in time and collided with rear of HGV. **Not LST-related.**
[16] 2016	Motorway	0	1	0	3rd party vehicle collided with rear of LST on motorway. Near side right under-run bar snapped. **Not LST-related.**
[17] 2016	Motorway	0	0	1	LST travelling on inside lane of motorway, drifted onto rumble strip and just over hard shoulder line. Driver observed a vehicle parked in hard shoulder. Steered to right to avoid the vehicle, but rear of trailer hit offside of parked vehicle. Pending further DfT investigation of the role of the steering axle in this or similar events, treated as, **LST-related (see discussion in 2016 Annual Report, page 40, para 6.24 onwards)**

Inc. No. [#] Year	Road type & urban / rural	Casualties (FATal, SERious, SLIGHT based on STATS19 police category definitions)			
		Fat	Ser	Slight	Incident summary [LST-related judgement]
[18] 2016	Motorway	0	0	1	LST travelling on motorway, driver did not react in time to changing road conditions and collided with rear of another vehicle. **Not LST-related.**
[19] 2017	Principal (rural)	0	1	0	LST travelling on A road, approaching split with another major A road, skidded and hit central reservation. Investigation recorded that driver lost control of his vehicle (cause unknown). Nothing indicating trailer design contributed. **Not LST-related.**
[20] 2017	Trunk (rural)	0	1	4	LST travelling on major A road, collided with rear of one vehicle and then a side impact (tractor unit and then trailer) with a second vehicle. Full company investigation report provided to DfT/Risk Solutions. Conclusion was driver error (following too closely) but nothing to indicate trailer design was a contributory factor. **Not LST-related.**
[21] 2017	Motorway	0	1	0	LST travelling on motorway, collided with rear of two HGVs that had been involved in a previous accident and had not cleared their vehicles from Lane 1. Detailed report and photos from Operator suggest simple driver inattention, but we are seeking further details. Currently judged to be **Not LST-related.**
[22] 2017	Trunk (rural)	0	0	1	LST travelling on major dual A road at night. Driver reported that he swerved to avoid an animal possibly a deer and lost control. Contact was made with the LH and RH barriers causing the vehicle to land on its side, causing extensive damage to the trailer. No other vehicles involved. **Not LST-related.**

Sources LST Data, Operator communications and STATS19 data for validation (except 2017 – at the time of writing the STATS19 data has not been released.)

The Road Type definitions adopted here are the same as those used in DfT table TRA3105 (the source for the vehicle km data for the GB artic. Population):

***Motorway** = all roads with road class M or A(M).*

***Trunk** = all major A roads managed by Highways England and their equivalents in Wales and Scotland*

***Principal** = all other A roads managed by local authorities*

***Minor** = all other road classes*

Road type assignments obtained by matching the location to the relevant OS ITN link information

Injury incidents of special interest

7.14 As in the 2016 Annual Report, we want to highlight a few of the incidents that are of special interest. The incident numbers in the discussion refer to the table above.

7.15 This part of the discussion focusses on the qualitative nature of these incidents and the possible further questions or areas for further study they pose for DfT in regard to LSTs. **The quantitative analysis in the subsequent sections treats all 22 of the public injury incidents equally, regardless of whether they were nominally judged to be LST related or not.**

7.16 There have been **no incidents involving pedestrians or other vulnerable road users in 2017**, and in three of the incidents the only person injured was the driver of the LST.

7.17 **Incident [20]** is notable in that 5 people were injured and so we requested further details from the operator. We were provided with the full investigation report of the event and so were able to review it for any indications of the trailer being a contributory factor. There was no such evidence and the event was clearly attributed to driver inattention/following too closely.

7.18 **Course Correction at Speed** was noted as an issue in **incident [17]**, reported in 2016 and discussed in some detail in the 2016 Annual Report as 'Transient Off-tracking'. We recommended that DfT look into it further. During 2017 we have had a number of technical discussions around this issue, and DfT is currently assessing the behaviour of different steering axle designs.

7.19 We are now routinely checking significant incidents for any evidence of this transient off-tracking effect. We have evidence of one event in early 2018 where it could have been a secondary factor in an event, but this is not yet confirmed. The event in question did not involve other vehicles.

7-4 Statistical comparison of injury incident rates: National

7.20 As the LST trial progresses, we have been analysing incident data to assess whether the LST trial operations pose an additional risk to other road users, when compared with the GB articulated HGV fleet (which includes the LST fleet) on a per km basis.

7.21 Our analysis focuses on the comparison of LST incidents in **public locations** (public highway, services areas etc.) as the best comparison to the background STATS19 data published for all personal injury road traffic collisions that take place on the public highway.

LST Incident Summary

7.22 There have been **22 personal injury incidents involving an LST in public locations in 443 million km travelled over 3.5 million journey legs from when the trial began in 2012 to the end of December 2017.**

7.23 Of these 22 public personal injury incidents, 3 events (resulting in 3 slight injuries) were determined to be LST-related.

7.24 This equates to:

- **1 injury event in a public place for every 20 million km travelled by the LSTs**
- **1 LST-related injury event in a public place, in every 148 million km travelled**.

GB Articulated HGVs summary

7.25 Table 23 summarises the number of collisions, vehicle km and casualties for the period 2012-2016 for the GB Articulated HGV fleet. Collision and casualty data is taken from STATS19 for all personal injury collisions involving articulated goods vehicles of 7.5

tonnes and over. Vehicle km data is taken from DfT statistics table TRA3105 for articulated goods vehicles with 3 or more axles. Table 24 summarises the data in Table 23 as a three-year average for the period 2014-16. This allows us to compare the rates of incidents and casualties for the GB fleet with the rate for the LST trial fleet, as described in the next section.

Table 23: Number of collisions, vehicle km and casualties for the period 2012-2016 for the GB Articulated HGV fleet

Number of Collisions	2012	2013	2014	2015	2016	Total
Motorways	723	741	831	795	625	**3,715**
Major-A / Minor:						
Major A-roads (Trunk and Principal)	1,189	1,187	1,250	1,204	1,090	**5,920**
Minor roads	310	265	286	265	236	**1,362**
Rural / Urban: (Exc M-way)						
Rural roads (Excluding motorways)	1,025	1,027	1,077	994	921	**5,044**
Urban roads (Excluding motorways)	474	425	459	475	405	**2,238**
Total Collisions	**2,222**	**2,193**	**2,367**	**2,264**	**1,951**	**10,997**

Vehicle Kilometres (billions)	2012	2013	2014	2015	2016	Total
Motorways	7.5	7.8	8.1	8.3	8.5	**40.2**
Major-A / Minor:						
Major A-roads (Trunk and Principal)	5.2	5.2	5.4	5.6	5.7	**27.0**
Minor roads	0.3	0.3	0.3	0.3	0.3	**1.4**
Rural / Urban: (Exc M-way)						
Rural roads (Excluding motorways)	4.7	4.7	4.8	5.1	5.1	**24.4**
Urban roads (Excluding motorways)	0.8	0.8	0.8	0.8	0.8	**4.0**
Total Vehicle Kilometres (billions)	**13.0**	**13.3**	**13.7**	**14.2**	**14.4**	**68.6**

Number of Casualties	2012	2013	2014	2015	2016	Total
Fatalities	116	117	111	125	133	**602**
Serious injuries	355	443	410	430	394	**2,032**
Slight injuries	2,650	2,547	2,878	2,733	2,232	**13,040**
Total Casualties	**3,121**	**3,107**	**3,399**	**3,288**	**2,759**	**15,674**

Source STATS19 and TRA3105 2012-2016 (2017 not yet published).

Table 24: Three-year averages (2014-16) for collisions, casualties and vehicle km for the GB Articulated HGV population, public locations

GB Articulated HGV three-year averages 2014-2016	Collisions per year	Casualties (All killed or injured) per year	Billion vkm per year
Motorways	750	1,139	8.3
Major A-roads (Trunk and principal)	1,181	1,658	5.5
Minor roads	262	352	0.3
Rural roads (excluding motorways)	997	1,447	5.0
Urban roads (excluding motorways)	446	562	0.8
Total	**2,194**	**3,149**	**14.1**

Source STATS19 and TRA3105 – annual average 2014-2016 (2017 not yet published).

LST comparison to the GB articulated HGV 3-year rolling average

7.26 In the early annual reports, we compared figures for individual years of data. Once the trial had been running for over four years, we also included the trend in annual incident rate and a three-year rolling average for LSTs (calculated from Table 23) and the GB fleet (calculated from Table 24), which helps to smooth out any natural variation in the data from year to year. This is shown in Figure 33 below.

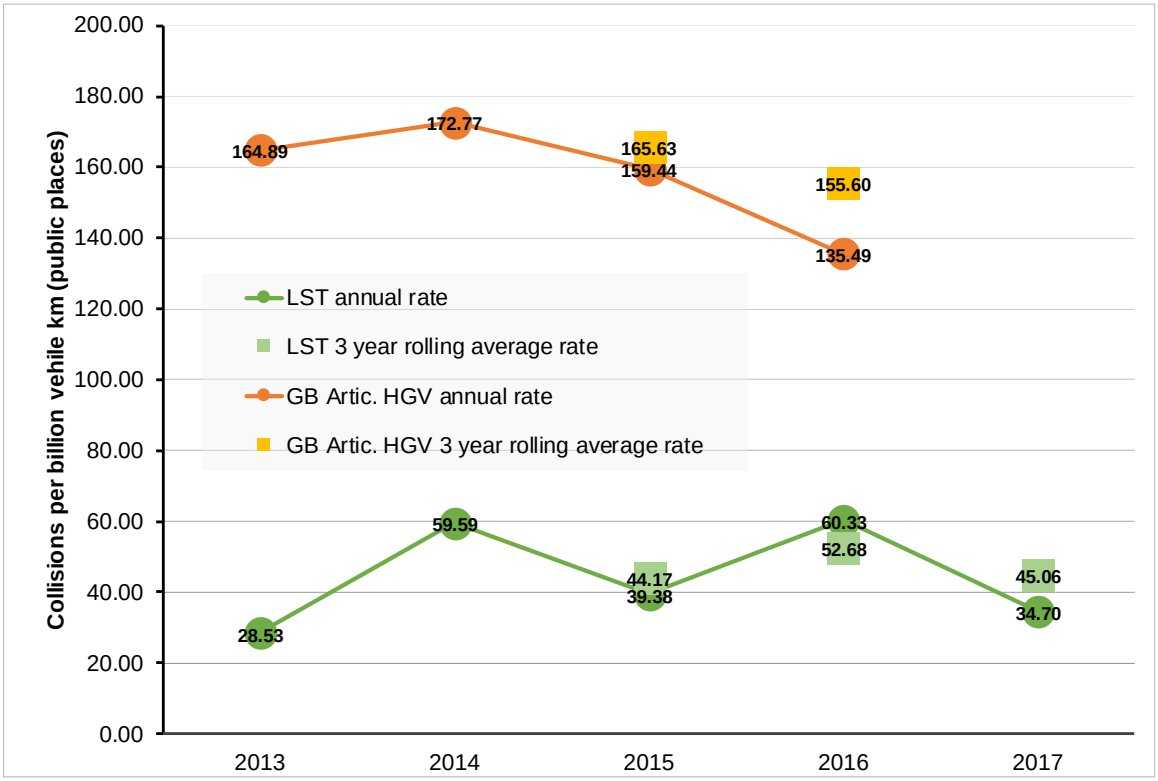


Figure 33: Annual incident rate and three year rolling averages, 2013-2017

Overall incident rates for LSTs are substantially lower than those of the GB articulated HGV fleet.

7.27 To establish whether these differences are real, rather than due to normal statistical 'noise' in the data, we calculate the **mean rate ratio.** This is defined as the LST incident rate (per billion vehicle km) divided by the incident rate for the background population of all GB articulated HGVs. If the mean rate ratio is equal to 1.0, then the rates are the same. If the ratio is not equal to 1.0, we apply a statistical test to determine if the difference from 1.0 is statistically significant. More details on the test can be found in the detailed analysis by road type, see below.

7.28 Table 25 shows that the national incident and casualty rates for LSTs are substantially lower than those of the standard fleet. The ratios in the table are less than 1.0 and are statistically significant.

7.29 **For the public access location comparison, per km operated, LST incidents are occurring at a rate of 29% of the GB articulated HGV fleet.**

Table 25: Summary comparison of LST public road collision and casualty three year rolling average rates (2015-17) vs. GB articulated HGVs (2014-16)

Injury incidents Public access locations	LST Rate per billion vkm	GB Artic HGV Rate per billion vkm	Mean Rate Ratio LST/GB-HGV
Collisions	45	156	0.29
Casualties	72	223	0.32

Sources: LST from trial data. GB from STATS19 and TRA3105 – all 2014-2016 (2017 not yet published) – all figures rounded. Both ratios shown to be statistically significant at the 5% confidence level.

7-5 Analysis of safety in urban locations and on minor roads

7.30 There is a valid question over whether LST operations in urban locations or on minor roads, where LSTs would be expected to perform most high angle turns, could pose a threat to vulnerable road users such as pedestrians, cyclists and powered two-wheeler users, as well as to other drivers. The analytical question is whether such an effect might be 'hidden' by the dominance of motorway and trunk road operations in the national average calculations given above.

7.31 In previous years we have estimated the number of urban incidents and urban distance travelled using the ONS classification of urban but excluding motorways, and performed various sensitivity analyses around these estimates. This year we have a much more comprehensive picture of LST vehicle kilometres travelled by road type from the route mapping work (described in para 4.40 onwards). This allows us to also look at the difference in risk between major and minor roads as well as between the much broader classifications of urban and rural locations.

7.32 Here, we have laid out the various preparation steps and data discussions. The actual comparison of LST incident rates with those of standard trailers is then presented in Section 6.6.

Consistent definition of urban

GB urban areas are defined by the ONS based on the national census data

7.33 The split between urban and rural for our analysis is the same as that used in all published government transport data. It is derived from the latest national census in which geographic areas are defined by the Office for National Statistics (ONS) as being urban or rural by the population living in the area.[34]

7.34 The STATS19 injury incident data and the national traffic flow data published by DfT are both broken down by road type and urban/rural and so the urban portion of each dataset is directly available.

7.35 The LST injury incidents have each been examined and classified as urban/rural directly by viewing the incident locations on maps, but also by cross-referencing the incident to STATS19 (where it is included).

7.36 It is important to understand that when an individual incident location or section of road is classified as urban, **this does not mean town centre**. A straight section of dual carriageway that was part of the trunk network could still be classified as urban where it by-passed a town, as it might still fall in an urban geographic area as defined by the ONS. However, it is a useful approach because it can be applied consistently across all the elements of the analysis and it is a nationally recognised definition.

For the LST analysis, we exclude motorways from the definition of urban

7.37 Our primary interest is in the use of LSTs off the Motorway or trunking network. Separating out the motorway data is easy for all datasets. However, further restricting the datasets to only consider roads that are ‘urban’ AND ‘not trunk’ would make the sample sizes too small for a statistically robust analysis.

Our definition of urban, major and minor roads enables us to compare risk meaningfully

7.38 We have presented results for the following data splits:

- Urban (excluding motorways) = ONS urban, not including motorways but including all other road types that pass through geographic areas classified as ‘urban’ including dual carriageways
- Rural (excluding motorways) = ONS rural, not including motorways but including all other road types that pass through geographic areas classified as ‘urban’ including dual carriageways
- Motorways = all motorways with a road class M or A(M), both urban and rural
- Major A-roads = all roads with a road class of A, both urban and rural, including Trunk roads that are the responsibility of Highways England and the equivalent bodies and Wales and Scotland, and Principal roads that are the responsibility of local authorities
- Minor roads = all other roads, both urban and rural

7.39 **Where the terms urban, rural, minor etc. are used without further definition, they can be taken to carry the meanings noted above**.

[34] The ONS defines an area as Urban or Rural based on the population living in that area according to the most recent national census (currently 2011). The Classification defines areas as rural if they are outside settlements with more than 10,000 resident population. For details see https://www.gov.uk/government/collections/rural-urban-classification

Source data for risk comparisons

The source for the GB articulated HGV fleet is DfT published data

7.40 For the general GB articulated HGV fleet, traffic census data[35] published by DfT includes a breakdown by road type in ONS rural or urban locations.

7.41 A similar approach is adopted for the STATS19 data – which is reported using the same classifications of roads and ONS urban/rural locations.

7.42 In each case, we have re-assigned the data to give the breakdown using our definition noted above.

The source for LST urban injury incidents is the trial data

7.43 The detailed data for the injury incidents noted in Table 21 have been analysed and the incidents classified in Table 26 using the tailored data splits described above.

Table 26: Number of personal injury collisions for LSTs (whole trial to end 2017)

Number of collisions in each location type	Public and private	Public only
Motorways	13	13
Non-Motorway – by Road Type		
Major A-roads (Trunk and Principal)	7	7
Minor roads	7	2
Non-Motorway – by Urban/Rural		
Rural roads (excluding motorways)	6	6
Urban roads (excluding motorways)	8	3
Total	**27**	22

The source for LST vehicle kilometres split

7.44 The trial data submissions do not contain detailed data on LST journeys by road type nor for urban or rural environments. Therefore, we do not have data on the actual proportion of LST journeys/distance that occurred in ONS urban/rural areas or the road type data to determine how much took place on minor roads. We have therefore estimated these using the modelling approach described in Section 4: LST Operations by road type.

Full details of how this was done can be found in Project Note E1[36].

7.45 Table 6 shows our modelled estimate of LSTs distance travelled in 2017:

- 13.1% on roads classified as urban (excluding motorways),
- 2.0% on minor roads

7.46 The results of the modelling are summarised in Table 27 below, alongside the comparison values for the standard articulated fleet in GB (as in Table 24 above).

[35] DfT road transport statistics - table TRA3105

[36] Project Note E1: LST Routing and Operational Analysis by Road Type September 2018 SPATS 1-403 PN-E1-v4-2

Table 27: Split of distance and percentage of vehicle km for LST fleet compared with the GB Articulated HGV fleet

Vehicle km split	LSTs (2017) million vkm from route modelling estimate	LSTs (Whole trial period to end 2017) estimated million vkm	GB Artic HGVs billion vkm - 3 year annual average 2014-2016	GB Artic HGVs billion vkm total for 2012-2016
Motorways	63 (62%)	274.7 (62%)	8.3 (59%)	40.2 (59%)
Major A-roads (Trunk and Principal)	37 (36%)	159.5 (36%)	5.5 (39%)	27.0 (39%)
Minor roads	2 (2%)	8.9 (2%)	0.3 (2%)	1.4 (2%)
Rural roads (excluding motorways)	26 (25%)	110.4 (25%)	5.0 (35%)	24.4 (35%)
Urban roads (excluding motorways)	13 (13%)	58.0 (13%)	0.8 (6%)	4.0 (6%)
Total	102 (100%)	443 (100%)	14.1 (100%)	68.6 (100%)

Sources: LST from trial data and LST route modelling. GB from TRA3105 to 2016 (2017 not yet published).

7.47 In Table 27, note that:

- The LST 'whole trial' column is generated by applying the percentage values from the route modelling carried out for 2017 to the entire 443 million vehicle km of the LSTs since the trial began.
- The GB articulated HGV fleet data is shown in two forms because we need to use the data over different time periods to fit the available LST data.
  - The first figure over the years from 2014-16 was used for the National incident rate calculation shown earlier, where we now have sufficient data on both collisions and vehicle km for the LSTs to do a 3-year rolling average.
  - The second is the based on the entire data for 2012-2016 – the whole trial period – and is used for the analysis in this section where we do not have sufficient LST injury incidents to drive a 3-year rolling average.

7.48 To summarise, we estimate **that LSTs on the trial in 2017, ran on roads in urban areas (excluding motorways) for 13.1% of their total operating distance, and on minor roads for 2.0% of their total operating distance. This compares with average values of 5.8% and 2.1% respectively for the GB articulated HGV fleet (2012-2016 data).** These values are taken forward into the comparison of incident rates in the next section of the report.

What does the LST operations result tell us about the LST fleet?

7.49 The Urban result in particular may seem counter-intuitive, since the general assumption to date has been that the LST operations would be more skewed towards motorway / trunking / rural routes than the general GB articulated fleet. What the route modelling is

showing is that the LST distances measured by road type are similar to the national fleet, while the Urban operation is higher.

7.50 The largest LST fleets on the trial happen to belong to retailers and parcels companies who use them to delivery to sites and depots at the **edges** of towns / large retail sites – locations that would fall into the ONS urban classification, but are not necessarily in town centres and the roads used to reach them may be entirely suitable for large HGVs.

7.51 We have looked in detail at some of the main routes contributing to the change from an estimate of 8% urban in 2016 to 13% in 2017 and see that it is largely due to the incorporation of a substantial set of data from two operators whose most frequent routes use large sections of major roads (including dual carriageways) which happen to fall within the ONS geographic area of the towns they are bypassing. This demonstrates the weakness of using the ONS 'Urban' areas as a proxy for the real interest, which is the operation of large vehicles away from the Trunk/principal road network.

7.52 Minor Roads are much better proxy for looking at roads where an HGV would be most likely to encounter other roads users in confined spaces/lanes, vulnerable road users, or be making sharp turns. We note that at 2.0% of all distance travelled, the modelled estimate of distance on minor roads is very close the equivalent figure for the national fleet.

7.53 It is important to remember that all figures relate only to the distribution and use of LSTs on the trial – they cannot be directly applied to any national roll out of LSTS. The allocation process was intentionally designed by DfT to encourage a diverse mix of operators, not to produce a fleet that accurately modelled the nature of the national trailer fleet.

7.54 It will be important to consider this issue of the trial vs national operational mix when interpreting the trial results and, later, scaling them up to any national impact assessment. There are two issues:

- The extent to which operators who have self-selected to join the trial, and their operations, represent any future projection of LST operations outside trial conditions, and
- The way the trial participants are choosing to use the trailers, which may itself only represent a particular segment of their fleet operations.

7-6 Statistical comparison of injury incident rates by road type

7.55 In this section we present our analysis of incident rates by road type, using the various data elements prepared in the previous section.

7.56 The number of safety incidents involving LSTs in some segmentations of the data is low, so as with the national statistical analysis presented earlier, it is important to test whether differences in collision rates observed between the LST fleet and the GB fleet of articulated HGVs (which includes LSTs) are 'real' (statistically significant), or are just the result of natural variation (noise in the data). We do this using both a classical Poisson rate ratio test and a Bayesian comparison. The details of this approach were given in some detail in the 2015 Annual Report

7.57 When we presented this analysis in the 2016 Annual report the tests were statistically significant in most cases, indicating that the data sets were now large enough to reach valid conclusions. As we show below, the addition of the 2017 data has further strengthened the robustness of the results.

Injury incident analysis – classical statistics

7.58 There is now sufficient trial data to determine a statistically meaningful assessment of the relative safety of LSTs compared with the background GB articulated HGV fleet (which includes LSTs) for all operations.

7.59 Using the STATS19 equivalent case, which only considers incidents that are on the public highway, there have been three LST incidents to date in urban locations and two on minor roads. We can be confident that these allocations to location and road type are robust due to the level of detail provided by operators for safety incidents.

7.60 The results in Table 28 summarise the incident rate calculations for our different road type splits. In each case, we calculate a key indicator - the mean rate ratio. This is the ratio of LST collision rate to the background (GB articulated HGV fleet) collision rate. So, a mean rate ratio >1.0 would imply that the LST collision rate is higher, a value <1.0 implies that the LST collision rate is lower.

Table 28: Injury incident rate analysis

	Urban roads (excluding motorways)	Minor roads	A-roads (trunk and principal)	Motorways
GB Articulated HGV fleet average collision rate (STATS19 data for 2012-2016)				
No. of collisions	2238	1362	5920	3715
Billion vehicle km	4.0	1.4	27.0	40.2
Mean collision rate per billion vehicle km	560	973	219	92
Trial LSTs (trial data for 2012 to 2017)				
No. of collisions	3	2	7	13
Billion vehicle km	0.0580	0.0089	0.1595	0.2747
Mean collision rate per billion vehicle km	52	226	44	47
LST vs GB Articulated HGV fleet average				
Mean rate ratio	0.09	0.23	0.20	0.51
95% confidence limit of rate ratio	0.02 – 0.27	0.03 – 0.84	0.08 – 0.41	0.27 – 0.88
p value that mean rate ratio equals 1.0.	< 0.001	0.017	< 0.001	0.011
Statistical interpretation	Significant at the 5% level. Sufficient evidence for all road types and locations to accept the hypothesis that the rates are different			

7.61 We then test whether we can be confident that any apparent difference between the two collision rates is significant (and not just noise in the data). We use the Poisson rate ratio test for all such comparisons.

7.62 In all these cases the analysis shows a mean rate ratio less than 1 across the confidence interval range so we can state with a high degree of confidence that the LST

incident rate is lower than the background population. We can also see that the mean rate ratio of 0.29 for all road types combined (from Table 25) arises from a contribution of 0.23 from minor roads, 0.20 from major A-roads and 0.51 from motorways.

7.63 **We can conclude that the use of national averages to compare LST incident rates to the general national fleet are not masking an underlying problem of higher injury rates in urban areas or on minor roads.** However, we will continue to monitor and report the urban and minor road incident rates separately as the risk of injury events in these locations will remain an area of concern for the trial.

Relative risk of Trunk and Principal A-roads

7.64 STATS19 records incidents by road class (Motorway, A-road, etc) but there is no flag to identify whether the A-road incidents occurred on the Trunk road network or on the Principal road network. This is potentially important because the Trunk A-roads are the responsibility of Highways England and their equivalents in Wales and Scotland whereas the Principal A-roads are the responsibility of local authorities.

7.65 We have therefore used our incident snapping tool[37] to create an unofficial mapping of the Eastings and Northings of all 10,997 GB HGV incidents onto the Ordnance Survey ITN road network, and hence to identify which incidents occurred on the Trunk network. We can do the same with the LST incidents that occurred on A-roads, to compare the relative risk of Trunk and Principal A-roads, as shown in Table 29 below.

Table 29: Injury incident rates for Trunk and Principal A-roads

	Trunk A-roads (estimated)	Principal A-roads (estimated)
GB Articulated HGV fleet average collision rate (STATS19 data for 2012-2016)		
No. of collisions	2,500	3,420
Billion vehicle km	16.6	10.4
Mean collision rate per billion vehicle km	151	329
Trial LSTs (trial data for 2012 to 2017)		
No. of collisions	5	2
Billion vehicle km	0.1037	0.0558
Mean collision rate per billion vehicle km	48	36
LST vs GB Articulated HGV fleet average		
Mean rate ratio	0.32	0.11
95% confidence limit of mean rate ratio	0.10 – 0.75	0.01 – 0.39
p value that mean rate ratio equals 1.0.	0.004	< 0.001
Statistical interpretation	Significant at the 5% level. Sufficient evidence to accept the hypothesis that the rates are different	

[37] The MapSnap™ tool has been developed over several years by Risk Solutions in support of other work for DfT and Highways England and forms part of a suite of tools for handling GB road related data, owned by Risk Solutions

7.66 The injury incident collision rates for LSTs on Principal A-roads and Trunk A-roads are similar (36 compared with 48 collisions per billion vehicle km). In contrast, the GB HGV population appears to have a collision rate that is much higher on Principal A-roads than on Trunk A-roads (329 compared with 151 collisions per billion vehicle km).

7.67 Both LST rates are much lower than the equivalent rates for the GB HGV population, so the mean rate ratios are 0.32 for Trunk A-roads and 0.11 for Principal A-roads. Both rate ratios are statistically significant at the 95% level.

Injury incident analysis – Bayesian statistics

7.68 A Bayesian statistical analysis estimates the probability that the LST injury incident rate is higher or lower than that for the background population. This is different from the classical Poisson Test described above, which just gives a pass/fail indication at a given confidence level. In simple terms, the Bayesian analysis gives an insight into how far away from, or inside a robust statistical test the result falls.

Analysis of the LST urban and minor road collision data using a Bayesian approach strongly supports our conclusion that the LSTs are being operated on the trial with a lower injury incident rate than the average for GB articulated HGVs.

7.69 We have used the Bayesian approach to consider the two data segments of most interest in terms of risk to vulnerable road users, the Urban operations and those on Minor roads.

7.70 The results in Table 30 show that there is a less than 0.1% chance that the urban incident rate is higher for the LST population than for the background population and only a 0.4% chance that the minor roads incident rate is higher for the LST population than for the background population.

Table 30: LST injury incident rate - Bayesian Analysis

Bayesian Analysis Summary	Median Collision Rate Ratio	The probability that the LST (injury) incident rate is:	
		HIGHER	LOWER
	=LST/GB HGV rates & (credible interval)	than the background rate for all large GB articulated HGVs.	
Urban roads (excluding motorways)	0.098 (0.030-0.26)	< 0.1%	> 99.9%
Minor roads	0.25 (0.057-0.80)	0.4%	99.6%

Conclusion: Statistical comparison of LST injury rates vs other trailers

At the end of 2017, based on the confirmed injury incidents, we can state that the trial LSTs were operated with a lower rate of injury incidents in public locations than the average for GB articulated HGVs for all of the data segmentations that we have studied. This includes urban roads (excluding motorways); minor roads; A-roads (trunk and principal) and motorways. (All results at a 95% confidence level).

7-7 Safety impact outcomes expressed as 1 in 'n' kilometres

7.71 For communication with the general, non-technical reader, it is also useful to summarise the key incident impact results in terms of "1 event in every n km" to convey a sense of the scale of the incidents being observed with LSTs, compared with existing semi-trailers in common use in the country. In Table 31 we present a summary of the safety incident data using this format.

7.72 The information in Table 31 relates only to incidents involving an LST, operating in a public location.

7.73 The data is presented at the national level, to be consistent with other published results. The urban operations (excluding motorways) analysis has concluded that these national results do not appear to be concealing an underlying problem of LST operations in urban areas.

Table 31: Summary of LST injury incident outcomes vs. all GB Articulated HGVs

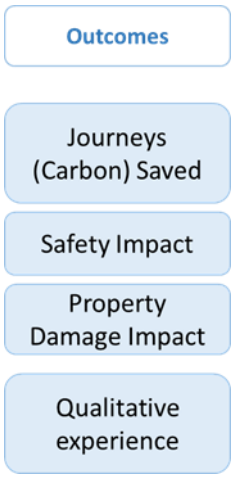
Summary of LST-related injury incidents and outcomes after 443 million km travelled, compared with those for all GB Articulated HGVs (>7.5T)

Collisions in all public locations and resulting casualties		GB Artic HGVs	LST Involved	Judged LST Related
		1 in every …	**1 in every …**	**1 in every …**
All Incidents	All locations	6.2 million km	20.1 million km	147.7 million km
	Urban only	1.8 million km	19.3 million km	58.0 million km
	Minor roads only	1.0 million km	4.5 million km	8.9 million km
By incident severity (the worst injury recorded for each collision – as per STAT19)				
Fatal accident	All locations	125.0 million km	No Incidents	No Incidents
Serious	All locations	41.7 million km	44.3 million km	No Incidents
Slight	All locations	7.8 million km	36.9 million km	147.7 million km

Notes to be included with table:

- **'**All public locations' covers all public roads and also private land where there is public access.
- 'Urban' here defined as all roads, excluding motorways, in ONS defined urban areas
- Minor' Roads are all roads that are classified 'below' the level of A-Road
- GB Articulated HGVs: Based on DfT National data for all articulated HGVs > 7.5T. 2012-2016 (TRA3105) = 68.6bn km of which 4.0bn urban non-motorway and 1.4bn minor roads. Injury incidents from STATS19 2012-16: Total collisions = 10,997 (2,238 urban and 1,362 minor roads).
- LST Involved: 22 events (3 urban and 2 minor roads). Any injury event in which an LST was involved, even if the trailer being an LST was not relevant – data from latest annual report table - Table 22. Non-injury (damage only) incidents are covered separately.
- LST Related: 3 events. Events involving an LST where the fact that the trailer was an LST rather than a standard length was considered to be at least part of the cause. ***Not used in headline figures for trial injury rates.***
- These figures are mean values. The latest annual report includes analysis that concludes that the comparisons between LST incident rates shown here are all statistically robust at a 95% confidence level

8 TRIAL OUTCOMES 3: PROPERTY DAMAGE IMPACT



8.1 In the 2016 Trial Annual Report we looked in more detail at the issue of **property damage** incidents.

8.2 This covered three separate analyses relating to 'damage' incidents

1. **The basic trial data** – looking at the events reported in the incident logs submitted by all operators
2. **Damage incidents vs measured 'kick-out'** – a study recommended in last year's annual report, matching the VCA measured tail-swing ('kick-out') for different LST designs to the incidents reported in the trial data.
3. **Operator 'In-house' damage incident comparison** – an extension of the feasibility work reported last year to explore a sample of cases where the LST damage incident rate might be higher than that for standard trailers and what might influence any such difference.

8.3 The **basic trial data** analysis is simply the report of damage only outcomes based on the logs submitted by operators. This is updated with the 2017 data in Section 8-1.

8.4 The **Damage incidents vs measured 'kick-out'** remains relevant, but there is now new work to report on this for 2017. A summary of the conclusions from last year has been retained here for easy reference in section 8-2, as it has a bearing on the ongoing work planned after the publication of this report.

8.5 The **Operator 'In-house' damage incident comparison** reported results from a test analysis using fleet data from a very small sample of operators. This led to a recommendation that the data collection format be revised to enable further analysis in this area. Progress in this area is reported in Section 8-3.

8-1 Damage incidents from trial incident logs

8.6 In earlier Annual Reports we explored a number of measures related to non-injury events, including any in depots and some where there was no resulting damage.

8.7 Our focus now is on events that:

- resulted in some damage
- were located on the public highway (or in a publicly accessible area)
- were assessed as being related to the fact the trailer was an LST.

8.8 We have chosen to focus on LST-related events here, whereas in the injury incidents we treated all incidents as 'relevant' and hence produced the most conservative result possible, to ensure the final outcome (a low incident rate per km) was itself, conservative. In looking at the damage events, we have a much larger dataset and a broader range of event types.

8.9 Each event is classified by the operator with their judgement of whether it was judged to be LST-related or not, using the options shown. The operator judgements are checked by Risk Solutions and, where necessary, amended with their permission. Where there is limited narrative information, for any event where the impact was at the rear of the trailer, we prudently assign it as LST-related = Yes.

8.10 Table 32 shows a summary of the breakdown of the **1004 incidents where some damage was recorded** (either to the vehicle or public/private property). Of these, only 234 occurred in a public location (as noted earlier – paragraph 4.104).

Table 32: LST non-injury incidents by location

LST Non-Injury incidents recorded as resulting in damage 2012-2017	Was incident LST-related ?					
	Yes	Yes - Partly	Maybe	Unclear	No	Total
PUBLIC LOCATION	**85**	**34**	**6**	**52**	**180**	**357**
00 On main carriageway ……..- not in restricted lane	**82**	**33**	**6**	**50**	**175**	**346**
01 Reversing	2	2	1	4	7	16
02 Parked					1	1
03 Waiting to go ahead but held up	1			1	5	7
04 Slowing or stopping				1	11	12
05 Moving off	1	2	2	1	10	16
06 U turn	5			3	1	9
07 Turning left	47	14		15	23	99
08 Waiting to turn left				1	1	2
09 Turning right	24	13	2	16	25	80
10 Waiting to turn right		1		1	1	3
11 Changing lane to left				1	12	13
12 Changing lane to right					3	3
13 Overtaking moving vehicle on its offside				1	1	2
15 Overtaking on nearside					2	2
16 Going ahead left hand bend		1		1	3	5
18 Going ahead other	2		1	4	69	76
04 Cycle lane (on main carriageway)	1					1
06 On lay-by or hard shoulder	2			1	2	5
07 Entering lay-by or hard shoulder					3	3
08 Leaving lay-by or hard shoulder		1		1		1
Unknown				1		1
PRIVATE LOCATION	**174**	**90**	**13**	**95**	**275**	**647**
10 Company Property / Depot	129	58	7	51	188	433
11 Other Private Property (not on road)	45	32	6	44	87	214
TOTAL	**259**	**124**	**19**	**147**	**455**	**1004**

8.11 With the increased focus on damage events from 2018 onwards, we have conducted a full review of all these events (2012-2017) and applied further conservative assumptions to cases where the operator data was ambiguous. As a result, the total number of damage events from 2012-2016 is now higher than the 733 presented in last year's annual report (on Table 19, page 55). The total has also been increased by the incorporation of a number of large data files which were not finalised in time for last year's report. The total for 2012-2016 with these adjustments is 844 damage events. Once 2017 data is added, the total is 1004.

8.12 If we consider all the events **in Public Locations** (357 events) and then conservatively treat with a judgement of as 'Yes' (83 events), 'Yes – partly' (34), 'Maybe' (6) or even 'unclear' (52) as potentially LST related, we have **177 "events of interest**" in 443 million km travelled over 3.6 million legs.

8.13 **This gives estimates of damage events where an LST was involved and the trailers design has not been explicitly ruled out as a contributory factor:**

- **1 reported damage only event for every 2.5 million km travelled by the LSTs**
- **1 reported damage only event for every 20,000 journey legs operated by LSTs.**

Damage events of interest involving other vehicles

8.14 From the table, we can see that of these 177 events of interest, **138 (78%) were events where the vehicle was turning** (highlighted in the table (red borders) – and hence where trailer kick-out might be a factor).

8.15 From other analysis of the data find that of these 177 events of interest, **117 (66%) involved contact with another vehicle**, and it is interesting to break this down further, as shown in Table 33. Of these, 92 of the events are part of the 'turning' set of data noted above.

Table 33: Damage events involving other vehicles (Public/LST Related)

177 Public and Potentially LST Related: LST Manoeuvre at time	VEH HIT LST	LST HIT VEH	LST HIT PARKED VEH	Total
01 Reversing		1	1	2
03 Waiting to go ahead but held up	1	1		2
04 Slowing or stopping		1	1	2
05 Moving off	1	1	4	6
06 U turn		2	1	3
07 Turning left	3	45	9	57
08 Waiting to turn left	1			1
09 Turning right	1	13	18	32
10 Waiting to turn right	1	1		2
11 Changing lane to left		1		1
13 Overtaking moving vehicle on its offside		1		1
16 Going ahead left hand bend		2		2
18 Going ahead other	2	2	2	6
Grand Total	10	71	36	117

8.31 The interesting split in this sub-set of the data is the difference between the data for turning left, vs turning right. From a qualitative review of the data we can see some patterns, but would not suggest these are statistically robust.

- Many of the **left turning** events involve either contact with another vehicle in an outer lane of a junction OR contact when the LST was exiting a roundabout.

8.32 Some of the **right turning** events are also at junctions, but many are right turns into depots, where cars are parked on the road outside.

8.33 There are a few events where another vehicle simply drove into the LST (VEH HIT LST) but within the other group (LST HIT VEH) there many of the events where although the LST hit the other vehicle , the fault lies at least in part with the drivers of the other vehicles, who were trying to pass the LST while it was already turning. We have conservatively still classed these as “LST HIT VEH”.

8.34 This type of event does of course happen with drivers misjudging the tail-swing of all HGVs, not just LSTS. However, with an LST steering axle, the rear of the vehicle moves differently to the other articulated vehicles roads users are familiar with. Of course, the responsibility to judging whether it is safe to pass a large vehicle which is turning remains with the driver making that decision, but in some cases their frame of reference (other articulated HGVs) may now be wrong. If they ‘cut it close’ then that difference in steering behaviour may lead to an incident. In discussing any future use of LSTs, it will be necessary to consider the options for education of other drivers regarding the behaviour of steering axles.

Damage to public property

8.35 Damage to PUBLIC property was only recorded in 28 events (16%) and if there is underreporting of damage events in the trial data, minor scrapes with roadside bollards, railings etc. would be the most likely area of concern.

8.36 Much of this damage will be minor and unreported simply because the drivers are unaware of the event taking place and damage to the trailer may be minimal.

8.37 As part of the revised data framework launched on 1 January 2018, we have sought to improve the reporting of damage events, especially those involving public property, by introducing:

- A clearer statement of the requirement to report any and all damage to property
- Narrative data fields for damage to property, separate from that for damage to the operator’s vehicle – with specific guidance to elicit some statement of the severity of damage resulting from the event
- A requirement to report whether the **owner** of the property is aware of the damage

8.38 The revised data format is discussed in more detail in Section 8-3

Non-injury (damage only) incident rates – trend over time

8.39 In previous annual reports we have noted that the rate of non-injury events, normalised by distance to remove the effect of fleet growth, reduced from the start of the trial until the end of 2013 and has remain broadly steady ever since.

8.40 Some operators have commented that they have also detected a reduction in all incidents once a group of drivers in a depot have ‘settled in’, with the pattern being repeated each time trailers are introduced at a new location. We confirm this quantitatively from the data, because the size of the LST fleet is now sufficiently large that the introduction of a new group of drivers in one company at a point in time would be masked by the size of the overall dataset.

8-2 The effect of increased tail-swing on damage incidents

8.41 A key area of interest on the trial has always been the increased 'kick-out' of the rear of these trailer compared to standard 13.6m trailers and the associated potential for safety risk to vulnerable road users. The potential impact on roadside furniture is also of particular interest to asset owners such as local authorities. In 2016 we carried out a detailed analysis of data[38] around this issue. The current situation is summarised here.

2016 analysis summary

8.42 In this analysis we linked data provided by VCA on steering mechanism, steering angle and measured 'kick-out' for every LST design to the main LST trial dataset of damage incidents. Statistical analyses was used to look for any correlation between trailer and incident type characteristics, and to test for the statistical significance of any relationship between other trailer design features and the rate of incidents resulting in injury or damage. The analysis focused on incidents where the trailer was (a) on the public highway, (b) turning, and (c) the incident was judged to be possibly LST-related.

8.43 **The analysis found no simple relationship between the measured trailer kick-out and the overall rate of injury and damage incidents.** Analysis did show that incidents were more prevalent on delivery (e.g. to/from a retail or industrial site) rather than trunking (e.g. supplier to distribution centre) routes, which is consistent with other analysis already performed during the trial. This may be expected as trunking operations typically involve a large proportion of their journey on major dual carriageways, and they often start and end at specially designed distribution centres.

8.44 **The probability of a relevant incident occurring on a delivery leg on a public road is lower by a statistically significant amount if the steering system is self-tracking**. Published studies (Cebon 2002[39]) indicate similar results, although the trailer designs in that study had dual steer axles.

8.45 **There is a reduction in incident frequency as turn angle limit of the axle design increases**. There is a weak correlation between the turn angle limit of the axle design and incident frequency, but the effect disappears if only incidents on public roads are included in the analysis. This suggests that it may be to do with manoeuvring in depots, where some very tight turns might be attempted, rather than public road operations.

8.46 **Leg distance was not found to be significant in any of the analyses.** This supports the view that this type of incident (turn related) is more associated with the start and ends of journeys rather than the overall number of miles driven.

8.47 **Our analysis could find no statistically significant correlation between kick-out and incident frequency**. The most plausible explanation of this lack of correlation is that behavioural factors and organisation operating policies (training, routing etc) are a bigger influence on incident rates than any effect arising from the difference in kick-out.

8.48 In the 2016 Annual report we made the following recommendation:

R 2016-4: Understanding the underlying basis for LST design variation
DfT / VCA should consider working with the industry, including manufacturers, to better understand (1) reasons why kick-out measurements are not strongly correlated to real world experiences (incident rates) and (2) the justification for the variety of LST designs with different kick-out measurements.

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[38] 7.1 Section 7-2 (pages 57-59), with the underlying statistical analysis reported in Annex 4 (pages 86-100).

[39] ' Comparative performance of semi-trailer steering systems' in 7th International Symposium on Heavy Vehicle Weights and Dimensions, Delft, NL, June 16-20, 2002

Engagement on LST design choices

8.49 While there is no clear statistical result pointing to the higher kick-out trailers experiencing more incidents, we believe it is still valid to explore the operational or other reasons why some operators or manufacturers appear favour command steer LSTs, given the much larger (on average) kick-out measurements, as illustrated in Figure 34 (reproduced from the 2016 Annual Report, Figure 27).

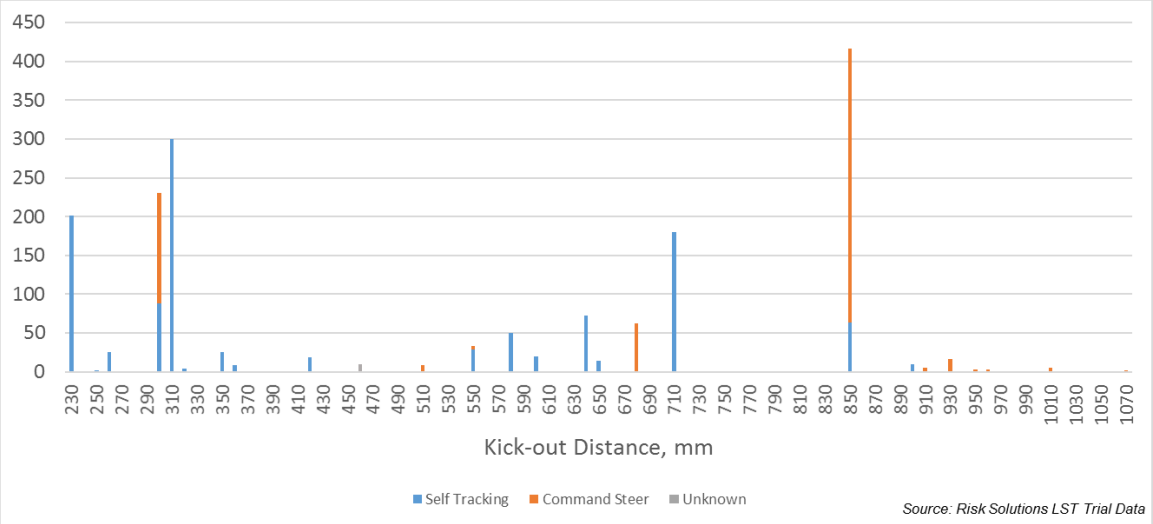

Figure 34: Number of LSTs by Kick-out Distance and Steering Type (2016)

8.50 We have had some initial discussions with stakeholders, including SMMT, about the reasons why some companies chose command steer options. Three are suggested:

8.51 First **Pre-trial indications from manufacturers/designers it might not be possible to meet the DfT/VCA turning circle requirements with a single self-steer axle**.

8.52 At that stage, it was thought that either two self-steer axles or one command steer axle might be necessary. (This can be seen in the fact that in the 2011 pre-trial impact assessment, there was no 1-Self-Steer option considered.)

8.53 Once the trial was formally launched and actual orders were being discussed, designers came up with single-self-steer designs that met the requirements and these have dominated the trial ever since (see Figure 7).

8.54 Second, **some operators see a value in the additional manoeuvrability of command-steer axles – including in reverse – within the depot.** Conversely, other operators see them as more of a problem in the depot because of the additional kick-out, especially when leaving the dock.

8.55 Third, there is which reflects their own views and perhaps history of using **an underlying issue of the individual manufacturer 'offering',** command-steer axles, or not, on other products in their portfolio. There are some manufacturers who offer command steer and others do not. When combined with existing relationships between operators and their favoured suppliers, this will have influenced who has command steer trailers on the trial.

8.56 These questions will be explored further as part of engagement discussed in Section 9.

8-3 Comparison of LST to non-LST damage incidents

8.58 Last year we reported on a special analysis of incident data recorded in the in-house databases of a small sample of LST operators.

8.59 The benefit of this approach was that it overcomes the problem of there being no national 'damage incident' database (comparable to STATS19 for injury incidents) against which to compare the trial data on LST damage events.

8.60 The purpose of the study was to see whether we could calculate relative damage incident rates of LSTs and standard length articulated trailers within the fleet operated by a single operator.:

8.61 The study was very limited in that:

- The sample only covered a small number of operators (7)
- The sample only covered a limited time range (1-2 years)
- The sample of operators chosen was intentionally skewed towards those most likely to be operating 'delivery' rather than 'trunking' routes – where the risk of incidents was anticipated to be higher
- The sample was limited to operators with good in-house data collection and reporting systems
- The sample size was limited by the time and resources available
- The sample could not be completely guaranteed to be comparing the LST operations with very similar operations in the operator fleet
- Only a few of the results comparing LSTs to non LSTs were statistically significant

8.62 The sample study showed that in just a couple of cases, the LSTs in a fleet had a higher damage incident rate than the non-LSTs in the same fleet. Perhaps of more value that the numerical result, the study led to some in-depth conversations with the operators involved around the reasons for the difference.

8.63 One operator (a retailer) noted that they had observed some similar effects with damage incident rates between their dual and single deck trailers and a second operator agreed with this. Where drivers operated mainly single deck units, but then picked up a dual deck in the middle of a series of runs, the operator had concluded that they sometimes failed to make the relevant compensations in their driving style. This might be referred to as their '**equipment awareness**' at any point in their journey.

8.64 These operators also expressed the view that the effect was amplified if the route involved an initial extensive stretch of motorway (where no adaptation of driving style was required) before the driver moved onto trunk or non-trunk A roads.

8.65 Both operators noted that a range of visual cues were now being adopted or considered, for both dual-deck and LSTs, including warnings on driver paperwork, and painting the front of trailers in different colours (as a visual cue from the cab). They were discussing the possibility of using any in-cab telematics or job display screens as another option for delivering such a reminder.

Damage incident rates across all operators

8.66 Conducting the sort of in-depth analysis performed in the sample study on all the operators on the trial would be untenable, but DfT were keen to explore what could be done in terms of a more high level analysis, if an amended data gathering framework could include a template that would enable operators to enter the basic data for their whole fleet incident count and distance (but not the individual events) and so generate an incident rate ratio similar to that in the sample study. This would then give an insight

into whether LSTs, on average, had higher damage incident rate either across the whole fleet, or in specific types of operation.

8.67 We therefore recommended two steps.

Recommendation 2016-5: Increasing data on the relative rate of LST damage incidents to those of all trailers in the fleet of each operator

DFT should consider working with the industry and/or amending the data framework, to assess how many operators experience a difference in damage only incident rates between their LSTs and standard length trailers.

This should include work to better understand the underlying causes, including but not limited to, the impact of route familiarity and equipment awareness, especially on non-trunking operations, on the ability of drivers to operate LSTs without an increased risk of collisions resulting in property damage

Recommendation 2016-6: Increasing data on the nature and severity of damage incidents involving LSTs

If DfT wish to assess the impact of damage only incidents in more detail, then operator in-house incident severity for both LSTs and ideally standard length trailers would need to be gathered as part of the standard trial submissions.

To achieve this we would recommend that the incident log template be revised to incorporate including at least narrative evidence of the severity of damage to the trailer and any objects hit in the collision and, potentially, a simple damage impact ranking.

8.68 In October 2017, DfT commissioned the work to amend the data framework and the new format Data Submission File (DSF) was launched for all trial operations from 1 January 2018. The first submissions of data in the new format were collected in May-June 2018.

8.69 The full DSF and a user guide explaining the requirements and rationale are available from the DfT website[40]. The main differences compared to the 'old' format, used from 2012-2017) are:

- Incorporation of a **Company Information Shee'** - previously a separate file
- Replacement of the main leg-by-leg **Journey Log** sheet with a summary format noting the number of legs and distance for each trailer on each type of work, with a breakdown showing FULL / EMPTY and PART-LOADED. From this summary, we will still be able to generate summary level quantitative trial results.
- Expansion of the **Incident Log** to include:
  - Multiple narrative fields looking separately at damage to the operator vehicle, damage to other property, the sequence of events and whether the owners of any damage property are aware of which operator was involved.
  - Summary figures for numbers of incidents (injury, damage) for the rest of the fleet in which the LSTs are operating. This is necessary for calculating the relative incident rates of LSTs vs their host fleets (at an aggregate level – not for any single operator)

8.70 **Results using the new data format will be available once we have gathered sufficient data. With the trial fleet now exceeding 2000 trailers, we anticipate being able to report in the first half of 2019, once we have a full year of data.**

[40] https://www.gov.uk/government/publications/longer-semi-trailers-trial-data-guidance-and-documentation

PART 3: Wider impact and conclusions/recommendations

The remaining two sections look ahead to the work of the trial in the coming year.

Section 9 looks at the work planned for last 2018 and early 2019, where the focus will be on a preliminary 'scaling up' analysis, looking at the potential national impact of LSTs if they were made more widely available. Alongside the numerical impact modelling, we describe a planned programme of conversations with the industry and other stakeholders around what sort of planning and preparation would be needed if the Department of Transport wanted to consider a wider roll-out of these trailers.

Section 0 takes a very broad view of the original aims of the trial and the questions it was designed to answer, and reviews how close we now are to meeting those objectives. This overview will form a key part of the areas to be covered in the conversation programme.

There are no **new** recommendations arising from this year's report, but what we will do is provide an update on progress on some of the recommendations made last year (here, and in Annex 1) in the light of the latest results and recent discussions with the Department, industry and other stakeholders.

9 WIDER IMPACTS - LOOKING AHEAD

9-1 Scaling up from trial conditions.

9.1 The emerging outcomes from the operation of LSTs on the trial are confirming positive results in terms of savings, without any evidence of an increase in safety risk during the trial operations.

9.2 These results can only reflect the position within the trial fleet and under trial conditions. In the 2016 annual report we made the following recommendation:

Recommendation 2016-7: Preliminary assessment of 'future impact' of LSTs – scaling up and emissions assessment
DfT should consider including an initial 'scaling up' analysis in their 2017-19 plans for the trial evaluation, to begin assessing the potential future impact of LSTs. This would include work to translate the current distance/journey saving results into measures of reduced emissions/air pollution.

9.3 In response to this, as part of the 2018-19 evaluation programme of work, DfT commissioned an initial scaling up model, which will be developed once this 2017 report is published. By creating a preliminary scaling-up 'model' at this point in the trial we can:

- Assess whether the data being captured on the trial is likely to be sufficient to support a balanced and robust impact assessment. If not, by identifying any gaps we can consider how they might be resolved as part of future years' data gathering.
- Open up evidence based conversations that will need to develop between DfT, the haulage industry and other interested parties such as Local Authorities and civil society groups regarding what guidance or regulation might be required to maintain the positive results seen on the trial under post-trial conditions.

9.4 The plan for the model is illustrated schematically Figure 35.

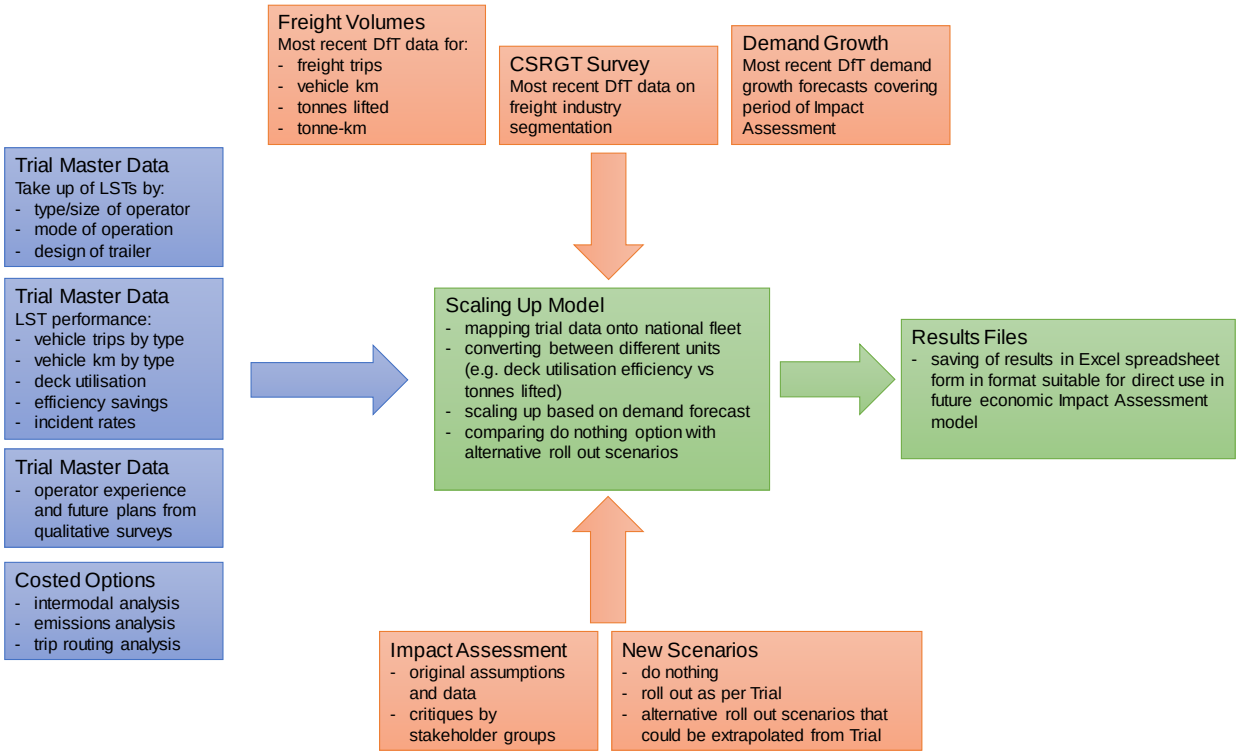

Figure 35: LST trial scaling up model schematic

Model functions

9.5 The model and its results files are represented by the green boxes. Subject to agreement with DfT the scaling up model will:

- map the industry segmentation available in the trial data onto the industry structure required for the Impact Assessment
- perform any unit conversions required. For example, the trial data statistics have focussed on measuring deck utilisation as a percentage of maximum available deck area to calculate efficiency savings. This may need to be translated into an estimated equivalent in tonnes lifted savings for comparison to national freight estimates
- model LST take up, and therefore overall efficiency and performance gains for the current GB fleet, based on responses from trial operators to the QSF2 survey (see next) and conversations planned with the industry (see below)
- forecast the future efficiency and performance gains, taking into account the expected demand growth and the replacement cycle for the standard and LST trailer fleets
- compare a “do nothing” scenario against selected roll out scenarios (see below).

9.6 The model will take its input from the core trial data (journey legs, trailer designs, incidents etc) and the results of the special topic work on LST routing, intermodal effects and emissions analysis (represented by the blue boxes).

9.7 The emissions modelling will require some further iterations to provide a range of emissions savings sensitivity cases to reflect the gradual introduction of EURO VI engines during an agreed timescale.

9.8 The scaling up also requires data from a number of DfT sources and a definition of a set of roll out scenarios (assumptions around take up of LSTs) that will be modelled (the orange boxes) as described below.

Model inputs

DfT national statistics

9.9 **Freight volumes:** The DfT produces annual statistics for the road haulage industry, including number of journeys, vehicle km, tonnes lifted and tonne-km. The most recent statistics available will be a key input to the scaling up model, as this represents the current level of demand to be met by the modelled fleet of LST and standard trailers.

9.10 The published freight statistics are not segmented in sufficient detail to map directly onto the trial population, however there is more detail available in the CSRGT survey.

9.11 **CSRGT survey:** The Continuing Survey of Road Goods Transport (CSRGT) surveys provide information on the domestic activity of GB-registered heavy goods vehicles over 3.5 tonnes gross vehicle weight operating in the UK. From this, DfT road freight statistics department can provide, subject to a suitable data use agreement, more detailed breakdowns of road freight statistics than the standard published tables. This will improve the segmentation possible in the scaling up model and hence the accuracy of the overall results.

9.12 **Demand growth forecasts:** The revised Impact Assessment will need to consider not just current road haulage demand but also how that demand is expected to change over the appraisal period (usually ten years following the beginning of the GB roll out). Therefore, the scaling up model will also take as input the most recently available forecasts for demand growth, and will apply this growth forecast to the modelled current demand.

9.13 **The 2011 Impact assessment:** Model development will be informed by a review of comments and criticisms made with respect to the original impact assessment. The original assumptions made in the assessment will be reviewed and assessed to see if they have been borne out in practice in the trial. This will inform any further assumptions that are necessary to define the roll out scenarios to be modelled.

9.14 **New roll out scenarios:** A new Impact Assessment will need to consider more than one roll-out option. As a minimum, therefore, the scale up model will generate results files for:

- the "do nothing" option, i.e. assuming that LSTs are not permitted on GB roads and that the future demand for road haulage is met by standard trailers
- the "base case" option, i.e. assuming that the take up of LSTs, the choice of technology options, the efficiency savings gained etc. observed in the trial, will all apply in the same proportions at the GB fleet level

9.15 It may also be possible to examine a limited number of alternative roll-out options if these can be estimated directly from the trial data. The next section presents our initial (un-validated) view of potential take up of LSTs after the trial.

Initial view on potential take up of LSTs after the trial

9.16 An initial estimate of the potential national take-up of LSTs was made in 2011 as part of the original trial impact assessment, based on the views of operator groups. At that stage, there was very limited information on designs, costs or operational constraints and so the estimate was speculative.

9.17 As part of the QSF2 survey discussed in earlier chapters, we therefore asked operators for their current best judgement on what their potential take-up of LSTs beyond the trial might be. We asked them to assume that:

- LST permitted designs were as per the trial, i.e. meeting the same design requirements (length, turning etc.)
- LSTs would be available without special data collection requirements or limits on numbers.

9.18 We asked operators to estimate how many of their current trailer fleet they might choose to replace with LSTs, broken down by primary operational leg type. We asked them to do this for two scenarios:

- If the infrastructure for handling semi-trailers remained unchanged from today
- If the infrastructure was updated, where physically possible, with LST handling in mind during the next natural renewal cycle

9.19 The raw results from the survey are summarised in Table 34 below. **It is important to note at this stage that the survey results are preliminary only, and have not been validated, so should not be treated as official take-up projections**. We will be checking whether the operators on the trial view these results as reasonable, and whether they are also valid for companies not currently part of the trial, as part of the planned industry consultations.

9.20 While these figures are by no means the 'final' answer or indeed a set of views validated by the wider industry, they are a starting point, based on the views of the companies who have real world experience of operating LSTs.

Table 34: Percentage of fleet trial participants might replace over time with LSTs

Percentage of current fleet trial participants might wish to replace over time with LSTs			
Operator's primary leg type	With today's infrastructure	With future LST infrastructure	
Supplier to distribution centre	19%	24%	(50 responses)
DC to DC	17%	30%	(55 responses)
To/from retail site	9%	10%	(45 responses)
To/from industrial site	12%	21%	(54 responses)
Palletised trunking	17%	28%	(71 responses)
Other leg type / mixed operations	4%	6%	(63 responses)

9.21 We also asked the operators roughly over what period they might replace their standard-length trailers with LSTs. The preliminary un-validated results are shown in Table 35.

Table 35: Replacement cycle for standard-length trailers by trial participants

Replacement cycle	
< 1 year	6%
1 - 3 years	25%
5 - 10 years	55%
> 10 years	14%
(122 responses)	

9.22 Finally, we asked the operators whether they believed that the general availability of LSTs (ignoring all other factors affecting their fleet size) would increase or decrease the size of their overall trailer fleet, and by how much. It is conceivable that for some operations, fewer LSTs would be required to deliver the same work as the existing, standard length fleet and hence the total size of the fleet could reduce. Conversely, for some operations, the general availability of LSTs could open up new business opportunities and hence result in LSTs adding to the overall fleet size.

9.23 The preliminary un-validated results are summarised in Table 36 below.

Table 36: Potential effect of availability of LSTs on participants toal fleet size

Will the general availability of LSTs increase/decrease the size of your overall trailer fleet	
Fleet reduction of > 10%	4%
Fleet reduction of 5 - 10%	11%
Fleet reduction of 0 - 5%	23%
No change in size of fleet	52%
Fleet increase of 0 - 5%	4%
Fleet increase of 5 - 10%	4%
Fleet increase of > 10%	2%
(126 responses)	

9-2 Evidence based conversations (Autumn 2018-Spring 2018)

9.24 A range of discussions with industry and stakeholders are being planned, once this report has been published. This stage of the evaluation fulfils a recommendation made in the 2016 Annual Report

Recommendation 2016-8: Preliminary exploration of possible post-trial requirements or guidance for operating LSTs

DfT should consider conducting evidence based conversations between DfT, the haulage industry and other interested parties such as Local Authorities and civil society groups, regarding what guidance or regulation might be required to maintain the positive results seen on the trial under post-trial conditions.

9.25 The precise topics for this engagement are currently under discussion with DfT and will take suggestions from a stakeholder group that DfT has been running alongside the trial since last year. Our current plan is to generate a set of agreed questions or topic of interest to a range of stakeholders which might include, but may not be limited to:

1. **LST Designs**
   a. What key factors affected the choice of different design features by operators?
   b. What are the marginal costs and weights of LSTs vs their 13.6m equivalent?

2. **LST Take Up**
   a. What is the view of future take-up among trial participants?
   b. What is the view of likely take up among operators who have NOT participated?
   c. What are the key commercial and infrastructure constraints on take up?

3. **LST Operational / Regulatory Issues**
   a. What operational constraints in place during the trial need to be reproduced outside of the trial environment? Why? How could this be done?
   b. What training should be expected in relation to LSTs, for drivers, loaders, job planners, route planners, fleet managers, directors etc? How might this be embedded into a requirement and from which regulatory or industry body?

4. **LST Data beyond the trial**
   a. Value and feasibility of ongoing identification of LST information as part of **national** data collection including possibly, CSRGT, STATS19 and traffic flow.
   b. What, if any, opportunity is there to monitor or regulate LST usage through other means, such as licence conditions.

9.26 **The engagement plan for these conversations will be developed over the summer and, subject to DfT approval, be launched after the publication of this report.**

9-3 Special Issue – Axle Designs

9.27 Earlier in the report (para 7.18) we referred back to the issue of Course Correction at Speed and the recommendation made in last year's annual report:

Recommendation 2016-3: Technical appraisal of LST 'course correction at speed'

DfT / VCA should consider the questions raised in this report, relating to the likely response of an LST using a self-steering / command steered axle to a sudden course correction 'at speed' (e.g. 50 mph).

9.28 From the evaluation perspective, the questions are:

1. What is the extent of any added risk arising from course correction at speed for different axle steering designs?
2. If command-steer axle designs (on average) have a larger kick-out in high angle turns and (perhaps) are more sensitive to course correction at speed, how essential are they to the users of these designs?

9.29 DfT and VCA have taken forward this action. Since the publication of the 2016 Annual Report (in September 2017) there have been a number of discussions with technical experts in the field, seeking to define the questions that need to be addressed and the scope of the analysis.

9.30 Risk Solutions has contributed suggestions for the scope and objectives of the work, based on our further observation of the trial during 2017.

9.31 We expect further advice from DfT and VCA on this area in due course.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 In this section we have presented conclusions and recommendations at this stage of the trial in relation to the questions the trial was designed to answer. In each case, we provide the key numeric results and refer back to the relevant section of the report.

10.2 In the opening section of this report (para 1.18) we noted the primary evaluation questions, set out in 2012 at the start of the trial:

a. Do longer trailers carry at full capacity?

b. Do longer trailers result in fewer vehicle trips or vehicle kilometres?

c. Do longer trailers result in more or different types of accidents? Is there potential for using extra safety devices on longer trailers?

d. What kind of operations are longer trailers used for? For example, what routes, trips, commodities and roads are they used on?

e. Does the pattern of usage differ significantly from the assumptions made in the original Departmental Impact Assessment?

f. Can the existing infrastructure (including roads, delivery depots and parking) cope with longer trailers? Does existing infrastructure limit their potential use?

g. Do real world operations identify any additional operational issues, risks, costs or benefits not identified in the Department's original research?

10.3 In the same section, we noted secondary evaluation questions, being to assess

h. To what extent has the trial process and the resulting data produced a robust data source?

i. What issues need to be considered in applying the results to any impact assessment of the wider use of LSTs, beyond the trial?

10.4 As the trial has progressed, the nature of the questions the Department has wanted to pose has changed slightly and in 2016 we re-articulated the issues above in seven questions, published in the 2016 Annual Report Summary. They are:

1. **What do operators use LSTs for?** [d, e]
2. **What are the savings realised in HGV journeys?** [a, b]
3. **What are the resulting reductions in emissions?** [implicit outcome of b]
4. **What about safety – will LSTs cause more injuries?** [c]
5. **What about damage and the associated costs – will LSTs cause more damage on the roads?** [f]
6. **Might any special operational requirements be appropriate for LSTs?** [g]
7. **What proportion of the existing GB fleet of semi-trailers might be replaced by LSTs, were numbers not restricted?** [i]

[letters in parentheses provide a rough cross-reference to the original list above]

10.5 In the discussion that follows, we note the extent to which the evaluation work to date provides sufficient evidence to answer each of these questions, and what work is already planned or required to complete the evaluation.

Q1 What do operators use LSTs for?

STATUS: READY - Sufficient data to inform impact assessment

While the trial continues to gather data in other areas, we believe the evidence we have already gathered in this area would be sufficient to inform a future impact assessment

10.6 The discussion in Section 4 shows that as was anticipated, the dominant usage is on well defined, repetitive trunking duties - supplier to distribution centre, DC to DC, palletised trunking etc- (67%) where the pick-up and drop-off points are both industrial sites. However, there has also been a significant take-up of the trial LSTs for deliveries to and from retail sites, although this partly reflects the strong adopted of trial LSTs by a number of retailers. We know from qualitative discussions with operators, in particular the retailers, that such use requires a careful selection of which retail sites (including the access routes) are able to accommodate the longer trailers.

10.7 It is clear that the LST operations are biased towards duty cycles where the goods are not only lower density, but also where control of the loading can be managed to ensure high levels of utilisation, demonstrated in the empty running results of ONLY 19% compared to 29% for the GB articulated HGV fleet as a whole.

10.8 There is some use of LSTs in more general haulage operations, but here the success in achieving consistently high utilisation is more limited.

10.9 In terms of where the LSTs operate, the results of route modelling discussed in Section 4 provided an operation summary by road type, which estimates that:

- **85.4% of the LST distance covered was on Trunk Roads** (Motorways and A roads operated by Highways England or the equivalent in Scotland and Wales)
- **12.6% was on Principal Roads** (A roads operated by local authorities) and
- **2.0% was on Minor Roads**

10.10 The full details can be found in Table 9, which also shows that **the proportion of LST distance covered by road type on the trial is very similar to that seen for the entire GB articulated HGV fleet**.

10.11 Finally, a number of specialist applications of LSTs have emerged during the trial, the notable ones being:

- Telescopic low-loaders or ISO carriers, which can be fixed at the LST length (15.65m) and so operate on the trial as LSTs or outside the trial requirements (either shortened to 13.6m or extended beyond 15.65 and operated under a bespoke VSO)
- Top loading bulk carriers – mainly for moving low density bulk waste or bio-fuel/wood chip.

Q2 What are the savings realised in HGV journeys?

STATUS: READY - Sufficient data to inform impact assessment

While the trial continues to gather data in other areas, we believe the evidence we have already gathered in this area would be sufficient to inform a future impact assessment

10.12 The results in Section 5 show that operators differ in the level of benefit (in terms of saved trips) being gained by different operators.

10.13 Since the start of the trial, the use of LSTs has removed between **29 and 33 million vehicle kilometres** of freight traffic from the roads of Great Britain, equating to **235-270,000 journeys** saved.

10.14 Over the whole fleet and across the trial we have calculated that the **average % distance saving is 7%, which equates to 1 in every 14 journeys**.

10.15 The most efficient LST operations are saving up to 1 in every 8 journeys.

Q3 What are the resulting reductions in emissions?

STATUS: READY Sufficient data to inform impact assessment

While the trial continues to gather data in other areas, we believe the evidence we have already gathered in this area would be sufficient to inform a future impact assessment

10.16 The results of modelling described in Section 6 provides results not just for Carbon Dioxide, but for six separate emissions, with spatial analysis by road type and a selection of areas for which emissions are of particular interest.

10.17 The results are presented both for the trial to date and projected forward to the nominal trial end point(s) and are shown in full in Table 19.

10.18 The emissions savings are expressed as a tonnage saved compared to a counterfactual of moving the same quantity of goods on 13.6m trailers rather than LSTs. The results are, as might be expected, around 7% overall, close to the average saving in distance noted above.

10.19 If we consider the key metrics of CO2(e) (as a dispersed emission) and NOx (as a localised emission) we estimate:

- **A net reduction from TRIAL TO DATE of around 28,000 tonnes of CO2(e) and 141 tonnes NOx, as well as other emissions**.
- **A PROJECTED net reduction if the trial were to run to the original 10 year end point of around 67,000 tonnes of CO2(e) and 336 tonnes NOx, as well as other emissions**.

10.20 In terms of impact on areas of particular interest, the analysis shows that for the trial:

- **15% of the emissions savings noted above are being made in Air Quality Monitoring Areas (AQMAs)** where air pollutant concentrations already exceed or are likely to exceed relevant air quality objectives defined by Defra
- **6.2% of the emissions savings noted above are being made within 200m of one or more Designated Areas (SAC, Ramsar, SSSI, SPA)** – areas which have cited features that are sensitive to changes in ambient NOx, nitrogen deposition and acid deposition that can be brought about by changes in traffic emissions of NOx – particularly from roads within 200m.

10.21 These emissions results related to the trial conditions, fleet and operational patterns, but they can be segmented by operator type and used to scale up the results as discussed under Q7, below.

Q4 What about safety – will LSTs cause more injuries?

STATUS: READY Sufficient data to inform impact assessment

While the trial continues to gather data in other areas, we believe the evidence we have already gathered in this area would be sufficient to inform a future impact assessment

There have been no fatal accidents involving LSTs

10.22 There have been no fatal accidents involving LSTs in 443 million km of operation.

10.23 Since the start of the trial there have been 23 injury incidents (28 casualties) involving an LST of which 18 incidents (23 casualties) were on the public highway or other locations accessible to the public.

10.24 Since the last annual report, there have been seven further injury incidents involving LSTs in public locations, resulting in three serious and four slight injuries.

10.25 The analysis in Section 7 shows that the operation of the LSTs on the trial has resulted in lower, rather than higher injury rates compared to the GB articulated HGV fleet in general. However, the application of this comparison to the wider GB fleet result needs to be carried out with care.

10.26 There are two separate elements to this question

a. The injury incidents saved by the reduction in the number of journeys

b. The incident rate (per km) compared to other trailers, for the journeys undertaken.

Q4a: How many extra injury collisions would have occurred if the same goods had been moved using standard trailers, requiring more journeys?

10.27 When we consider the risk arising from delivering the same quantity of goods using LSTs rather than standard length trailers, the work is carried out in fewer journeys. Put simply, to deliver the same goods using LSTs requires, on average, 1 in 14 fewer journeys/km of operation.

10.28 This is equivalent to a 7% reduction in collisions. At the average incident rate for large articulated HGVs (dominated by standard length trailers) this equates to **around 4 collisions and 7 casualties saved by the operation of the LSTs on the trial, independent of any difference between the LST and standard trailer incident rates per km.**

Q4b: Do the LSTs have a higher incident rate (per km) that the trailers they replace?

10.29 This is considered both at a national level on all road types and then specifically on Minor Roads that is, once the trailers leave the major trunk and principal A road network, where they are more likely to encounter vulnerable road users and/or make high angle turns.

When measured across ALL ROAD TYPES, the LSTs on the trial are being operated as safely if not more safely per km, than the trailers they replace

10.30 LSTs have been involved in around 70% fewer personal injury collisions and casualties, compared to the average for GB articulated HGV Injury incidents operating over the same distance. (Result confirmed at 95% statistical confidence)

When measured on operations on MINOR ROADS, the LSTs on the trial are being operated as safely, if not more safely, per km, than the trailers they replace

10.31 This analysis uses route modelling to estimate that LSTs on the trial in 2017, ran on minor roads for 2.0% of their total operating distance, close to the average of 1.9% for the GB articulated HGV fleet as a whole.

10.32 LSTs have been involved in around 77% fewer personal injury collisions and casualties, on minor compared to the average for GB articulated HGV Injury incidents operating over the same distance. (Result confirmed at 95% statistical confidence).

10.33 The analysis in the main report provides much more detailed breakdowns of the incident rates on different types of A road and the difference between operations in rural vs urban areas.

10.34 To be clear – these results do not mean that LSTs are in any sense intrinsically 'safer' than other trailers, but the trial has demonstrated that they can be operated as safely, or more so, than standard length trailers, given the right management.

Q5 What about damage and the associated costs – will LSTs cause more damage on the roads?

STATUS: ONGOING: Further data required to inform impact assessment

While we have damage data for all operators, comparative data for non-LSTs has only been gathered for a sample of operators. Further data for all operators is being gathered in 2018 and will be required to inform a future policy impact assessment

10.35 We have reported the number of damage incidents involving LSTs as reported to us by operators, in Section 8 with a breakdown by location type (junctions etc) in Table 32.

10.36 **This gives estimates of damage events where an LST was involved and the trailers design has not been explicitly ruled out as a contributory factor:**

- **1 reported damage only event for every 2.5 million km travelled by the LSTs**
- **1 reported damage only event for every 20,000 journey legs operated by LSTs**

10.37 In the last year's annual report we noted the challenges of comparing damage incident rates of LSTs to other trailers, since there is no national dataset for the non-LSTs.

10.38 A small scale comparison of damage incident rates across their LST and non-LST fleets for 7 operators showed that in a small number of cases, the LSTs might be experiencing a higher incident rate than the fleet as a whole.

10.39 As a result of our recommendation last year, the incident log template used to gather data was replaced as from 1 January 2018 and now incorporates more narrative evidence of the severity of damage to the trailer and any objects hit in the collision and, crucially, a requirement to report summary figures for incidents and total distance for the non-LST trailers in the fleet where the LSTs are being used.

10.40 **Results from this new-format incident data will not be available until we have gathered and analysed the 2018 data**.

10.41 The other area of interest here is whether there is any correlation of damage events with specific trailer design elements, in particular the kick-out, which is itself related to the choice of steering design (self or command steer).

10.42 Although only very weak statistical correlations to any design feature were found in work undertaking in 2016, we did make a recommendation that this be better understood.

Recommendation 2016-4:
Understanding the underlying basis for LST design variation
DfT / VCA should consider working with the industry, including manufacturers, to better understand (1) reasons why kick-out measurements are not strongly related to real world experiences, and (2) the justification for the variety of LST designs with different kick-out measurements.

10.43 We still believe this is an important area that DfT will need to take into account when considering any wider roll-out of LSTs, since they will need to decide whether the same range of design features permitted on the trial should continue to be allowed, or perhaps, whether some operational restrictions would be applied to certain designs.[41]

10.44 We anticipate the rationale for adopting certain designs of trailers to be one of the topics discussed in the industry and stakeholder engagement beginning in Autumn 2018.

Q6 Might any special operational requirements be appropriate for LSTs?

STATUS: ONGOING: Further data required to inform impact assessment
Some qualitative data / suggestions available. A series of conversations with industry and stakeholders is planned to inform a future policy impact assessment.

10.45 We have some understanding of the sorts of special arrangements operators have put in place for the trial LSTs, as shown in Figure 11.

10.46 As part of the 2018 data gathering we are collecting some further data covering LST training of drivers (the nature and duration).

10.47 We have already started developing some initial ideas of the areas where special arrangements for LSTs might be appropriate, including training (beyond just drivers), route planning and other issues.

10.48 The wider engagement with industry and stakeholders planned to begin in Autumn 2018 (see Section 9) will provide a number of opportunities to develop these ideas and also to look at practical approaches to implementing any such arrangements. This is implementing our recommendation in last year's annual report (below)

Recommendation 2016-8: Preliminary exploration of possible post-trial requirements or guidance for operating LSTs.
DfT should consider conducting evidence based conversations between DfT, the haulage industry and other interested parties such as Local Authorities and civil society groups, regarding what guidance or regulation might be required to maintain the positive results seen on the trial under post-trial conditions.

[41] Note that this possibility is stated in "Trial of Longer Semi-trailers (LSTs): How to take part in the trial: (updated) January 2017" published on the DfT website which states that:
"In the light of evidence collected in the course of the trial, particularly with regard to safety impacts, the Department may also withdraw certain types of semi-trailers with design characteristics from the trial. For example, some combinations of semi-trailer length and axle configuration"

Q7 What proportion of the existing GB fleet of semi-trailers might be replaced by LSTs, were numbers not restricted?

STATUS: STATUS: ONGOING: Further data required to inform impact assessment

Initial estimates from the operators on the trial are available. We need to expand this data to include a range of operators who have not participated in the trial, in order to fully inform a future policy impact assessment

10.49 The views of operators on the trial on their personal potential future take up of LST, now that they have experienced them in real-world operations, has been presented in Section 9, broken out by the predominant type of operation (Table 34 and Table 35).

10.50 While these figures are by no means the 'final' answer or indeed a set of views validated by the wider industry, they are a starting point, based on the views of the companies who have real world experience of operating LSTs.

10.51 The highest replacement figures are 20-30% of trailers involved in trunking type operations, with retail delivery operations replacing only around 10% of trailers.

10.52 The estimates also suggest that LSTs would not be introduced rapidly, but largely over the natural replacement cycles for the companies, which are 1-3 or 3-5 years.

10.53 As part of the industry engagement later in 2018, we will need to test those take-up figures with a wider range of operators outside the trial, once we have presented the trial results from this report.

10.54 These values will then be applied to relevant segments of the current GB road freight forecasts to produce a revised projection 'with LSTs'.

RESPONSIBILITY FOR TRIAL COMPLETION DECISIONS

10.55 In noting that the evidence required to fully answer some of these questions is now 'READY', Risk Solutions is not stating that the trial data is now complete and we are not making a recommendation that LSTs be made part of standard equipment. **Any decision on trial completion is a matter for the Department for Transport.**

ANNEX 1: 2016 ANNUAL REPORT RECOMMENDATIONS

The table below lists the recommendations made in the previous LST Trial Annual Report, along with the action taken in each case.

Area of work recommended	Progress
2016-1 Industry Engagement We recommend that DfT liaise with FTA, RHA and other stakeholders to arrange a further LST Trial industry forum, ideally during 2017, to communicate with the operators and retain participant engagement, as the trial enters its sixth year and the trial community is extended.	Discussions took place mid-2017 but for a number of reasons it was not possible to arrange an event in 2017. Engagement webinars (20) around the new data framework took place in Jan-Feb 2018. Further engagement is now being planned for Autumn 2018
2016-2 Understanding low efficiency use of LSTs Once the Qualitative Survey (QSF2) analysis is completed, the scope of work for 2017-18 should include further enquiry with operators whose results suggest limited benefits from using LSTs, to better understand the range of factors involved.	We have some insights from the QSF2 data (presented in this report). The most common causes are intermittent demand, lack of control over loading density (e.g. third-party logistics companies or general hauliers on per-load contracts) or simple inertia in decisions to sell unproductive LSTs.
2016-3 Technical appraisal of LST 'course correction at speed' DfT / VCA should consider the questions raised in this report relating to the likely response of an LST using a self-steering / command steered axle to a sudden course correction 'at speed' (e.g. 50 mph).	DfT have stated that: "DfT officials are reviewing the behaviour of LSTs when they are subjected to a sudden course correction at speed as part of a review of the performance of the whole range of axle steering options in operation on the trial."
2016-4 Understanding the underlying basis for LST design variation DfT / VCA **should** consider working with **the** industry, including manufacturers, to better understand **the** design and operational choices or requirements that have led to the variety of LST designs with different kick-out measurements.	We have had some initial discussions with manufacturers on this topic and it is planned to be a primary topic for the consultations planned for Autumn 2018.
2016-5 Increasing data on the relative rate of LST damage incidents to those of all trailers in the fleet of each operator DFT should **consider** working with the industry **and**/or amending the data framework, **to assess** how many operators experience a difference **in** damage only incident rates between their LSTs and standard length trailers. This should include work to better understand the impact of route familiarity and equipment awareness, especially on non-trunking operations, on the ability of drivers **to** operate LSTs without an increased risk of collisions resulting in property damage.	The new data framework launched from January 2018 has been designed to increase the flow of data on damage incidents, along with non-LST incident totals for the same fleets. Analysis of this new data will be carried out once we have 2-3 periods of data. The issues of route familiarity etc. will be addressed by the planned selected operator visits during 2018 and the consultation in Autumn 2018.

Area of work recommended	Progress
2016-6 Increasing data on the nature and severity of damage incidents involving LSTs If DfT wish to assess the impact of damage only incidents in more detail, then operator in-house incident severity data for both LSTs and ideally standard length trailers would need to be gathered as part of the standard trial submissions. To achieve this, we would recommend that the incident log template be revised to incorporate including at least narrative evidence of the severity of damage to the trailer and any objects hit in the collision and, potentially, a simple damage impact ranking. This recommendation is subject to DfT determining whether the value of this additional data justifies the additional reporting requirement on operators.	See above.
2016-7 Preliminary assessment of future impact of LSTs – scaling up and emissions assessment DfT should consider including an initial scaling up analysis in their 2017-19 plans for the trial evaluation, to begin assessing the potential future impact of LSTs. This would include work to translate the current distance/journey saving results into measures of reduced emissions/air pollution.	The first step in this process has been completed with the projections of emissions savings to the end of trial presented in this report. The second stage, scaling up to a hypothetical roll out of LSTs is scheduled to start in August 2018 and should be completed in early 2019.
2016-8 Preliminary exploration of possible post-trial requirements or guidance for operating LSTs DfT should consider conducting evidence based conversations between DfT, the haulage industry and other interested parties such as Local Authorities and civil society groups, regarding what guidance or regulation might be required to maintain the positive results seen on the trial under post-trial conditions.	Risk Solutions and DfT have had some initial discussions with FTA, RHA and SMMT in this area and have further stakeholder meetings planned which will consider options. We plan to test some of those options in wider consultation in 2018/19.

ANNEX 2: EVALUATION PERFORMANCE SUMMARY

The table below summarises the evaluation to date in terms of the elements of the evaluation programme logic model. The principles of good evaluation require that we test each stage of model to ensure it is delivering what is needed for the later stages.

Inputs | Activities & Processes | Outputs | Outcomes | Wider Impacts

PLM Element	Evaluation indicators	
Policy Inputs (DfT)	• Continued investment of time and resources by internal DfT freight policy team, VCA and funding of data evaluation.	✔
VSOs (VCA)	• Live VSO system managed by VCA. Good communication between DfT / VCA / Risk Solutions to update data or correct mismatched records.	✔
LST Designs (Manufacturers)	• 14 manufacturers involved in LST production. • More than 50 unique LST models tested and documented by VCA.	✔
Investment (Hauliers)	• To be confirmed. Initial test dataset with SMMT before agreeing the best approach to estimating this value.	2018
Eval'n Framework	• Evaluation framework first published in 2013 Annual Report still in use.	✔
Applications and Allocations	• 376 individual applications for LST allocations across all allocation rounds. So far more than 200 companies carried allocations forward to trailer order and VSO.	✔
LSTs in Operation	• 1,939 LSTs on the road and submitting data at end December 2017. 2176 now on road or on VSO with more later this 2018. • More than 100% of the original aspiration of 1800, and 78% of the increased allocation of 2,800.	✔
Data Gathering & Submission	• Total data submitted each period currently around 300,000 legs.	✔
Participation Engagement	• At the end of 2017-P3 many operators submitted the data without significant problems, having established a robust process, while some continue to struggle to get consistency. There is no apparent relationship to company size. However this marked the end of the use of the original template and data collection experience may change with the introduction of the new template. • More than 2,400 individual email/phone/other contacts with operators logged by Risk Solutions in 2017 and a further 245 with DfT.	✔
Data Framework and Process	• Core framework stable since start of the trial. • New data framework launched 1 January 2018.	✔
Participation Range	• Satisfactory mix of size and operation type.	✔
Master Data (Quality/Timeliness)	• Quality checking now stable and producing few if any invalid data records. Master data produced within 1 week of the end of a submission period.	✔
LST Ops Data	• Now collecting almost 1 million journey records a year.	✔
LST Incident Data	• Now around 200 events reported annually • Good data on the few injury events.	✔
Qualitative Data	• Majority of experiences very positive – very few poor experiences.	✔
Journeys (Carbon) Saved	• 1 in 14 average across fleet. Best cases 1 in 7. • Work still required to explore data of lower efficiency cases.	✔
Safety Impact	• Nationally – 70% lower than standard fleet. • Urban operations (excluding motorways) and Minor Road usage – also have substantially lower injury incident rates than standard fleet	✔
Applicability to general UK fleet	• 'Scaling up' analysis using the trial planned for Autumn 2018	2018

ANNEX 3: INTERMODAL EFFECTS

A3-1 Why revisit the intermodal effects of LST availability?

1. To understand the potential role for LSTs and the implications of the trial for any future wider roll out, it is important to consider the impact on other freight modes. While LSTs could result in a reduction in the demands placed on key parts of the Strategic Road Network, by reducing the number of HGV journeys taken, rail and sea also play a significant part in meeting national freight demands. Greater use of rail and waterways is recognised through government policy as being an important driver of sustainability as well as offering greater modal choice for businesses.
2. The 2011 pre-trial impact assessment base case, forecast a major shift of goods from rail to road once LSTs were available, unless the rail freight industry responded by accommodating longer intermodal units. In contrast, Annex 6 of the impact assessment forecast that, if the rail industry **did** respond by accommodating longer loads, rail market share could increase even beyond ambitious industry forecasts.
3. **The purpose of the study carried out during 2017 was to revisit the whole question of the impact, if any, of LST availability on the relative attractiveness of road/rail to operators, in the light of new information that was not available or was not considered in 2011.**
4. The full study is available in Project Note E3[42].

New evidence sources since the 2011 pre-trial impact assessment

5. We now have several years of real world LST experience in a range of operations in general - including, for the trial, where the primary routes are and how these relate to the locations of the current rail freight terminals and hence the potential for transfer of movements where LSTs are being used, to rail for part of their journey.
6. The rail freight industry has also had the opportunity to better understand the impact of LSTs in the light of those industry-wide operations and so is better placed to provide a response to questions about the impact of LSTs.
7. Most importantly, Malcolm Group, a major rail and road freight operator, has participated in the trial and has developed an LST+Rail, rail freight solution allowing LST compatible 50ft ISO units on rail and is operating this model today.
8. A second operator is currently preparing to start a similar operation.
9. Since the pre-trial impact assessment two more important sets of rail freight forecasts have also been published:
   - **2013 Freight Market Study (FMS)[43]** from Network Rail (NR), and
   - **2016 DfT Rail Freight Strategy**, which included constrained rail freight forecasts that are significantly lower for some commodities than the NR figures.
10. Both forecasts continue to assume strong growth in rail freight (particularly in the intermodal sector) driven by increased volumes of containers arriving in ports and an assumption of dramatic growth in the number of rail connected distribution parks.
11. Growth is focussed into two distinct markets for movements of containers:
    - Deep sea cargo to and from ports – to which LSTs may be irrelevant
    - Consumer goods between inland distribution hubs - where LST might be used.

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[42] Project Note E3: LST Intermodal Effects September 2018 SPATS 1-403: PN-E3-v4-1

[43] The 2016 FMS was published just after the analysis to support this annex was completed.

Scope of work

12. Specialists in Freight and Logistics from WSP were brought into the evaluation team and asked to undertake a wide-ranging study of the factors influencing operator decisions to move freight by road vs road/rail related to the availability of LSTs.
13. The scope of the study included:
    - **A desktop review** covering:
      - The assumptions and modelling applied in the pre-trial analysis
      - The current forecasts of the intermodal freight market and corridors, and their relevance to the LST operations on the trial or in future
      - The trial experience in relation to any competition between rail and LSTs
      - The availability of rail wagons to carry 50ft (LST compatible) ISO units
    - **An in-depth meeting with Malcolm Logistics** around:
      - the role of LSTs in the intermodal market
      - the limitations of LST use in their operations – including customer response
      - competition for LSTs on rail
      - the challenges for intermodal freight and the future for LSTs.
    - **A range of stakeholder interviews**, following up on themes developed from the desktop review and Malcolm Group discussions.
      - The selection of companies for these interviews included some operators who already use rail as part of their operations (but not yet with LSTs) and other chosen because their LST operational pattern included a significant use of routes which included start and end points near to existing rail hubs
      - Beyond operators, the study consulted with a range of industry groups and a meeting with some members of the LST trial stakeholder group, which includes ‘Freight on Rail’.
14. Note that the scope of the study was only to address the question of whether the availability of LSTs (and now, LST container + rail options) affected the decision of operators to consider rail as part of their operation. It was not to assess the wider policy and national infrastructure questions on the future of rail freight.

A3-2 Revisiting the pre-trial intermodal analysis

15. The 2011 impact assessment forecast that rail would lose over 50% of its forecast domestic intermodal freight by 2026 if rail did not adapt to carry LST units. On the other hand, if rail did adapt, its forecast volume was estimated as potentially 10% higher than in the 2013 FMS. However, the forecast in the 2011 pre-trial impact assessment of the impact of LSTs on rail freight was extremely sensitive to the assumptions used, in particular,on:
    - Take up of LSTs for road haulage - how many and what types of goods on which routes
    - The assumptions made about the type of wagon used – with and without LSTs
    - The rail freight operators’ willingness and potential to invest in new equipment.
16. In practice, rail has shown that it can adapt and provide a LST+Rail solution that efficiently carries LST length intermodal units and integrate these into an existing road-rail operation. It resolves a series of questions raised in the 2011 impact assessment about the feasibility of such an operation and removes the argument that led to the 2011 base case assuming a major shift of freight from rail to road.

A3-3 GB intermodal growth assumptions and corridors for rail

17. Having considered how the pre-trial impact assessment considered intermodal effects, we now look at the situation today, seven years on from that original work. By looking at the rail freight intermodal market in more detail, we can consider which parts of that market could be affected by the introduction of LSTs
18. Broadly speaking there are three categories of intermodal rail freight in the UK:
    - **Deep sea Intermodal**: the movement of standard ISO shipping containers to and from ports. The containers typically arrive on ships from the Far East.
    - **Channel Tunnel Intermodal**: the movement of trains of containers or swap bodies by rail between UK intermodal terminals intermodal terminals on the continent.
    - **Domestic Intermodal**: the movement of containers or swap bodies by rail between intermodal terminals in the UK, but excluding Deep Sea Intermodal containers.

A. Deep sea intermodal

19. The deep sea Intermodal rail freight market in the UK is long established and successful. Rail competes strongly for medium to long distance movements inland from ports. This is because all deep sea ports have rail terminals, and the ISO containers are well suited to rail transport.
20. Deep Sea intermodal is also a fast growing market for several reasons including:
    - Deep sea volumes of freight through ports has a strong record of growth, boosting demand for all methods of transport to and from the ports.
    - The rail freight market is increasing partly because there are more warehouses located near intermodal terminals, particularly at Strategic Rail Freight Interchanges (SRFI). More SRFI leads to more rail freight because rail has a point to point offer, without any need for long road deliveries at either end.
21. The 2013 FMS forecasts Deep Sea Intermodal volume to grow from 15.1 Million tonnes and 5.1 Billion tkm in 2011 to 32.7 million tonnes and 10.8 Billion tkm by 2025.
22. However, this traffic is exclusively in ISO deep sea containers, which are a maximum of 45’ long, this traffic should not have any impact from the introduction of LSTs. Longer containers do exist (50’ and 53’), but they are not currently moved on ships and there are no plans to do so in the foreseeable future.
23. **Availability of LSTs will not directly affect the Deep Sea sector of the market.**

B Channel tunnel intermodal

24. This is a very small market with significant potential for growth. Rail has failed to penetrate the cross channel market since the opening of the Channel Tunnel for a variety of reasons, including price, service quality, the impact of strikes, and, more recently, long periods of service closure due to incursions by migrants.
25. The 2013 FMS forecasts modest growth, from 0.6 to 1.3 million tonnes.
26. Again, it is unlikely that this market will be impacted by the introduction of LSTs. Many international hauliers already use draw bar trailers to achieve higher length platforms. Without further EU legislation, LSTs would not be able to drive on most roads in the EU (noting some special permissions already granted in Ireland).
27. **Availability of LSTs is unlikely to directly affect the channel tunnel market.**

C Domestic intermodal

28. In this market, rail freight has a small, but fast growing, share of a very large freight market (including most retail goods). The Domestic intermodal market is forecast to grow very strongly in the future. The 2013 FMS forecast growth from 2.3 million tonnes in 2011 to 16.6 million tonnes by 2023 (1.1 to 13.1 billion tkm).
29. The table below is an analysis of region to region domestic intermodal rail freight flows (2011 and forecast for 2023), extracted from data used to prepare the 2013 FMS. (The more recent 2016 FMS data has now been published; however, it does not contain regional breakdowns to allow the table below to be updated.)
30. Data in green represents low volumes of rail freight, the data in pink and red represents relatively high volumes of rail freight (greater than about 170 thousand tonnes per annum). The table shows significant growth is predicted in many areas. This growth is achieved by significant growth in the area of warehousing near strategic rail freight interchanges (SRFI). Rail freight can compete for traffic over short distances if both the origin and destination are on an SRFI. A key observation is that there are imbalances between flows north to south and south to north – with more travelling north than south.

Table 37: Domestic intermodal rail freight flows 2010 / 2023

		Channel Tunnel	East Midlands	East of England	Greater London	North East	North West	Scotland	South East	South West	Wales	West Midlands	Yorks and Humber
2010	Channel Tunnel	0	0	0	0	0	0	0	0	0	0	0	0
	East Midlands	0	20	0	1	0	3	585	1	0	0	0	15
	East of England	0	0	0	0	0	5	0	0	0	0	0	0
	Greater London	0	67	0	1	0	7	11	0	0	0	0	0
	North East	0	0	0	0	0	3	0	2	0	0	0	0
	North West	0	6	4	5	3	31	68	12	5	147	1	7
	Scotland	0	443	0	9	0	89	368	0	0	0	182	2
	South East	0	32	3	177	0	13	0	7	16	0	2	7
	South West	0	0	8	0	0	6	0	1	0	0	4	0
	Wales	0	0	0	0	1	16	0	0	0	0	5	0
	West Midlands	0	0	1	0	0	2	180	6	0	1	19	0
	Yorks and Humber	0	1	0	0	0	99	11	0	0	11	0	4
2023	Channel Tunnel	0	40	0	0	0	0	0	0	0	2	0	0
	East Midlands	2	32	175	110	238	680	1,850	335	291	156	161	459
	East of England	0	173	10	39	139	720	387	100	274	78	434	592
	Greater London	0	78	0	0	0	0	10	0	0	0	0	0
	North East	0	218	180	13	0	63	51	152	86	22	224	16
	North West	0	429	487	35	25	133	552	456	163	108	103	24
	Scotland	0	1,274	163	36	17	482	425	232	89	16	560	322
	South East	0	181	47	140	86	431	322	38	65	19	270	412
	South West	0	204	152	16	48	186	203	80	103	7	105	279
	Wales	0	89	47	5	20	51	42	25	11	2	15	63
	West Midlands	0	96	329	33	168	123	760	343	102	10	23	153
	Yorks and Humber	0	219	394	26	7	43	457	498	268	66	124	9

Note: Freight origin is on the left and destination across the top. Figures are thousands of tonnes per annum
Source 2013 FMS Forecasts. (2016 FMS did not contain regional details to allow this chart to be updated)

31. Currently services to and from Daventry International Rail Freight Terminal (DIRFT), near Rugby, (East Midlands > Scotland in the table) demonstrate the potential, with 5-6 trains per day between DIRFT and Scotland, and daily trains to Wales and London carrying perhaps 70-80 containers. The number of trains is partly limited by demand, but also by the available 'paths' for freight trains alongside the rest of the rail network traffic. To give some context to this, just one of the companies interviewed said that their throughput every night was 300-400 deliveries/trailers.
32. While this market has the strongest potential to grow, it is also the market which is most sensitive to changes in rail or road costs[44]. **It is, effectively, the only market where LSTs could be considered to compete directly with rail freight, with DIRFT-SCOTLAND being the only currently competitive service**.
33. The factors that drive decisions between modes, and the influence of LSTs, are discussed in the next section.

[44] Returning to the 2011 IA results, the base case impact assessment forecast a loss of 9.1 million tonnes (and 3.7 billion tkM) of rail freight compared to industry forecasts. While this is a small percentage of total rail freight, all of the losses would, implicitly, come entirely from the domestic intermodal market, representing a reduction of around half of the forecast market for domestic intermodal rail freight by 2025 (as described earlier). This seems sufficiently unlikely to at least raise the question of whether the reduction is a facet of the model, rather than a real scenario.

A3-3 Factors influencing operator mode choice

34. All operator stakeholders interviewed said that LST's have not changed their decision making in relation to use of road or rail (none of those interviewed had considered water as part of their multimodal options). Our stakeholder engagement and review of research papers[45], explored the reasons behind freight mode choice.
35. On a per kilometre basis rail is less expensive than moving the equivalent volume of goods by road. However, few road depots are currently rail connected, road use will therefore often be required at one or both ends of the rail leg adding cost, complexity and risk.
36. Even if rail meets all the requirements of an operator from a cost, location and access perspective, even in optimistic forecasts, rail is still a minority share of freight transport due to an overriding need for flexibility. Interviewees told us, for example, that the nature of their supply chains mean that lead-times are short, which does not always allow for significant forward planning. This combined with often very specific pick-up and delivery time slots from their customers, means that matching timeslots for trains are frequently not available to meet these needs. Many HGV operators do not operate the regular, large volumes of commitments that lend themselves to rail movements. The average number of vehicles specified to operator licences is 4.3 - demonstrating the large proportion of smaller operators in the industry.
37. The need for flexibility and the logistics of getting to and from rail hubs affects LSTs and standard trailers equally.
38. Our research concluded that the dominance of factors unrelated to LSTs will mean that forecast volumes of rail will not increase due to the availability of LSTs, even the availability of an LST-Rail solution, as suggested in the 2011 impact assessment.
39. Interviewees told us that for price to become a dominant factor, such that freight will move from rail to road, the additional load per vehicle would need to be much more than the saving of 15% or less offered by LSTs, especially when a joint LST+Rail solution exists, offering the best of both worlds. Interviewees identified Double Decker trailers as the more direct competitor to rail than LSTs, because of their potential to double the number of pallets on a single load. The potential for the availability of LSTs to effect a shift from road to rail is therefore also small.
40. Other factors that may in future affect take-up of LST intermodal compared with road based solutions and standard intermodal, include:
    - Driver shortages may encourage businesses to revisit intermodal solutions
    - Further technological developments – which may lead to LST Intermodal becoming more or less attractive compared with other solutions.
    - Further development of UK rail and intermodal hub.

41. In conclusion we find that **few, if any, of the factors affecting decisions to move to or away from rail freight as part of an intermodal operation are affected by the availability of LSTs, especially with a proven LST+Rail option now available.**

[45] Including Freight Modal Choice Study (2010) and DfT Rail Freight Growth & Modal Shift Study 2016.

A3-4 Availability of intermodal wagons compatible with 50ft containers / LSTs

42. The final issue we need to consider is to what extent the LST+Rail solution demonstrated by the Malcolm Group operation could be expanded, given the availability of compatible rail wagons.
43. This is important as if the emerging demand for combined LST and rail operations (within the other constraints such as rail path availability) exceeded the available wagons, then this would limit the benefits that could be claimed from the technical availability of such operations.
44. Presently, the only wagon that can carry LST containers is the Megafret (Figure 36). Megafrets operated in the UK are owned and leased by a subsidiary of VTG, the largest wagon operator in Europe. On the continent hundreds more Megafret wagons are operated by other wagon operators and freight operators.
45. Over time, the use of Megafret on deep sea services is being supplanted by the Ecofret wagon (Figure 37), also VTG operated (in part because of an efficiency gain derived from having a smaller gap between every other carriage). This will release a number of Megafrets for domestic use.

Figure 36: Megafret Wagon Source: VTG Brochure

Figure 37: Ecofret Wagon

46. VTG is looking for ways to make use of surplus Megafret wagons, including possibly shortening them to make them more efficient when carrying 40’ or 45’ containers, but of course some could, instead, be retained for use in conjunction with LSTs, carrying 50’ containers.
47. VTG were consulted during the study, and they confirmed that surplus Megafrets could be made available for use carrying 50ft containers (delivered by LSTs).
48. Over the medium to longer term, domestic intermodal, deep sea intermodal, and aggregates traffic are all forecast to grow strongly. There is no pool of unused wagons to meet this strategic growth: invariably wagon operators and freight operators invest in new wagons to meet demand. Shortage of wagons may deter ad hoc rail freight opportunities, but wagon supply has never been a constraint to rail freight growth and is not seen as a constraint in DfT or Network Rail forecasts.
49. The type of wagon built for domestic intermodal traffic will depend on market demand – and if demand is to carry containers longer than 45’ then there is no reason to believe that the wagon leasing industry will not meet that demand.

A3-5 Conclusion: Effects of LST availability on rail freight

50. The study concludes that:

- Overall where routes operating LSTs (during the trial) might have competed with rail at a limited level, **rail has been able to respond effectively and integrate LST operations into its business model**.
- This LST+Rail option **will not allow rail to increase its forecast volume, but is effective enough to avoid rail losing potential traffic to LSTs**.
- The effect of introducing **LSTs can currently be regarded as neutral or at least a second order influence on operator's modal choice.**

51. The primary reasons behind these conclusions are summarised in Table 38

52. If DfT were assessing impact over a much longer timeframe (10-20 yrs) then the factors relating to availability of rail hubs and rail network paths might change.

Table 38: Limits on the relationship between LST availability and rail freight

Themes	Summary
Theme 0: The introduction of trial LSTs on the trial has not been a factor in decisions to use/not use rail	**The availability of LSTs with a slightly larger load capacity, is a second order influence on their decisions. The primary influences are in Themes 1-4.** All operator stakeholders involved said that LST's have not changed their decision making in relation to rail. None of those interviewed had considered water as part of their multimodal options.
Theme 1: Limited number of rail-connected distribution centres (depots)	Rail's major offer is as a replacement for depot to depot road deliveries, but few road depots are currently rail connected. Road use will therefore often be required at one or both ends of the rail leg adding cost, complexity and risk. The logistics of getting to and from rail hubs affects LSTs and standard trailers equally.
Theme 2: Highly variable demand for freight requires flexibility	Even if rail meets all the requirements of an operator from a cost, location and access perspective, even in optimistic forecasts rail is still a minority share of long distance freight due to an overriding need for flexibility. This affects LSTs and standard trailers equally
Theme 3: Collection and delivery time criticality	Pallet trunking, a major sector that has adopted LSTs, would not, as it is currently set up, find rail an attractive alternative. For these operations, there are about 300-400 drops per night into the central depots and the role of redistributing the product across the network of operations is highly time critical and so it is felt that rail wouldn't be appropriate. In addition, volumes vary massively which would be difficult to plan for in the rail market. This makes road (with or without LSTs) a more attractive option than rail.
Theme 4: LSTs offer insufficient economic gain to overcome other variables affecting modal choice / shift decisions	For price to become sufficiently dominant factor will move freight from rail to road, the additional load per vehicle needs to be much more than the 15% or less offered by LSTs, especially when a joint LST+Rail solution exists, offering the best of both worlds. The industry stakeholders identified double-deck trailers as the direct competitor to rail, since they offer double the number of pallets per wagon.

GLOSSARY

CIF	Company information form - the MS Excel workbook developed to capture background information about the operator's company and standard operations prior to the trial.
DfT	Department for Transport
Double deck/ dual deck	A specialised trailer with two floors covering all or part of its internal length to allow for more cargo to be loaded.
DSF	Data submission form - the MS Excel workbook developed to allow operators to submit all trial data in the required format for analysis.
Flatbed	A flat trailer with no enclosure or doors. Can be loaded/unloaded from the sides or above and does not require elevated access for forklifts.
FMCG	Fast Moving Consumer Goods - products that are sold quickly and at relatively low cost. Examples include non-durable goods such as soft drinks, toiletries, over-the-counter drugs, processed foods and many other consumables.
FTA	Freight Transport Association
ISO	Containers meeting the international specification for intermodal transport.
Leg	A single journey from A to B.
LST	Longer Semi-Trailer - a trailer exceeding the standard length of 13.6m, towed by a tractor unit (as opposed to standard length trailers).
LST Related	A judgement (on scale of options) of whether or not an incident involving an LST would have happened had the trailer been a standard length.
MOA	Mode of appearance - the physical form of the load, for example standard pallets, loose/ bulk, livestock.
Model Report	A document specifying the conformance criteria for a specific model to be licensed for use on the road, created by the VCA after testing new vehicle types.
PLM	Programme logic model - a diagrammatic representation of the structure of a process for the purposes of evaluation.
QSF	Qualitative survey form - the MS Excel workbook developed to capture qualitative information from operators about their trial experience.
RHA	Road Haulage Association
RST	Regular Semi-Trailer – i.e. up to a maximum length of 13.6m (not requiring a VSO) – sometimes use to refer to a GB standard length HGV trailer.
Skeletal	A skeletal trailer composed of a simple chassis for the mounting of an intermodal trailer.
VCA	The Vehicle Certification Agency is an Executive Agency of the United Kingdom Department for Transport and the United Kingdom's national approval authority for new road vehicles, agricultural tractors and off-road vehicles.
VIN	Vehicle Identification Number - a unique 17 digit identifier required on all vehicles, stamped on the chassis on manufacture.
VSO	Vehicle Special Order - a certificate provided by the VCA to allow vehicles that do not conform to standard legislation in terms of dimensions to operate on roads in Great Britain under specially licensed conditions.