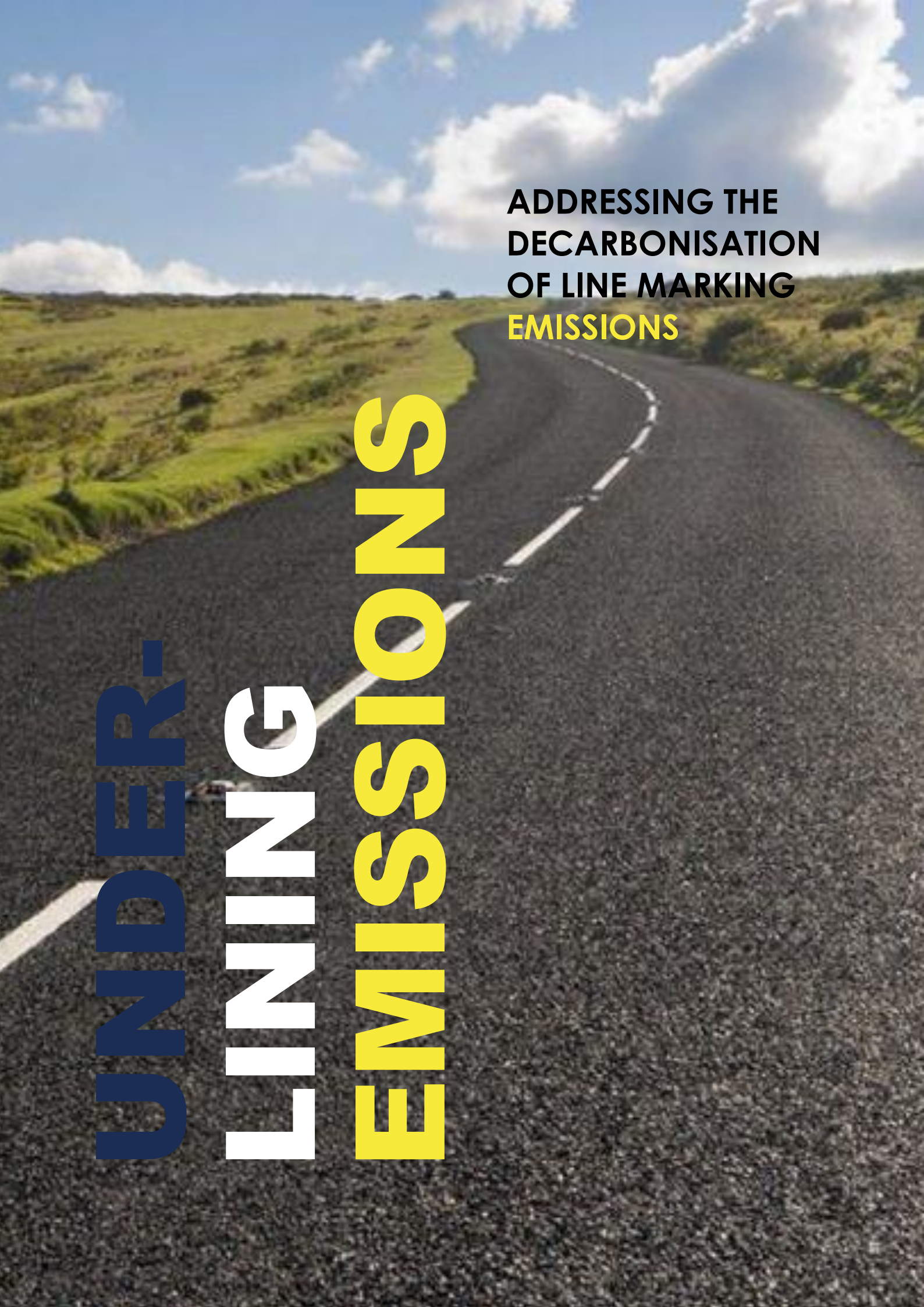

UNDER-LINING EMISSIONS

ADDRESSING THE DECARBONISATION OF LINE MARKING EMISSIONS

This study was verified by Avieco on behalf of Meon. The study was carried out independently from Meon by the university of Alberta, Canada, drawing on industry insight, scientific research and product specifications. **It explores the carbon emissions differentials between hot and cold applied line marking systems.**

Study conducted by:

UNIVERSITY OF ALBERTA

Verified by:

avieco

Endorsed by:

BLUE SYMMETRY

avieco

Avieco is a market-leading independent sustainability consultancy that works with businesses and the public sector to provide the widest range of best-in-class solutions to help effectively tackle the most complex sustainability challenges.

We believe that sustainable business has a positive impact on our environment, society and economy -it is ambitious for all its stakeholders. Sustainable business is resilient, innovative and embraces change; and change must happen as what we do today will not be enough for tomorrow -every business must be sustainable. **Our mission is to make sustainability more than a word.**

Debating whether to incorporate sustainability into your business strategy is no longer an option. Regulations are here, expectations have risen, targets must be set and plans to achieve them must be made. No sector will be immune from the need to act – whether you are in retail or property, leisure or government, manufacturing or services, transport or packaging, food or finance. At Avieco, we have a vast experience supporting clients from different sectors in reducing their environmental impacts and improving their sustainability profile.

We are independently appointed by MEON Ltd, and no member of the team has a business reason for bias with regard to this carbon footprint. Our team is experienced in GHG reporting to WRI GHG protocol and ISO 14064:1 standards; has extensive experience of verification using ISO 14064:3; and PAS2050:2011 for product carbon footprints

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Executive summary

Line marking is a fundamental part of transport systems helping to manage traffic flow and maintain road safety. The UK government has set an ambitious target to achieve net zero carbon emissions by 2050[1]. Line marking plays a role in supporting the infrastructure sector to achieve this goal.

Line marking industry activities on a large scale can contribute to significant carbon emissions. Whilst the industry is adapting to changes and becoming innovative, traditional line marking systems are carbon intensive. Modern line marking systems include the use of products that can be cold-applied and are under investigation for their potential to reduce carbon significantly. Combined with electric powered application equipment, these technologies have scope to revolutionise the industry.

This white paper examines the carbon footprint associated with various line marking systems. Thereby showing the potential for carbon reduction based on a comparison of hot thermoplastic line marking application and cold applied line marking systems. The carbon footprint study was carried out independently and verified externally by Avieco in accordance with ISO 14064-3. The results of the carbon footprint study show that

- Using a cold applied system with a standard Light Commercial Vehicle (LCV) could result in **6 times less carbon emission.**
- Hot applied thermoplastic system using a heavy-duty class 8 support truck emits **1,734 kgCO_2e/km** whereas on average cold applied systems result in **253 kgCO_2e/km**
- Line marking emissions are significantly driven by the product choice which contributes up to at least **80%** of the total life cycle emissions

- **6 times** less carbon emission using **cold applied systems**
- **1,734 kgCO_2e/km** from thermoplastic system
- **253 kgCO_2e/km** from cold applied system
- **Even lower emission of 181 kgCO_2e/km** from electric powered systems

[1] Department for Business, Energy & Industrial Strategy, UK becomes first major economy to pass net zero emissions law, 4 June 2019, GOV.UK, www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law

1. OVERVIEW OF LINE MARKING

Thermoplastic Line Marking

Thermoplastic Road Markings (TRMs)are used on more than 95% of public roads in the UK since the 1950s[2]. The high use of TRM's for line marking public roads represents a significant carbon output. This is because TRM's are typically applied using a heavy-duty class 8 support truck. The system also requires heating and agitation of the material before application onto the road surface. The material also has to be maintained at a constant temperature throughout the line marking shift.

Thermoplastic applied linemarking systems

Cold applied line marking systems

Cold applied line marking systems offer a high-performance alternative to systems such as thermoplastic line marking. Cold applied systems include; Methyl Methacrylate (MMA) cold plastics and solvent, or water based acrylics. These systems do not require-heating during the line marking process and they can be transported by LCVs. The cold paints can be applied with a range of modern, efficient line marking equipment. The line marking equipment also reduces wastage of product as the application is precise and efficient. Furthermore, cold applied line marking equipment can also be battery powered.

Cold applied line marking system

Scope and subject matter

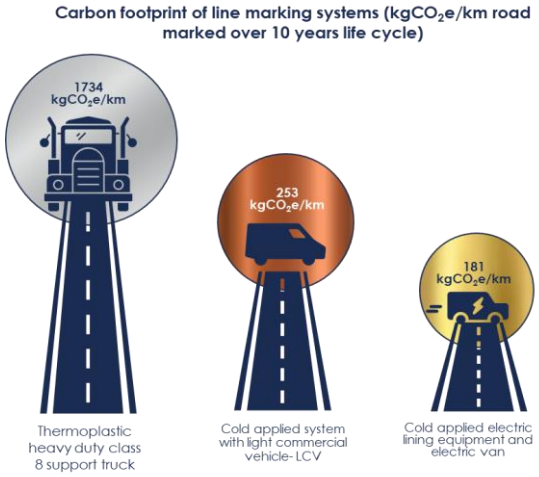
Description	Road surface marking using different paints, equipment and vehicles
Function	To provide safe navigation for road users
System boundary	Cradle to gate: line marking activity including paints
Functional unit	tCO_2e/km line marked over a 10-year surfacing life cycle.

[2] Atkins (2015) Durability of white thermoplastic road markings
https://www.transport.gov.scot/media/2639/durability-of-thermoplastic-road-markings-final.pdf

2. CARBON EMISSIONS OF LINE SYSTEMS

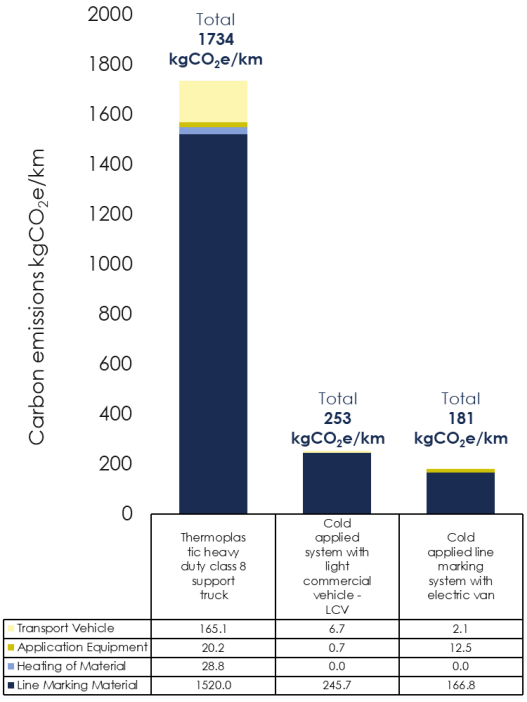
Thermoplastic system vs cold applied line marking system

- Using a cold applied line marking system on a LCV leads to **6 times less carbon emissions.**[3]
- Hot applied thermoplastic system using a heavy duty class 8 support truck emits **1,734 kgCO2e/km** of road marked.
- The carbon emissions from cold applied system is **253 kgCO₂e/km** of road marked. These systems have lower embodied carbon and do not require heating paint.
- The cold applied system, if using electric powered vehicle and lining equipment results in **10 times less** carbon emissions at **181 kgCO2e/km**.



Key drivers of line marking emissions

- **87%** percent of the carbon emissions by the thermoplastic systems is due to the high energy input required to prepare the raw materials leading to a high embodied carbon of **1520 kgCO₂e/km**.
- Thermoplastic paint emissions are significantly higher because the ingredients are derived from petroleum and also contain 40% calcium carbonate fillers and 20% glass beads from energy intensive aggregate industries.
- Transport during line marking is the second largest driver of thermoplastic line marking system, making up **165 kgCO₂e/km** due to fuel consumption of the heavy duty truck class 8 support truck and truck idling.
- The emissions from cold applied systems are driven by the materials from the solvent based Acrylic paint resulting in **245.7 kgCO₂e/km** of road marked whereas MMA systems have a lower carbon impact of **166.8 kgCO₂e/km.**



[3] The results have been verified in accordance with ISO 14064-3: 'Greenhouse gases - Part 3: Specification with guidance for the verification and validation of greenhouse gas statements'.

3. VISUALISING THE LONDON NORTH CIRCULAR A406

The data visualisation highlights the carbon impact of marking the London North Circular A406 highway using various line marking systems. Line marking emissions may not be viewed as significant. However, when scaled up to a project level, there are opportunities for the industry to reduce its carbon footprint. The line marking of both carriageways of the A406 is approximately 83km linear metres of road. Applying 10-year life cycle modelling, which includes a 2.5 year refreshing programme results in the carbon emissions below.

Thermoplastic line marking delivery

Line marking the North Circular route using thermoplastic and a purpose built support truck results in **144 metric tonnes of CO_2e**. The emissions are predominantly driven by the embodied carbon of thermoplastic screed, of which 16.6 tonnes of thermoplastic is required.

Cold applied line markings using petrol driven equipment transported in a Light Commercial Vehicle

Line marking the North Circular using cold applied systems, such as MMA applied by airless spray machines and transported in a diesel powered LCV will result in **21 metric tonnes of CO_2e.** The emissions reduce **6** times less compared to the thermoplastic system. This is due to lower embodied carbon of the MMA system, combined with improved application efficiencies.

Cold applied line markings using battery powered equipment and a hybrid LCV

A further **32%** reduction in emissions can be achieved by switching to a fully electric powered cold applied lining system. Using a battery powered line marking equipment and hybrid van to line mark the A406 results in **14 metric tonnes of CO_2e.**

4. METHODOLOGY

Goals

The goals of the line marking carbon footprint study were to:

- Quantify emissions of thermoplastic line marking
- Quantify emission of cold applied line marking
- Conduct a comparison between both systems and various line marking equipment and vehicles

System boundary

The system boundary of the study is a cradle to gate analysis of the line marking activity. The embodied carbon of the line marking material, heating of thermoplastic paint, fuel consumption of the line marking equipment and transport vehicle emission during the line marking. **The system boundary excludes the following:**

- Manufacturing of the vehicle and line marking equipment
- Transport of the line marking paints from the manufacturer
- Travel of line marking crew members from their homes

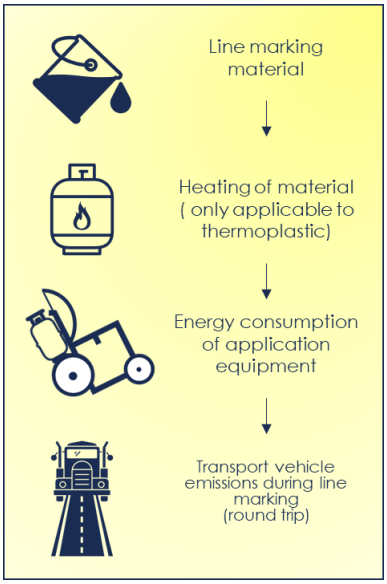
Key Assumptions

Line marking width: All line markings are assumed to be 100 mm wide.

Line marking efficiency: Based on industry insights, during a typical 8 -hour shift. A two-man line marking crew can complete 4 km of road using thermoplastic application carts and 10 km if using pedestrian spray equipment designed for use with MMA's and paints.

Application rates: The application rates are 2,000 gm/m^2 for thermoplastic, 715 gm/m^2 for MMA and 490 gm/m^2 for solvent based paints.

Proactive maintenance programme: the study assumes line refreshing every 30 months over a 10-year life span.



Data source and quality

Data was collected and assessed against the PAS2050:2011 scoring criteria. DEFRA 2019 emission factors were applied to fuels and electricity. The ICE Vol.5 database was used for line marking paints as seen in the Highways England carbon emissions tool.

Aspect	Data source	Data quality
Thermoplastic	ICE Vol.5, 2008[4]	4
MMA paint	Cruz, 2016[5]	4
Acrylic paint	ICE Vol.5, 2008[1]	4
Petrol	DEFRA 2019	5
Diesel	DEFRA 2019	5
Electricity	DEFRA 2019	5
LPG factors	DEFRA 2019	5
Lining equipment	Graco LineLazer	5

[4] Hammond, G., Jones, C., Lowrie, F. and Tse, P., 2008. Inventory of carbon & energy: ICE (Vol. 5). Bath: Sustainable Energy Research Team, Department of Mechanical Engineering, University of Bath.

[5] Cruz, M., Klein, A. and Steiner, V., 2016. Sustainability assessment of road marking systems. Transportation research procedia, 14, pp.869-875.

5. CONCLUDING REMARKS

"According to the LGA, around 230 Councils have declared a climate emergency. We all have a responsibility to consider every option to reduce transport-related CO_2 emissions. This study clearly shows the fantastic potential to reduce line-marking carbon emissions to as little as a tenth of the traditional thermoplastic approach. With over 40 years experience in the highways business, and as a former technical Director at Newcastle City Council, I believe that cold-applied products, methodologies and solutions should always be considered for every line marking project" - ***Michael Murphy BSc. CEng. MICE, Independent Business Consultant***

Reducing the carbon emissions from line marking activities show a significant potential to achieve carbon reduction goals in the highways industry. If all UK A roads were line marked again using cold applied system instead of the thermoplastic system up to **70,000 metric tonnes of carbon emissions would be avoided**[6]. The study highlights scalable carbon savings by adopting efficient line marking equipment, cold paints and light commercial vehicles.

As Net Zero targets are becoming more prevalent, businesses within the supply chain must provide low carbon line marking systems that can meet the needs of the council and local authorities.

Further development areas to compliment the study could include financial savings, whole-life cost evaluation, compliance with DMRB, and health and safety benefits.

"The Under Lining Emissions Report is a welcome and timely addition to the debate on sustainability on the highways network; it raises some very significant issues to be set amongst a range of challenging questions relating to safety, durability, and maintenance budgets. There are no easy answers, however, this is a debate the industry needs to responsibly engage with if it is to deliver an environmental and financially sustainable future" – ***George Lee, Senior Consultant, Blue Symmetry Ltd***

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[6] 29,400 miles of A roads Department of transport https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/801357/road-lengths-in-great-britain-2018.pdf