Guide to Road Safety Route Treatments

March 2025

Contents

Part 1

Part 2

Glossary

ADAS: Advanced Driver Assistance Systems
ANPR: Automatic Number Plate Recognition
ASC: Asset Support Contract
ASEC: Average Speed Enforcement Cameras
COBALT: Cost and Benefit to Accidents – Light Touch
DAS: The Departure Approval System
DMRB: Design Manual for Roads and Bridges
DVSA: Driver and Vehicle Standards Agency
ERIC: Eliminate, Reduce, Isolate, Control
FSI: Fatal and Serious Injury
FYRR: First Year Rate of Return
GtRSRT: Guide to Road Safety Route Treatments
HFS: High Friction Surfacing
HGV: Heavy Goods Vehicle
iRAP: International Road Assessment Programme
KSI: Killed or Seriously Injured
LTN: Local Transport Note
MAC: Managing Agent Contractor
PIC: Personal Injury Collision
PoLAR: Project Evaluation (POPE) of Local Network Management Schemes (LMNS) Analysis Reporter
PRS: Pedestrian Restraint Systems
PSV: Polished Stone Value
POPE: Post Opening Project Evaluation
RDI: Road Death Investigation
RIS: Road Investment Strategy
RoSPA: Royal Society for the Prevention of Accidents
RSF: Road Safety Foundation
RRT: Route Review Tool
SAR: Scheme Appraisal Report
SES: Safety Engineering and Standards
SFAIRP: So Far As Is Reasonably Practicable
SME: Small and Medium-Sized Enterprises
SR4D: Star Rating for Design
SRIP: Safer Roads Investment Plans
SRN: Strategic Road Network
SRS: Star Rating Scores
TAL: Traffic Advisory Leaflet
TRO: Traffic Regulation Order
TSM: Traffic Signs Manual
TSRGD: Traffic Signs Regulations and General Directions
TTM: Temporary Traffic Management
VAS: Vehicle Activated Sign
VMS: Variable Message Signs
VRS: Vehicle Restraint System
VM: Value Management
WCHAR: Walking, Cycling, Horse Riding Assessment and Review
WYLIWYG: Where You Look is Where You Go

Foreword

At National Highways, our purpose is to connect the country, so that our nation can thrive. And that means having a road network that is safe and reliable, allowing our customers to make the journeys they need, whether for work, to see family and friends or to access the goods and services they need.

In short, the Guide to Road Safety Route Treatments is a recipe book for road safety design interventions; one that allows you to understand the impact of different enhancements along a route. It makes it easier to compare the benefits and determine the most appropriate solution to meet the road safety challenges you face.

It brings the requirements from a number of DMRB documents to life via dedicated pages for each type of road safety treatment, photography, a case study and is aligned with both Safe System delivery and the IRAP approach.

And it has a new home, sat alongside our other Road Design guidance documents – The Wrong-Way Driving Toolkit and Designing for Motorcyclists - to form a comprehensive suite of documents that can support you in delivering hugely important solutions.

Thanks to having such a fantastic team working on this, we've enhanced The Guide, making it easier to read, understand and apply to the challenges we face in not only improving safety, but designing roads that serve the communities that will use them for generations to come.
It's a brilliant read, and I hope it helps you to design solutions that make our roads safer both today and tomorrow.

William Spurr, Head of Road Design, Research, Development and Innovation Division, Safety Engineering & Standards

"the Guide to Road Safety Route Treatments is a recipe book for road safety design interventions"

Guide to Road Safety Route Treatments

Part 1 - Principles of Road Safety Route Treatments

Introduction

General

The Guide to Road Safety Route Treatments (GtRSRT - referred to as The Guide throughout this document) has been developed to provide guidance on applying route treatment techniques to road safety problems. It should be used by internal and external design teams and the wider supply chain when considering road safety route treatments on the Strategic Road Network (SRN).

Figure 1: Strategic Road Network

The Guide provides road safety treatments that are aligned to the **Safe System** (notably **Safe Speeds** and **Safe Roads**). Treatments target a range of road users, including drivers and passengers (vehicle occupants), motorcyclists, cyclists, pedestrians and horse riders. Generally, they are **engineering treatments,** although a small number of treatments within The Guide are **enforcement** and **education** based.

The Guide advocates the use of the International Road Assessment Programme (iRAP) approach from the start of the process, enabling priority routes for treatment to be identified along with the treatments that could have the greatest impact on safety.

Guidance is provided on appropriate data sources that can be used alongside iRAP to support the justification for route-based road safety treatments.

The Guide also highlights the importance of stakeholder engagement throughout the development of a scheme to aid problem identification, derive appropriate solutions and to ease scheme delivery.

The Guide provides advice that will help those developing route-based road safety schemes to estimate injury collision savings for input into the scheme appraisal process or business case. This includes the use of iRAP to calculate the potential impact that intervention measures may have on a route's Star Rating and estimated Fatal and Serious Injuries, and evidence from historic scheme information.

Following completion of a scheme, evidence of the scheme's performance should also be recorded.

What is a route?

In terms of this Guide, a route is:

A length of road which has similar characteristics. It is likely to have a relatively consistent traffic flow along its length, be predominantly either rural or urban, and be primarily either dual or single carriageway.

There may be cases where several lengths of a road form a route, although the characteristics may vary.

Examples of routes where characteristics vary may include:

- Routes between more urban environments (Towns or Cities) and suburban or rural destinations. An example would be the A3, which starts in central London and changes character as it continues southwest through more rural areas.
- Villages along a route with lower vehicle speeds (or lower speed limits) and higher levels of vulnerable road users in comparison to other lengths of the route.
- A route with much heavier vehicular flows on one length than on other adjacent lengths.
- A single carriageway route with climbing lanes or short lengths of dual carriageway.

In these cases, the variations can be accommodated within iRAP (which considers flow, rurality, number of lanes etc.) but care needs to be taken when assessing data outside of iRAP. For example, lengths of the route with different types of traffic, speeds or flows may need to be considered separately.

Routes may change in character along their length, although it is likely that most road users, despite these changes in character, will view roads as single routes.

Figure 2: Rural section of the A1, Felton, Northumberland.

What is a route treatment?

A road safety route treatment takes a holistic view of the route and recognises that road users experience roads as continuous lengths rather than as individual sites, junctions or links. Route treatments also recognise that collision risk at different locations may share an underlying cause.

They allow for a proactive approach to be taken by incorporating the whole route and ensuring that locations with similar characteristics (such as geometric features) which may carry a certain level of risk for road users, but may not have a collision history, are treated consistently. This **consistent approach** for an extended length may assist in improving a route's iRAP Star Rating.

Consideration of the route as a whole offers consistency for all road users, including cyclists, pedestrians and horse riders. This helps those unfamiliar with the route, as well as local users, to understand what is expected of them, for example, when negotiating bends, crossing junctions or passing through settlements. It also increases road users' awareness of hazards ahead by increasing the predictability of the road environment. It is however recognised that, in some circumstances, short length or spot treatments may be required to address a specific problem.

Structure of The Guide

The Guide is split into two distinct parts:

Part 1 'Principles of Road Safety Route Treatments' provides information on how to build an evidence case for a road safety route treatment.

Part 2 'Road Safety Route Treatments' provides examples of treatments that could be used to improve road safety and a case study

of a scheme that has followed The Guide's approach.

Road safety route treatments

Road safety route treatments may be implemented to:

- Provide safety-related improvements across an extended length
- Reduce the risk of a future collision issue
- Reduce the potential for Fatal and Serious Injury (FSI) collisions
- Provide improvements for a specific road user group (e.g. drivers, motorcyclists, cyclists, pedestrians or horse riders)
- Address a known collision issue

The main advantages that road safety route treatments have over conventional collision treatments are consistency, proactive treatment of risk and the ability to address collisions which are dispersed along a length of road that may be difficult to target or justify with site specific measures. Many sites with a history of high collision rates are likely to have already received some treatment, meaning targeting measures to treat remaining collisions can be difficult without using a route treatment approach.

In undertaking any route treatments, an improvement to the iRAP Star Rating of the route is likely to be achieved and treatments should contribute towards a safer road environment.

Safer roads and speeds can be realised by making roads more self-explaining and forgiving. This could be achieved by implementing route treatments in locations where the road does not naturally inform the user of the standard of road and the potential hazards likely to be encountered, and where additions can be made to the road environment that could lower the potential severity of an incident.

Figure 3: Speed reduction treatments on A120

These treatments are most likely to be **engineering** based, but could also involve alterations to speed limits, **education**, information and **enforcement** measures.

Safer road related route treatments may have most benefit on the more historic and / or environmentally challenging roads, which may not have been designed and built in accordance with the current Design Manual for Roads and Bridges (DMRB), or where a combination of factors in the existing road environment have combined to create a hazard.

Engineering based treatments can be utilised to offer road users a **consistent** message at repeated features such as villages, junctions, carriageway pinch points or bends, so that road users recognise when to adjust their driving behaviour to suit the conditions. This consistency is key to the successful application of road safety route treatments and means that similar treatments should be provided at similar sites along a route, even if some of these sites have no recent collision history.

In the case of pedestrians, cyclists and horse riders, the aim of **engineering** measures should be to create situations where conflicts with motorised road users are removed. This helps to create safe environments, where vulnerable road users also feel safer.

There may also be opportunities to separate vulnerable road users from each other. Where this is not possible, appropriate measures should be used to minimise conflicts and the potential severity of collisions, should they occur.

Figure 4: Pedestrian, cyclist and horse rider facilities over the A30, Cornwall

Where an issue involves a specific category of road user (e.g. young drivers or motorcyclists), collision type or behaviour, **engineering** measures may not be the most appropriate treatment or could be further reinforced by influencing users' behaviour through road safety **education** and information.

Education and information campaigns can involve collaborative working with other organisations to bring together expertise, information and education from the most suitable resources.

These campaigns can then be targeted at the specific road users. When developing an **education** and information campaign, the regional road safety teams, Communications team and Social Research and Behaviour Change Centre of Excellence within National Highways should be engaged.

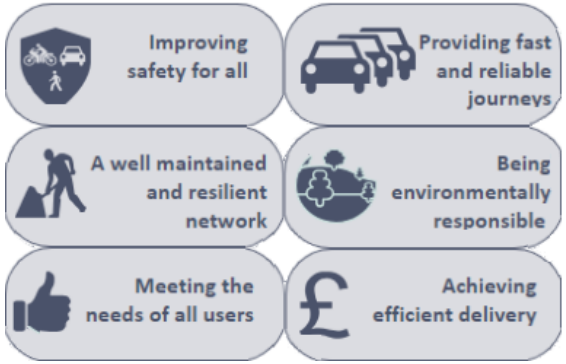
Where an issue involves unsafe behaviours (e.g. speeding) that cannot or have not been changed through the use of other measures, then the use of **enforcement** may be appropriate. This is likely to involve collaborative working with road safety stakeholders and a commitment from the local police force.

National Highways policies and objectives

The key policies and performance metrics, including the proposed iRAP Star Rating metric, in relation to the safety performance of the SRN during 2025 / 2026 and the third Road Investment Strategy (RIS3) will be subject to final approval by DfT in 2025.

The Guide is a key document in providing information and advice to assist road safety practitioners in identifying ways to introduce road safety measures that will improve both road safety and iRAP Star Ratings, and in turn help achieve National Highways' targets as outlined in the Operational Metrics Manual.

Figure 5: Categories of Key Performance Indicators within Operational Metrics Manual



The Guide will also help deliver the objectives of the Road to Zero Harm initiative, which is also aligned to the **Safe System** and iRAP. Road to Zero

Harm is an ambitious road safety initiative to help realise National Highways' vision that no-one should be killed or seriously injured on the SRN.

The Home Safe and Well document outlines National Highways' approach to health, safety and wellbeing, with a vision that 'no one should be harmed when travelling or working on the strategic road network'. This includes all road users as well as employees and the wider supply chain. Achieving this ambition requires fresh thinking and innovative approaches towards health, safety and wellbeing across the industry.

The Home Safe and Well vision outlines six themes for National Highways:

- Effective leadership
- Capable people
- Clear expectation
- Engaged stakeholders
- A learning organisation
- Health, safety and wellbeing by design

The Guide is most closely aligned to the 'Health, safety and wellbeing by design' theme, which focuses on designing out health, safety and wellbeing risks from the outset and investing in decisions that will lead to improvements in health, safety and wellbeing.

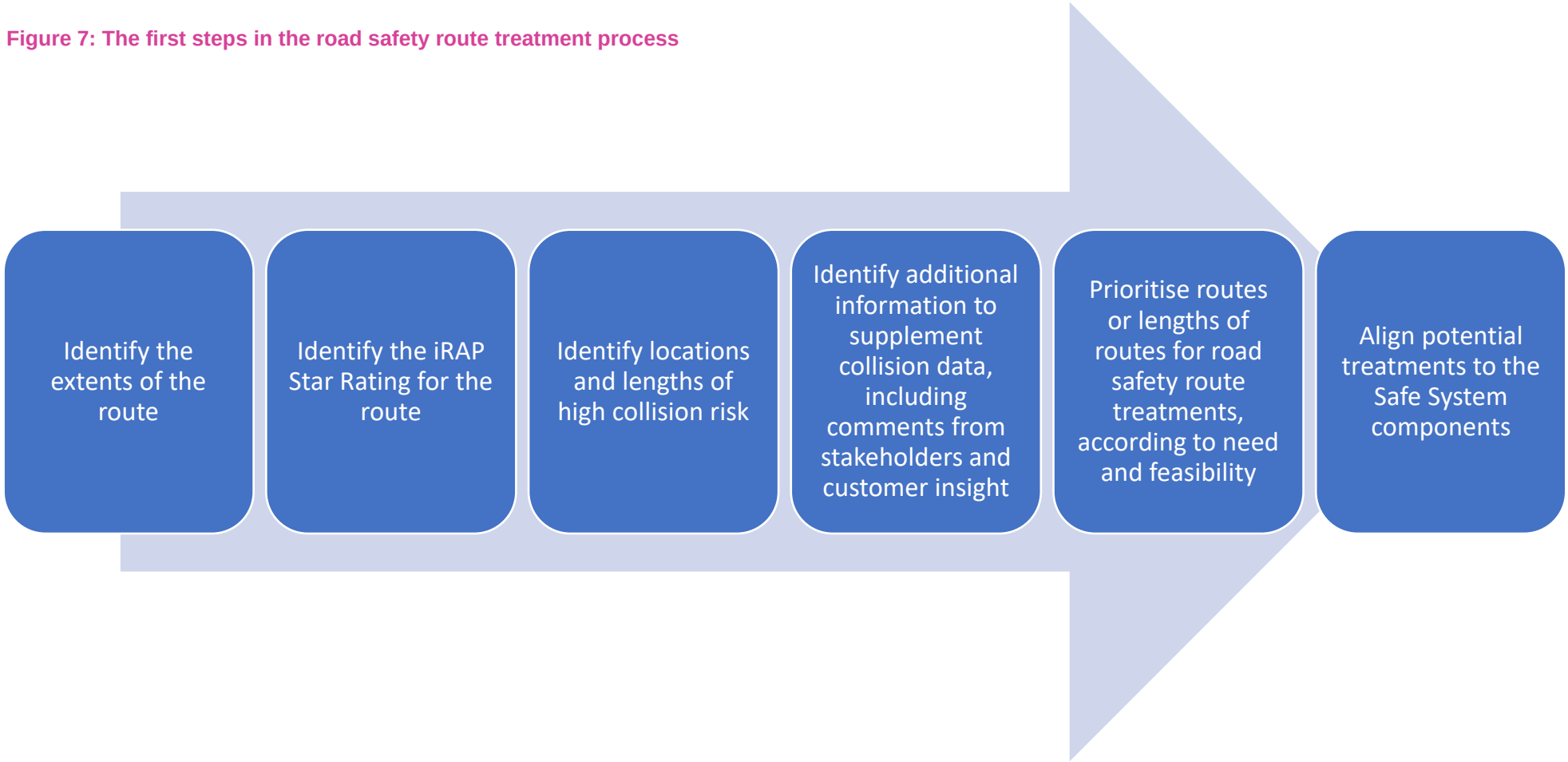
Figure 6: Home Safe and Well cover

Objectives and first steps of road safety route treatments

Objectives

The objectives of road safety route treatments are to improve the road safety performance of a route. This can be to proactively improve the safety of a route or reactively address road safety performance issues on the SRN, where route-based safety problems or road safety risks have been identified.

Figure 7: The first steps in the road safety route treatment process



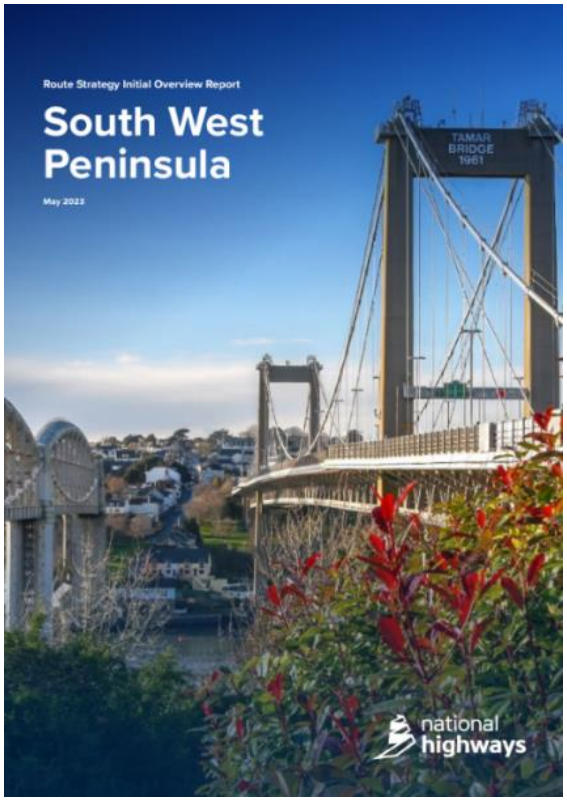
First steps

Identification of priority routes where action may be required could include consideration of information and recommendations provided in Route Strategy reports, along with the associated Evidence Reports and iRAP Star Ratings. These reports summarise relevant safety performance information and present it in a route-based format, identifying where problem areas exist. In addition, the latest Strategic Road Network Star Rating Report and any additional internal prioritisation exercises that may be undertaken, can be used to identify roads and routes with the lowest iRAP Star Ratings combined with the highest route-based crash densities.

There are a number of other sources of road safety related data which can be used to supplement collision data when justifying a road safety route treatment. Further details of these road safety related data sources can be found in the 'Implementation of a Road Safety Route Treatment' section of this document.

As treatments are identified, they will be aligned with a **Safe System** component(s). This will generally be **Safe Speeds** and **Safe Roads**, but complementary treatments or initiatives that could be undertaken alongside treatments may be aligned to other components, such as vehicle technology (**safe vehicles**) or **education** programmes (**safe people**).

Figure 8: Route Strategy Initial Overview Report for the South West Peninsula



Benefits of road safety route treatments

Road Safety Route Treatments can provide numerous benefits to road users and road workers, while helping National Highways deliver in line with their targets and visions. Benefits can include:

Consistency

By treating individual routes or numerous routes across the SRN in similar ways, drivers, motorcyclists, cyclists, pedestrians and horse riders gain familiarity with road environments and what is expected of them as a user. This could result in smoother, slightly slower speeds, increased awareness of hazards ahead (e.g. when curve treatments are applied consistently) or increased awareness of how to drive within road environments with different characteristics.

Route wide benefits

Where site specific treatments are introduced in isolation, there is a risk that the benefits of a reduced number of collisions at one site may be counteracted by an associated increase in collisions at other sites (migratory effect). Treating all similar sites along a length **consistently**, even those which do not have a collision problem, will make this less likely to occur.

Economies of scale

By treating routes, rather than individual sites, route treatments can benefit from economies of scale during design, installation, commissioning and as part of future maintenance. Although it is acknowledged that installation of treatments may have to be undertaken over a period of years for practical reasons.

Future proofing

Consistent, route wide, treatments can aid in future proofing the SRN in a number of ways. Reduced collisions and more reliable journey times help to reduce congestion.

Figure 9: Congestion on A120

Clear treatments can help both Advanced Driver Assistance Systems (ADAS) and drivers themselves, with this being particularly necessary for an aging population who may have declining vision and / or cognitive abilities.

Road Workers and First Responders

A reduced number of collisions can help to reduce the demand on road workers and first responders.

A reduction in collisions should also reduce the requirement for post collision repair and replacement activities. This could include the repair of barriers and surfacing or the replacement of signs and other roadside features that may have been struck and damaged.

Figure 10: Emergency services during training excercise

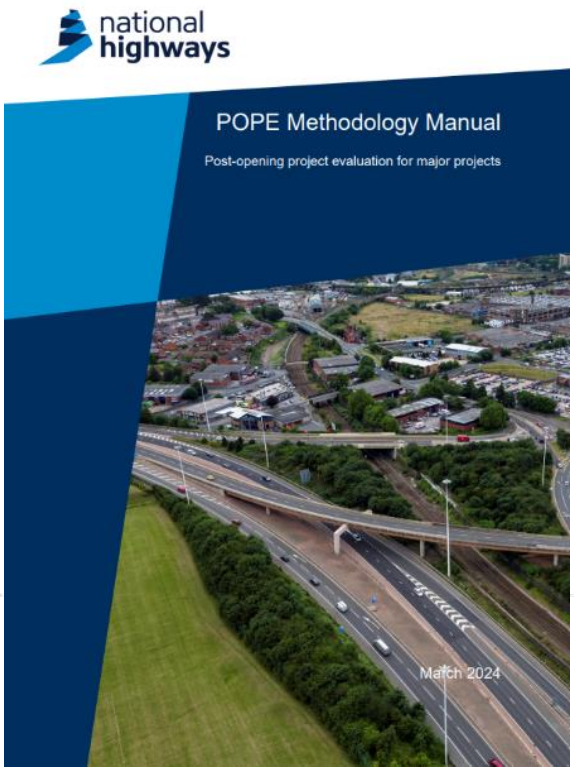
First year rate of return (FYRR)

Analysis of all the safety and economics performance of schemes uploaded on the Post Opening Project Evaluation (POPE) database has shown that, on average, schemes in the database result in 29% fewer collisions within the first year of operation. Schemes detailed within the database cost on average £320,000 to implement. Based on the first year's performance, these schemes are typically forecast to produce a scheme life collision saving of £7.6 million. On average this provides (with journey time benefits / costs factored in) a First Year Rate of Return of 62% and a Benefit Cost Ratio of 14.0.

Historically, schemes have been shown to recoup their cost in approximately 16 months. This evidence supports the theory that route treatments can achieve high rates of return, however outcomes can be highly variable, emphasising the need for detailed analysis of potential benefits at an early stage to justify the scheme.

More information on FYRR can be sought from the Transport Planning Group: TPG-guidance@nationalhighways.co.uk

Figure 11: POPE methodology manual



Road safety route treatments and the Safe System

Safe System

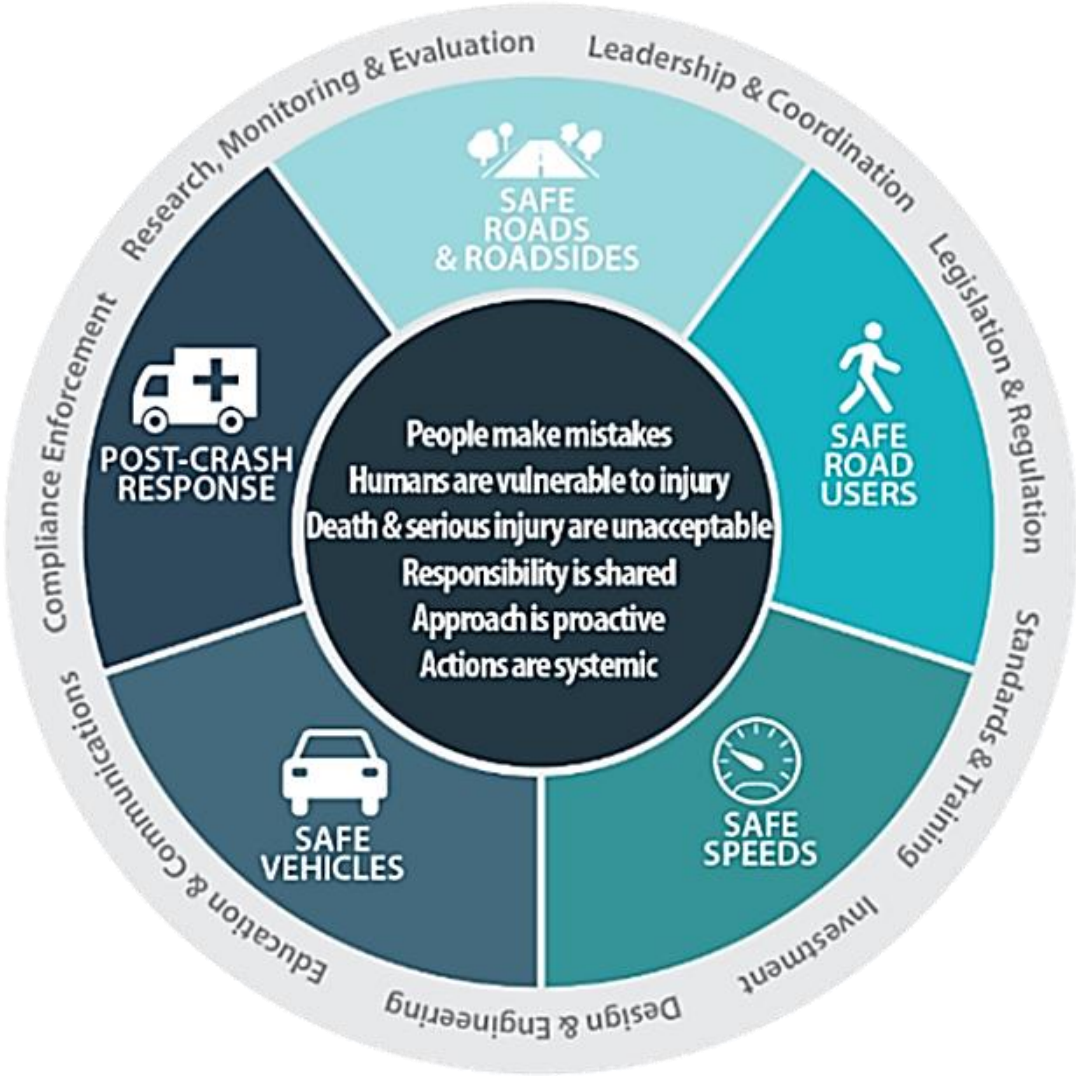
The **Safe System** framework for delivery puts safety at the heart of planning, design and **engineering**. It does this under five components.

The **Safe System** acknowledges that people make mistakes and that they are vulnerable to being killed or seriously injured if they are involved in a collision. It therefore aims to design out the potential for mistakes with a focus on preventing death and mitigating serious injuries should a mistake be made. This proactive approach places road safety at the forefront of road-related planning, design, operation, and usage by both customers and workers.

The key principles of the **Safe System** include:

- People make mistakes
- Humans are vulnerable to injury
- Death and serious injury are unacceptable
- Responsibility is shared
- The approach is proactive
- Actions are systemic

Figure 12: The Safe System Framework (image credit: Agilysis)



The **Safe System** framework seeks to achieve its goals through five components of action: safe roads, safe speeds, safe road users, post-crash care, and safe vehicles.

Alignment with the Safe System

This Guide, and the intervention measures detailed within it, primarily align with the "Safe Roads" and "Safe Speeds" components of the Safe System. However, through educational programs, information dissemination, and enforcement measures, aspects of The Guide also align with the "Safe People" and "Safe Vehicles" components. Some intervention measures may also span multiple components.

Table highlights characteristics associated with each of the **Safe System** components that can support improvement efforts for users.

In Part 2 of The Guide, road safety route treatment measures are aligned to the Safe System safe roads and safe speeds components.

Adopting a route treatment approach that provides improvements across extended lengths of carriageway, whether or not historical collisions have been identified throughout, ensures proactive enhancements are made along the entire route. These treatments then contribute to the broader system for promoting safety.

The **consistent** application of treatments can also help influence user behaviour across larger stretches of the network, rather than at isolated locations.

All treatments detailed within Part 2 of The Guide can be utilised to positively impact road safety and contribute to a systematic, multi-disciplinary approach to improve safety for all users within the broader **Safe System**.

Table 1: Examples of characteristics aligned to Safe System components

Component	Characteristics
Safe roads 	▪ Minimum 3 ★ rated roads ▪ Where speeds are higher than 20mph, providing segregated facilities for walking and cycling where there is demand or the potential for demand ▪ Forgiving roads ▪ Self-explaining roads ▪ Safer verges ▪ Improved signing and lining ▪ Improved alignment with standards and guidance
Safe speeds 	▪ Align speed limits to (more) survivable speeds through legislation and regulation ▪ Establish appropriate speed limits that align with road function ▪ Enforce existing and / or new limits ▪ Educate and inform road users
Safe road users 	▪ Intelligence led, innovative programmes to encourage and enable safe driving behaviour ▪ Review laws or rules, and their policing ▪ Campaigns, compliance and culture
Post-crash care 	▪ Coordinate and collaborate with emergency services ▪ Emergency treatment and trauma care and rehabilitation improvement
Safe vehicles 	▪ Support better maintenance ▪ Support the deployment of improved vehicle safety technologies, including connected and autonomous vehicles ▪ Influence supply and demand of safer vehicles ▪ Adopt the European General Safety Regulations (or local equivalent) ▪ Roadworthiness – tyres, fuel and maintenance ▪ Influence user behaviours relating to safe vehicles

iRAP

Introduction

The International Road Assessment Programme (iRAP) is an international charity with a vision for a world free of high-risk roads. It provides the tools and training to highways stakeholders to make roads safer.

iRAP works in partnership with governments, road authorities, NGOs and research organisations in over 120 countries worldwide, to:

- Inspect high-risk roads and develop Star Ratings, Risk Maps and Safer Roads Investment Plans
- Provide training, technology and support that will build and sustain national, regional and local capability

The iRAP model itself is an infrastructure safety management system which aligns to the safe roads component of the **Safe System**.

It provides a robust, evidence-based approach which enables identification of infrastructure improvements that will have a positive impact on the safety of roads.

The iRAP Star Rating system provides an objective measure of the level of safety which is 'built-in' to the road for all road users. Research shows that a road user's risk of death or serious injury is approximately halved for each incremental improvement in Star Rating, as shown on **Error! Reference source not found.**13.

By using the iRAP model throughout the design process, highways stakeholders are able to assess the impact of highways treatments before they are delivered.

Table 2: iRAP Star Rating system

Star Rating	Risk Level
★★★★★ Five Stars	Low risk
★★★★ Four Stars	Low medium risk
★★★ Three Stars	Medium risk
★★ Two Stars	Medium high risk
★ One Star	High risk

The iRAP assesses roads with the goal of saving lives and preventing serious injuries by improving road infrastructure safety.

The iRAP Star Rating system enables road authorities to manage road safety proactively, addressing risk factors before they contribute to serious collisions. This aligns with the principles of the **Safe System**, where actions are taken proactively based on potential risks rather than waiting for collisions to accumulate. By focusing on risk factors instead of just crash locations, many serious collisions can be prevented.

iRAP in United Kingdom

In the UK, the Road Safety Foundation (RSF) serves as the lead for United Kingdom RAP, overseeing iRAP activities in the UK. National Highways, in collaboration with TRL and the RSF, published 'The Strategic Road Network Star Rating Report' in March 2022. This report provided an overview of the road safety performance of the SRN.

Prior to the report, National Highways had set a target that 90% of travel on the SRN was to be undertaken on 3-star or above rated roads by 2020. The 2022 survey confirmed that the target was met.

Risk Mapping

Each year, the RSF independently develops Crash Risk Mapping Results

for the National Highways network. These Risk Maps offer insights into the overall performance of the road network. Crash Risk Maps, combined with Star Ratings, can be used to guide prioritisation and provide an outline of investment potential.

Star Ratings

iRAP Star Ratings provide an objective measure of the level of safety "built into" a road – both with respect to collision likelihood and severity. Star Ratings reflect the risk for individual road users, with 1-star roads representing the highest risk and 5-star roads the lowest. Table 1 shows examples of design elements consistent with different Star Ratings for the four user groups that iRAP recognises, although it should be noted that some elements may not be achievable on the National Highways network for a number of reasons, including: network constraints, alignment with DMRB and established safety baselines.

Unlike traditional approaches to manage safety that rely on analysing the longer-term trends of crashes, Star Ratings are based on data obtained from road inspections and works by assessing the quality of infrastructure, presence of road features and operational characteristics (traffic volumes and speeds) that influence risk for vehicle occupants, motorcyclists, cyclists, and pedestrians. The features assessed include (but are not limited to):

- Speed limit, 85th percentile speed and mean speed
- Vehicle and non-motorised road user flows
- Adjacent land use
- Number of lanes, road surface condition, skid resistance, curvature, quality of curve, lighting etc.
- Junction type, quality and intersecting road volumes
- Median e.g. lining system or vehicle restraint systems
- Roadside e.g. type of obstacle, distance to obstacle, presence of hardstrip / shoulder and raised profile markings
- Facilities for vulnerable road users e.g. crossings, footways and cycleways.

Star Ratings Assessment Process

During the assessment process, roads are video surveyed and information about the road is coded. In the coding process, 50 attributes that are relevant to road safety outcomes are coded every 100m along each route. The coding is undertaken by accredited coding teams who review digital images and record road attributes in accordance with the iRAP Star Ratings and Investment Plans: Coding Manual to create a data file / upload file compatible for upload to the iRAP online software ViDA. Quality assurance is completed in accordance with the same manual. Coding can be carried out using videos of existing roads, design drawings, or using more innovative sources such as connected vehicle data or auto-coding of imagery.

The assessment of risk is based on around 50 attributes and how the road is being operated (speeds and flows).

The iRAP model combines this information based on known relationships between the attributes and crash likelihood and severity, providing a detailed Star Rating Score by crash type for each road user type which is then banded to provide Star Ratings.

Star Ratings are based on road attribute data relative to speeds. They

provide a simple and objective measure of the level of safety built into roads for each of the four types of road user: vehicle occupants, motorcyclists, pedestrians and cyclists. Star Rating information can be viewed using charts, tables and maps.

Each iRAP project is calibrated based on overall historical crash data on the route or network surveyed. The model estimates future fatal and serious injuries at each 100m location by taking into account vehicle and non-motorised user flows.

Over 100 countermeasures are then tested against the Fatal and Serious Injury estimates every 100m along the route. The effectiveness of treatments, based on published research, is used to determine their likely impact on expected fatal and serious injuries.

For example, if the model forecasts 20 head on loss of control vehicle occupant fatal or serious casualties along a particular route in the next 20 years, and central hatching typically reduces this risk by 17%, then the application of this measure along the whole route would be expected to prevent 3.4 fatal or serious injuries.

The Safer Roads Investment Plan (SRIP) generated by the model compares the average cost of implementing measures against the value of preventing the casualties giving an indicative benefit-cost ratio for each measure.

Decimal Star Ratings

Any reduction in risk and improvement in decimal Star Rating will be beneficial, even if the road does not reach the next 'whole' Star Rating.

As the improvements required to jump between Star Ratings can be significant, in order to help demonstrate smaller improvements a decimal Star Rating is used. This allows greater distinction between roads that fall within the same Star Rating band.

Decimal Star Ratings are produced by splitting each of the five Star Rating bands into tenths using the underlying Star Rating Scores (SRS) produced by the iRAP model.

Figure 13: Cost of killed and seriously injured per vehicle-km travelled

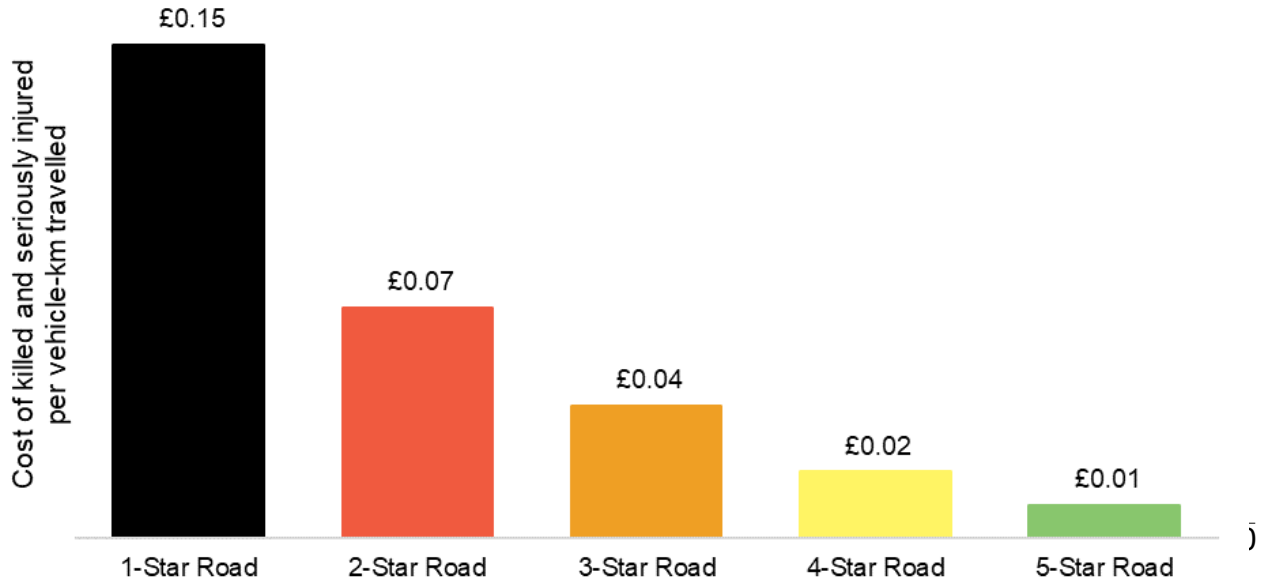


Table 1: Star Rating of roads by user group

Star Rating	Pedestrians	Cyclists	Motorcyclists	Vehicle Occupants
★★★★★ Five Stars	Footway present Signalised crossing with refuge Street lighting 40kph traffic	Off-road dedicated cycle facility Raised platform crossing of major roads Street lighting	Dedicated separate motorcycle lane Central hatching No roadside hazards Straight alignment 80kph traffic	Safety barrier separating oncoming vehicles and protecting roadside hazards Straight alignment 100kph traffic
★★★ Three Stars	Footpath present Pedestrian refuge Street lighting 50kph traffic	On-road cycle lane Good road surface Street lighting 60kph	On-road motorcycle lane Undivided road Good road surface >5m to any roadside hazards 90kph traffic	Wide centreline separating oncoming vehicles >5m to any roadside hazards 100kph traffic
★ One Star	No footpath No safe crossing 60kph traffic	No cycleway No safe crossing Poor road surface 70kph traffic	No dedicated motorcycle lane Undivided road Trees close to road Winding alignment 90kph traffic	Undivided road with narrow centreline Trees close to road Winding alignment 100kph traffic

ViDA

ViDA is an iRAP online data processing engine for Star Ratings, FSI Estimates and Investment Plans. VIDA provides a platform for hosting data and analysing results, and is the portal for iRAP's tools, including Star Rating for Designs (SR4D) and the Star Rating Demonstrator.

The Star Rating Demonstrator is a tool which can be used for small assessments of existing roads or road designs. For longer sections, such as route treatments, it is recommended to use the full iRAP process.

Route Review Tool

The Route Review Tool (RRT) is a web-based tool developed by RSF and iRAP for road safety engineers. The RRT should be used as part of the road safety route treatment process.

The RRT displays Star Rating mapping, a fatal and serious injury profile for each of the road user types, a speed profile and an image of the location from Google Street View. The RRT allows practitioners to select the countermeasure treatment, or combination of treatments, that they wish to take forward, process them and see the impact on Star Ratings and, importantly for business case development, predicted fatal and serious injuries for the route.

The RRT allows road safety engineers to test different treatment options that are targeted at the specific risks that are present, and to return an assessment of the impact of different

treatment options on Star Ratings and the likely impact on fatal and serious injury numbers.

These expected fatal and serious injury savings can then be used for entry into economic analyses to calculate an expected benefit-cost ratio. This is acheived using the National Highways CAVE tool that receives downloads from the RRT and provides outputs in the correct format for National Highways appraisal requirements.

Using the RRT to calculate and report the predicted benefits of safety interventions ensures that a consistent approach is taken across the organisation.

The RRT can be used to:

- Review Star Ratings and FSI estimation at the road, section, and 100m level
- Review Safer Roads Investment Plans (SRIP)
- Use safety **engineering** insights, local knowledge, and expertise to update the road safety countermeasures directly through the tool
- See how each safety treatment impacts the Star Rating and FSI predictions
- Make sure the final road designs are not just good on paper but also practical and highly effective

iRAP's role in road safety route treatments

All practitioners developing road safety route treatment schemes on the SRN should be using the RRT to develop their options and report on scheme benefits.

This ensures consistency of methods across the organisation and use of the same outputs to justify the benefits of road safety route treatment schemes.

The flow chart below (Figure 14) shows how the route review process should be used when developing road safety route treatment schemes.

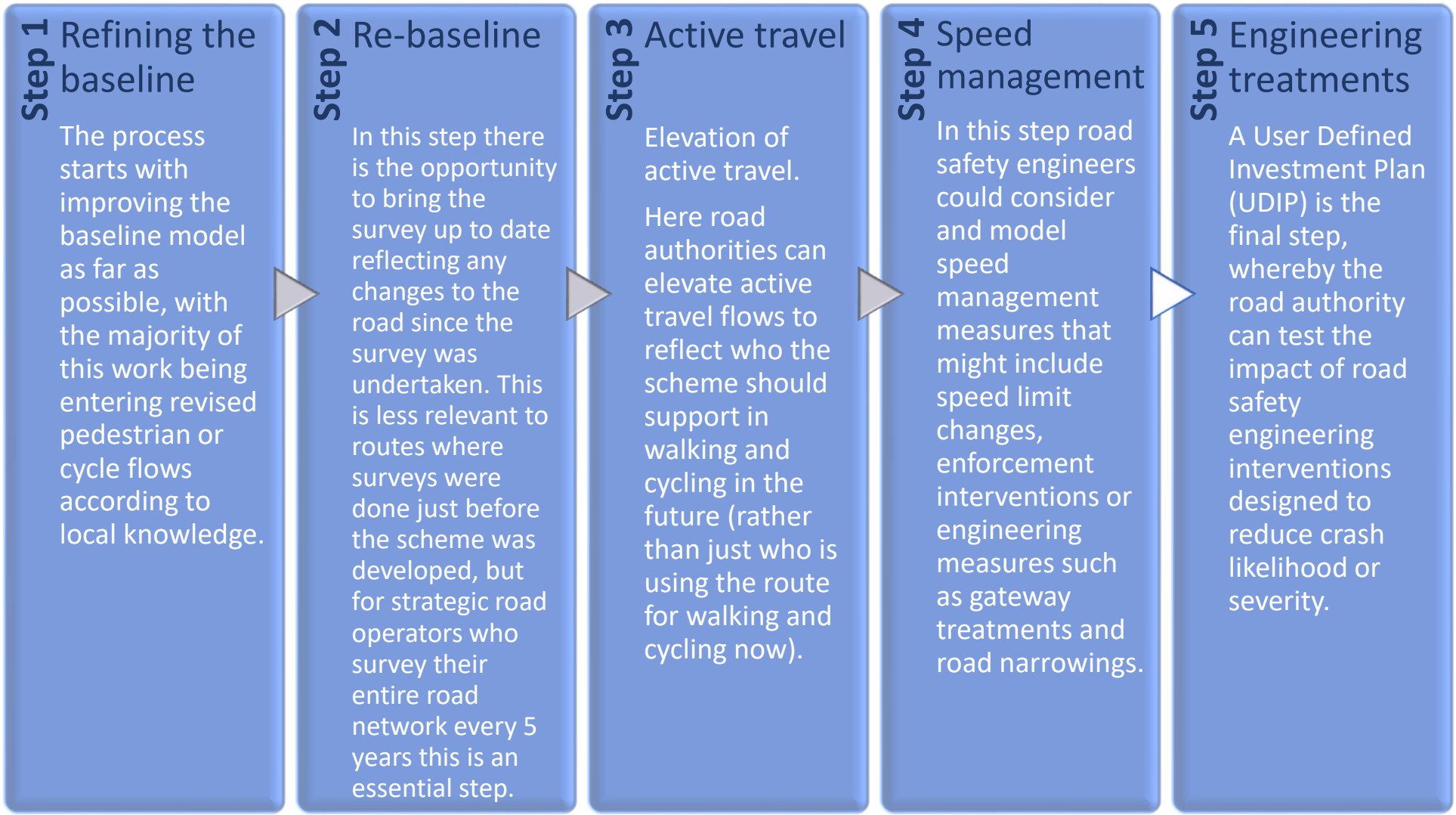
Training

The National Highways Strategic Safety Team administers all iRAP training for the organisation and they should be contacted on ssteam-roadsafety@nationalhighways.co.uk if any training is required. This ensures suitable levels of competency for those using the RRT. The data for routes will only be released to individuals who have completed the training and passed a competency test.

This team can also be contacted for any further information on the use of iRAP within National Highways.

More information on iRAP is available on the iRAP website as well as on the RSF website.

Figure 14: Implementation of iRAP in road safety route treatments



Development of a road safety route treatment

Introduction

The following section of The Guide provides advice on the implementation of Road Safety Route Treatments. It includes advice on:

- When and where to use Road Safety Route Treatments
- Methods of identifying potential Road Safety Route Treatments
- Justification of Road Safety Route Treatment schemes
- Practical considerations relating to the installation of Road Safety Route Treatments

When and where to use road safety route treatments

Road Safety Route Treatments can be used in a variety of circumstances, either as proactive or reactive approaches to improving road safety.

Proactive

The proactive approach, which is more closely aligned to the **Safe System**, aspires to deliver improvements to road safety risks before they are realised in terms of collisions. A proactive approach can also provide route (and possibly network) wide safety benefits, improve a route's iRAP Star Rating, reduce the potential for collisions and reduce the potential severity of their outcome.

A proactive approach may identify a route suitable for treatment for a number of reasons. This could include:

- It has a low Star Rating (a rating of 1 or 2)
- A high collision density record
- It is known to include features that could result in safety problems
- Adjoining routes or junctions are experiencing issues that could be replicated if left untreated
- A study or report (route study, WCHAR etc.) has identified the potential for an incident or for a safety-related improvement
- There have been significant reports of near miss incidents
- Stakeholders have raised concerns based on local knowledge

Figure 15: Public consultation for A358

Examples of where route safety treatments could be used as proactive interventions include, but not limited to:

- A series of sub-standard bends with similar geometry
- Persistent abuse of speed limits
- Locations where persistent asset damage or damage only collisions have occurred
- A high proportion of vulnerable road users
- Issues involving driver behaviours that elevate risk

Reactive

A reactive approach is sometimes required if collisions are occurring on

the network.

Collisions could be identified through a variety of studies or reports, but personal injury collision analysis is undertaken in the same manner for a route treatment scheme as for any other road safety scheme following National Highways guidelines and using best practice guidance such as Royal Society for the Prevention of Accidents (RoSPA's) Road Safety Engineering Manual.

Road safety route treatments will generally be applicable on sections of road found to have a higher number of collisions per kilometre than expected when compared to similar routes.

Road safety route treatments may also be applicable where:

- Collisions are distributed throughout a route as a whole, rather than clustered at a number of specific sites
- There is a higher than expected rate of a particular type of collision
- Collisions involve a particular type of road user
- There are higher than expected numbers of serious or fatal collisions

Single site clusters may lie within a section identified as suitable for road safety route treatment. These locations should generally be treated in a **consistent** manner with the rest of the route treatment, although there may be a requirement for additional measures at the specific cluster site.

There may be situations where a specific cluster site has a unique collision problem that is not replicated at other similar locations on the route, but which requires treatment. In such cases it may be appropriate to treat the cluster site with site specific measures.

A road safety route treatment approach can be used to successfully address the following typical collision patterns (although this may not be exhaustive):

- Loss of control collisions as road users fail to judge the severity of bends
- Striking or avoiding objects located too close to the edge of carriageway (e.g. street furniture or vegetation)
- Overshoot / failure to stop collisions at similar junctions along a route
- Head on collisions
- Nose to tail collisions as drivers fail to slow for congestion
- High rate of night-time (dark) collisions
- Turning manoeuvres to / from similar side roads creating a collision problem
- Collisions involving:
  - cyclists
  - pedestrians
  - motorcyclists
  - horse riders

Figure 16: Collision involving a vehicle leaving the carriageway

Selection of treatments

Part 2 of The Guide details a wide range of treatments that could be applied to a route where the need for improvement has been identified.

These treatments could be applied independently of each other, or in combination.

The treatments detailed in Part 2 of The Guide are split by category and the type of road they are applicable to be used on is also identified. Each treatment is then outlined in order to provide users of The guide with a description of the treatment, the targeted collision types, references to applicable standards / guidance and images of the treatment.

Figure 17: Example treatment page

In addition, each treatment includes a table showing its expected impact on Star Rating by user group (Vehicles, Motorcyclists, Cyclists and Pedestrians).

Designers and project teams can therefore use The Guide to identify treatments that may help to address their safety problem. These treatments can then be tested within iRAP as detailed in the previous section.

In addition, treatments could be selected using knowledge within the PoLAR database, which can be used as a source for examples of treatments and combinations of treatments that have been used previously on the SRN. The information available includes details of how schemes were justified, scheme costs, cost / benefit information, value for money considerations and outturn cost and performance information.

Some of the schemes within the PoLAR database are justified on the basis of road safety improvements on routes, or sections of routes, that are similar in characteristics to the type of road safety route treatment schemes which this Guide promotes.

The PoLAR database also includes examples of site-specific spot treatments. Although these may not be directly appropriate for road safety route treatments, they can provide valuable cost and collision saving information.

Justification of road safety route treatment schemes

Treatments can be justified using a variety of methods depending on the type of treatment (or package of treatments) being proposed, the safety problem(s) being addressed and whether the treatments are proactive or reactive.

It is recognised that justification of a road safety route treatment scheme may be harder than for a single site treatment, as scheme delivery generally involves more works and therefore higher overall costs.

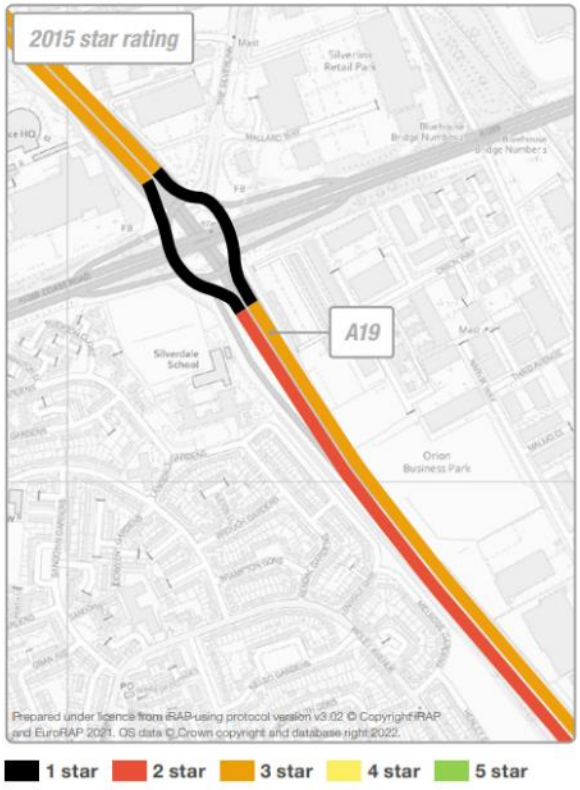
Locations within a route being treated without a history of reported personal injury collisions can result in costs being identified without a quantified expected personal injury collision saving against which this can be balanced. Despite this, other methods of justification can be utilised.

The following text details methods that can be used to justify route treatments.

Star Rating

As detailed in the iRAP section of The Guide, Star Ratings can be produced without reference to detailed crash data and they provide a clear and objective measure of the level of safety "built into" the road for different types of users.

Figure 18: Example Star Rating (A19 in 2015)



A road safety route treatment approach can improve the Star Rating, either in terms of whole stars or by decimal increments for one or more road user group on a particular route.

The potential Star Rating change of individual treatments is included in Part 2 of The Guide; however, a combination of treatments may provide greater improvements to Star Ratings.

The use of Star Ratings to justify schemes enables the whole route safety benefit to be identified and justified, rather than just at locations where collisions are already occurring or where safety concerns have been raised.

Treatments can be tested within the iRAP model and RRT.

Personal injury collisions

While the iRAP approach provides a better understanding of whole route impacts, personal injury collision data can be used to justify improvements.

In order to do this, a thorough understanding of the current (pre scheme) collision record should be established. When analysing the collision history, analysis of the collisions which have occurred within the specified timeframe (e.g. previous 5 years) and within the extents of the road safety route treatment scheme should be considered. This could then be used to estimate the expected number of personal injury collisions saved by the scheme and / or the reduction in Killed or Seriously Injured (KSI) collisions. The expected collision and casualty savings can also be converted into monetary savings using the 'Average value of prevention of road casualties by severity and element of cost' data within the latest Reported Road Casualties Great Britain annual report.

Figure 19: A12 Chelmsford to A120 – road traffic collisions between 2015 and 2017

Predicted collision savings can be calculated by comparing the detailed collision history and proposed scheme treatments, together with any supporting information available on the expected effectiveness of the treatments.

There are a variety of ways to assess the effectiveness of road safety route treatments, including computer programmes such as COBALT and Junctions 10, and other information on the success of similar previous schemes, which may be available from:

- The Road Safety Observatory
- The RoSPA Road Safety Engineering Manual
- The PoLAR database
- Case studies documentation for similar schemes

Following the implementation of road safety route treatments, personal injury collision benefits may be gained at a limited number of sites along the route or aligned to a specific user group or collision type throughout the route.

Additional benefits

Installation of a road safety route treatment scheme may also result in additional non-monetary benefits, for example environmental, social and journey quality.
Identification of these additional benefits may assist with scheme justification.

Figure 20: A616 natural flood measure, North East & Yorkshire

Other sources

Other sources of information can be used to demonstrate that the proposed road safety route treatment scheme has been well researched and assessed. The information sources outlined in Table 2 could be used as further evidence to supplement iRAP Star Ratings and / or road safety collision data.

Table 2: Sources of additional data to supplement Star Ratings and / or personal injury collision data

Additional Information	Description	Data Source	Further reading
Asset Maintenance Records	National Highways area teams maintain a database of routine inspections that could highlight both injury and damage only collisions with assets along a route.	Area Teams	National Highways Asset Data Management Manual (ADMM) Part 2
Compliance Data	Information on road user compliance, which could include use of dynamic hard shoulders, Red X lane use, and adherence to variable speed limits. It should be noted that some of this data is aligned to Smart motorways and therefore only covers a small proportion of the SRN.	roadusercompliance@nationalhighways.co.uk	-
Conflict Studies	Conflict studies can be a useful technique where there have been a limited number of reported personal injury collisions and drawing clear conclusions about problems and solutions is difficult due to a lack of observed factors. Conflict studies align with the Safe System and can be considered a proactive method to help identify road safety issues. However, it should be noted that there are some reliability and validity concerns with this method. In the UK there is little information on the correlation between conflicts and personal injury collisions.	Area Teams	A method for undertaking conflict studies can be found in RoSPA's 'Road Safety Engineering Manual.'
Damage Only Report Forms	Damage Only Report Forms are used by National Highways Traffic Officers in order to record damage to street furniture and minor damage to vehicles not resulting in casualties on the SRN. They could be used to highlight collision issues along a route.	National Highways Traffic Officers	-
National Highways Customer Contact Centre (CCC)	National Highways encourages road users to provide feedback on the operation of the SRN. The National Highways Customer Contact Centre is the first point of contact for all public enquiries. Feedback ranges in topic but could provide customer views on a specific location or length of road.	www.info@nationalhighways.co.uk	Complaints Procedure

Additional Information	Description	Data Source	Further reading
National Highways ControlWorks Data	The National Highways ControlWorks database is an incident management system. The database captures the details of any impact on the carriageway, the effects of the impact on both the network and people involved, and the actions taken to resolve the incident.	Area Teams	-
National Highways Witness Statements	In the event of a fatality, coroners may request a witness statement from National Highways. These may detail whether the road conformed to standards and guidance at the time of the collision.	Area Teams	Investigation of fatal and serious injury road collisions authorised professional practice
Incident Report Forms	The Incident Report Forms (also known as Traffic Officer Forms) are used by National Highways Traffic Officers nationwide. The forms aim to record damage to street furniture and vehicles when there is an identifiable culprit / casualty.	Area Teams	-
Operational Incident Data	Network / Regional Control Centre data is collected by MACs and ASCs to record information on network incidents. Records most commonly feature asset damage, lighting failures and road surface failures.	Area Teams	National Highways Asset Data Management Manual (ADMM) Part 2
Prevention of Future Death Reports (Coroners' Reports)	A coroner will conduct an inquest into any unnatural or violent death in order to establish when and how the death occurred, including fatal collisions on the SRN. These reports will provide detailed interpretation about the causes of the collision.	Courts and tribunals judiciary	Courts and tribunals judiciary
Red / Green Claims	Red Claim – Road user compensation claim against National Highways, e.g., vehicle damage due to pothole. Green Claim – National Highways compensation claim against a road user, e.g., negligent road user crashes and damages asset.	Area Teams	National Highways Asset Data Management Manual

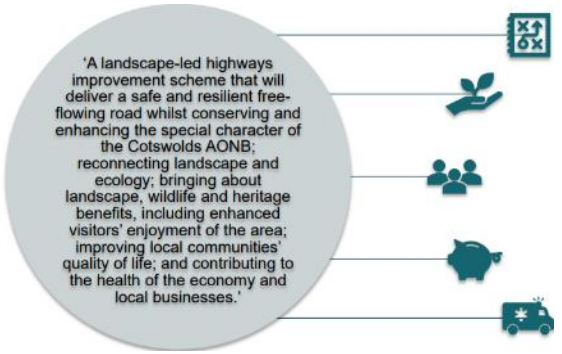
Additional Information	Description	Data Source	Further reading
National Highways Fatality Data	Internal fatality data that provides additional information and context following post fatality investigations. The Central Investigation Team can be contacted so that designers can understand if additional intelligence is available to inform scheme development.	Central Investigation Team Legal Services / SES	-
Road Death Investigation Reports	A Road Death Investigation (RDI) is undertaken by the police in order to establish the circumstances which have led to a road fatality.	Appropriate Police Authority	Investigation of fatal and serious injury road collisions | College of Policing
Stakeholder Engagement	See the Stakeholder Engagement section of this document.	-	-
Traffic Speed / Flow / Composition Data	Speed, traffic flow and composition data on the SRN is widely available and road safety engineers are likely to be aware of how to use such data in order to justify schemes.	WebTRIS	WebTRIS - Frequently Asked Questions
Watchman Reports	Watchman reports detail and analyse numerous network characteristics, including safety, congestion, length of road closures and planned growth. Network safety is often evidenced using STATS 19 Personal Injury Collision (PIC) data. Area managers have access to these reports.	Area Teams	Network Management Manual

Business cases

In some circumstances, road safety route treatments will be required to be justified through the development of a business case which will typically include information on:

- **Background** – this should identify the road safety problem(s) that the treatment is aiming to address.
- **Scope of the treatment** – this should clearly set out the aims and objectives of the treatment that is being proposed, who it is targeted at and how the treatment will address the road safety problem or potential issue.
- **The strategic context and how the treatment will fit with the Safe System** – this should clearly set out how the treatment fits with national policy as well as any route-based / local area safety targets and objectives.
- **How the scheme could be implemented** – details of how the scheme will be implemented and what agreement with key stakeholders will be secured.
- **Funding** – This could be from a single source or utilising a mix of funding streams such as resilience, maintenance, innovation or improvement funds. If funding is limited, could some benefits be realised immediately, with additional measures implemented in the future?
- **Costs to deliver the treatment** – ensuring value for money across the whole life cost of delivering the proposed treatment, including any specific maintenance requirements not deemed to be routine.
- **Estimated benefits** – This could be via the value of any iRAP Star Rating improvements (whole stars or decimal), an estimate of the number of personal injury collisions potentially saved by the proposed treatment and the monetary value of this saving (from iRAP or more traditional approaches), and / or details of the improved compliance (e.g. with speed limits) the scheme is likely to achieve.

Figure 21: A417 Missing Link Full Business Case – Scheme Vision



- **Benefits Realisation Monitoring** – Indication of how post construction monitoring of personal injury collision occurrence, road user behaviour and compliance will be undertaken to verify estimated scheme benefits.

Practical considerations relating to the installation of road safety route treatments

Phasing

Road safety route treatments may involve relatively simple installations at any one particular site. However, the treatment of a number of sites along a route will inevitably result in a greater level of disruption.

A detailed schedule of works will be needed to ensure the effective delivery of the road safety route treatment. This needs to be undertaken as soon as practicable to ensure effective delivery. This should consider traffic flows, the timing of peak flows and seasonal impacts on these.

The phasing of implementation will require detailed consideration of local circumstances and events at the outset, and management throughout the scheme's delivery to minimise and manage the level of disruption.

Consultation

Consultation with those responsible for construction of the scheme and network operation should be undertaken during delivery of a road safety route treatment scheme to ensure unnecessary problems are avoided.

Conditions

The type of treatment to be implemented may also have an impact on the programming of works. The application of some treatments may be able to be delivered alongside, or as part of, renewal schemes or may be dictated by weather conditions. For example, it may only be possible to install certain treatments when the road surface is dry and free from winter maintenance.

Traffic Regulation Orders

Some measures implemented in a road safety route treatment scheme will require a Traffic Regulation Order (TRO) to enforce new regulations, such as parking or banned manoeuvres. A Speed Limit Order is required to change a speed limit. Early contact with the appropriate regional traffic order team should be made to ensure that the order can be implemented in line with the project timescales. The procedures for making a TRO are set out in the following documents:

- The Local Authorities' Traffic Orders (Procedure) (England and Wales) Regulations 1996
- The Secretary of State's Traffic Orders (Procedure) (England and Wales) Regulations 1990
- The Road Traffic (Temporary Restrictions) Procedure Regulations 1992
- The Road Traffic Regulation Act 1984

Key considerations of road safety route treatments

Key considerations

There are a number of key considerations that need to be taken into account when considering a road safety route treatment. These include:

Justification and evidence

A route based approach is likely to incur higher costs than for site specific treatments, due to the volume of materials and treatments that are required. Assessment and justification for a road safety route treatment approach will be required, as greater benefits will need to be demonstrated and achieved from the higher cost, especially as the proposed treatments may include parts of the route where there are few or no historical collisions. Where this occurs, improvements to the iRAP Star Rating and expected future FSIs as modelled using iRAP, can be used as evidence.

Temporary Traffic Management

Temporary traffic management during the installation of a road safety route treatment scheme may be more complex and may incur higher costs than a site specific scheme. Programming road safety route treatment schemes can also be complex due to the level of disruption these measures can cause during installation. Consequently, allowance for the impacts that temporary traffic management may have on the scheme costs and road users should be considered when developing road safety route treatment schemes.

Figure 22: Example of Temporary Traffic Management on the SRN

There may be opportunities to combine the installation of a road safety route treatment scheme with other highways schemes, to minimise disruption and share costs, while accelerating the scheme's delivery.

Liaison with local highway authorities

Liaison with local highway authorities is critical both before and during construction to minimise problems on the surrounding road network. Consideration should be given to the programme and phasing of the works over a period of time to minimise the cost and inconvenience to the public (for example working outside of peak traffic periods).

Seasonality

Weather conditions, seasonal traffic trends, other highways construction (on or off the SRN) and local events are all examples of issues which could have an impact on the operation of the route (and the surrounding network) both during construction and subsequent operation.

Figure 23: Seasonal conditions

Such factors would require consideration to ensure an effective and achievable programme of delivery.

Maintenance

The effectiveness of road safety route treatment schemes can be compromised if they are not well maintained. During the scheme preparation process GD 304 Designing health and safety into maintenance, shall be taken into account.

Below are a number of maintenance-related points to consider during the design of a road safety route treatment scheme:

- Choose materials appropriate to the anticipated lifespan and traffic levels of the scheme.
- Consider maintenance costs and requirements of a scheme during the design stage.
- Involve those responsible for the maintenance of any proposals to ensure unnecessary problems are avoided.
- Identify any extraordinary maintenance costs and report these alongside construction costs. In the case of road safety route treatments using more innovative products, costs may not be fully predictable.
- Ensure the scheme is incorporated into the appropriate inspection schedule and subsequent rolling maintenance programme.
- Ensure maintenance plant and personnel have convenient and safe access to all parts of the scheme and that the required traffic management is minimised.
- Use materials which may be re-used or recycled in the future.

Figure 24: Maintenance works at M5 Wynhol Viaduct

Buildability

The ability to construct a scheme, or certain treatments within a scheme, should be considered early in the process. Land ownership, legal aspects, environmental constraints, utilities and cost could all impact the buildability of a scheme.

Good design

Schemes should be developed in line with National Highways Good Design principles. They put sustainability and climate change at the heart of future road design and help achieve a higher quality of life, greater economic vitality and a more efficient use of resources.

Monitoring and evaluation

Post construction monitoring is a crucial element of collision reduction schemes and should be incorporated into the budget and post construction programme. It is recommended that sufficient approved funding is identified to monitor and evaluate the road safety performance of the scheme, as it may require the collection of additional data before and after construction.

The results from monitoring of a scheme should be forwarded to National Highways Evaluation Group along with any associated Scheme Appraisal Reports (SAR) and outputs from Value Management (VM) workshops. This will enhance the available data for future road safety route treatments.

The scheme appraisal process, incorporating the SAR and VM workshops, is enhanced by reference to similar previous schemes. This includes from the POPE process and PoLAR Database (Project Evaluation of Local Network Management Schemes Analysis Reporter).

It is recommended that the National Highways Evaluation Group are engaged in relation to all post

construction monitoring. They can be contacted by emailing evaluation@nationalhighways.co.uk.

Walking, cycling and horse riding assessment and review

Road safety route treatments are also subject to the requirements of the Walking, Cycling, and Horse riding process identified in DMRB GG 142 Walking, cycling, and horse riding assessment and review.

Figure 25: Footpath at St Annes Road Bridge over A57

Road safety audit

Whilst the aim of a road safety route treatment scheme is to improve the safety performance of a particular route or stretch of road, there is still a requirement for the scheme to be subject to road safety audits as detailed in DMRB GG 119 Road Safety Audit.

The Construction (Design and Management) Regulations (2015)

The Construction (Design and Management) Regulations (2015) will apply to all road safety route treatment schemes, both during the design and construction phase. The Principal Designer and Client shall ensure that consideration is given to the safe design, construction, operation, maintenance and eventual removal of traffic management during the scheme preparation phase, ensuring a design risk assessment is carried out and made available to the construction team.

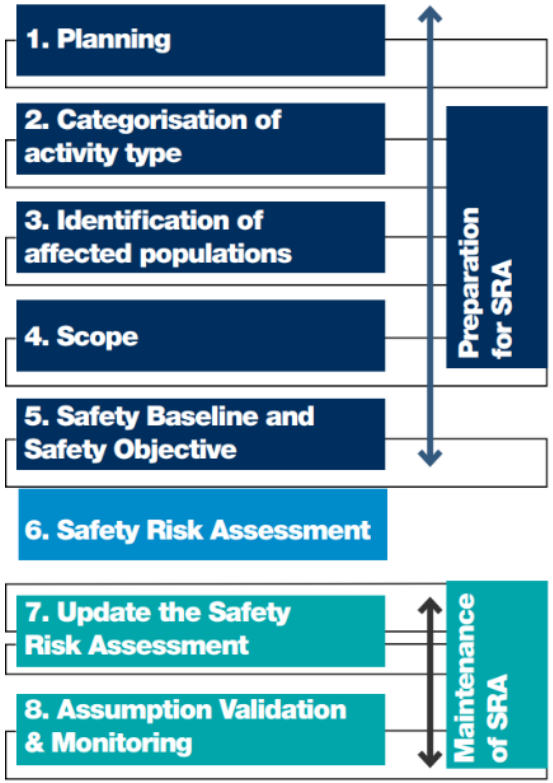
Risk assessment on the strategic road network

DMRB GG 104 Requirements for safety risk assessment shall be applied to road safety route treatment schemes when designing, operating and constructing on the SRN.

GG 104 sets out the framework for managing safety risks for all populations affected by an activity, defined as ‘something that does or can have an impact on the safety of our customers, workers or other parties, either directly or indirectly’. It details that safety objectives for all populations shall always be to ‘manage risk so far as is reasonably practicable (SFAIRP)’.

GG 104 also states that any safety risk treatments ‘shall follow the ERIC hierarchy - Eliminate, Reduce, Isolate and Control’, for each safety risk. The preferred option for any safety risk treatment is to eliminate the safety risk. Where this is not possible due to the costs associated with doing being ‘grossly disproportionate’, treatment measures that reduce, isolate or control the risk should be assessed in turn.

Figure 26: The 8 steps of Safety Risk Assessment in GG 104



Suicide prevention

National Highways recognises the wide reaching and devastating impact of suicide for both individuals and communities. Suicide is not inevitable, it is preventable, and the vision is that no one attempts to take their life on National Highways' roads. Reducing the number of suicides or attempted suicides on the National Highways network will make the roads safer for all users and will contribute to reducing the overall number of fatalities on the SRN. Designs need to consider schemes in the context of suicide prevention: could a scheme help prevent suicides or inadvertently contribute to the problem?

The National Highways Suicide Prevention Strategy outlines improvements to the safety of roads aimed at reducing the number of people who attempt to take their lives and in turn the impact suicide has when these tragedies occur.

The vision of the Suicide Prevention Strategy is aligned to three key principles – Prevention, Crisis Intervention and Postvention. The countermeasures provided in this Guide, although not specific to suicide prevention, contain elements that align with the prevention principle.

Figure 27: Suicide prevention measures at M11 Junction 33

In addition to the strategy, the Suicide Prevention Toolkit can be used to guide decisions on interventions that could help prevent suicides and how you can work with others to deliver them. The Toolkit outlines how suicide prevention should be applied to new schemes and that consideration of the potential for suicides should be considered at the early stages of any scheme development. It notes that "Factors which contribute to the risk of suicide need to be assessed and the appropriate action built into planning, design, construction and operation."

At present iRAP does not model the impact of suicide prevention specific countermeasures. Despite this, any proposed counter measures should consider the life cycle of assets and their potential role in suicide prevention. The National Highways Suicide Prevention Team are able to provide advice and guidance to design teams and the supply chain; they are contactable at suicide.prevention@nationalhighways.co.uk.

Road safety route treatments and innovation

Innovation strategy

Road safety route treatments should have a robust evidence base in terms of their past performance on the SRN or roads with similar characteristics. However, National Highways encourages innovation and therefore users of this document may want to investigate innovative road safety measures.

National Highways' approach to innovation is set out in the Innovation and research strategy.

Figure 28: The National Highways approach to innovation

The strategy document sets out National Highways' key principles for innovation and research and the vision for developing innovation and research. The investment in innovation and research represents a sector-wide commitment to modernising National Highways' network, its relationship with its customers and its impact on the environment.

The strategy includes five themes and challenges, with the focus on driving bold and ambitious change:

Themes

- Design, construction and maintenance
- Customer mobility
- Connected and autonomous vehicles
- Energy and environment
- Operations

Challenges

- Net zero carbon by 2050
- Zero harm
- Cheaper, faster construction by 2030
- Connected journeys by 2035
- Enabling ambition - Research and innovation excellence across industry by 2025

The strategy recognises that innovation needs to deliver value today while giving the foresight and solutions needed for tomorrow and beyond. Innovation can come through academia, Small and Medium-Sized Enterprises (SMEs) and start-ups, competitions, and the industry and supply chain.

Figure 29: Innovation

Innovation and the departures process

Innovation could take many forms in relation to road safety route treatments, including but not limited to: infrastructure, materials, carriageway layouts, technology and methods of enforcement.

Road safety route treatments, as detailed in Part 2, are generally established ways of improving the

safety of routes that are compliant with existing standards and practices. Despite this, it is recognised that innovative solutions could be used to address specific problems or provide greater improvements to a route's safety performance.

If an innovative solution is to be proposed and / or utilised, contact should be made at the earliest opportunity in the project timeline with the innovation team via innovation@nationalhighways.co.uk. Development of an innovative solution may also require a pilot or trial. Advice on these can be found within the Pilots and Trials Guidance document.

Innovative solutions are also likely to require an approved Departure from Standards prior to implementation. Departures are an important way to bring innovation to schemes and should not be seen as stifling or prohibitive to innovative solutions. DMRB GG 101, the Introduction to the Design Manual for Roads and Bridges, specifically details innovative methods or materials as a situation where a departure should be submitted.

The Departure Approval System (DAS) should be utilised to manage the application for a departure.

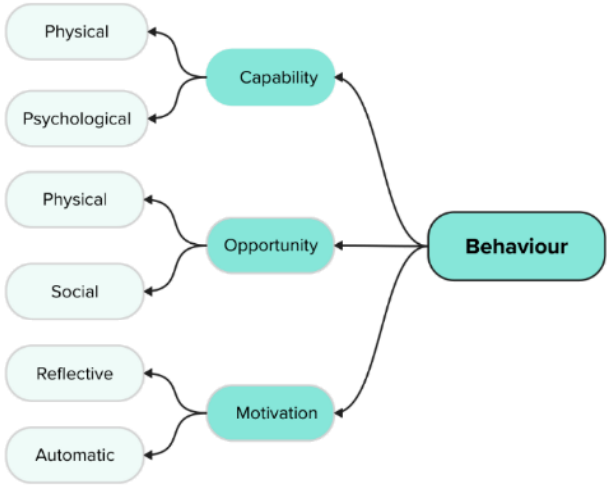
Figure 30: Pilots and Trials Guidance document

Using behavioural theory to influence driving behaviours

Safe road users is a key component of the **Safe System**. When investigating a road safety issue and considering which route safety treatment(s) should be implemented, it is important to determine whether road user behaviour is playing a significant role and what is influencing current behaviour. This aids the choice of treatment option and can be combined with iRAP modelling (or more traditional methods) to identify the greatest potential road safety benefits.

Behavioural models can aid understanding of why road users behave as they do currently and how their behaviours could be influenced. A behavioural model that can support with selecting the most appropriate treatment option(s) is the COM-B model (Michie et al, 2011). This suggests that behaviours are influenced by three factors: an individual's capability to perform a behaviour, their opportunity to perform it and their motivation. Each of these factors can be further separated into two, as shown in Figure 31.

Figure 31: COM-B model for behaviour change



- Capability – physical (skill and strength) and psychological ('know how').
- Opportunity – physical (the set-up of the environment, availability of resources, etc) and social (people who matter to me behave like this or want me to behave like this).
- Motivation – reflective (considered response weighing up advantages and disadvantages) and automatic (reflexes).

The route safety treatment(s) that is required will depend on the road user behaviour that is being targeted and which of the COM-B factors are influencing this behaviour.

The first step in applying the COM-B model is to define the behaviour that is being targeted. Existing data and evidence should be used to identify and prioritise potential target behaviours. For example, data about collisions (e.g., STATS 19 or ControlWorks) may provide clues about unsafe behaviours that are more prevalent in certain locations or on certain routes. Customer insight can also help to understand road users' experiences on the network, including areas where road users feel unsafe – potentially due to the behaviour of other road users. It is recommended that a range of data sources are used to decide which behaviour to target.

Once a target behaviour has been identified, insight and evidence should be used to determine which of the COM-B factors are relevant to this behaviour. It may be helpful to hold a workshop to bring together individuals with a breadth of experience and gather evidence about the target behaviour. In addition to reviewing existing evidence, practitioners should consider the context of the route and how this may influence road users' behaviour. For example, whether the route is close to key destinations (e.g., airports, ports, tourist attractions) that

may influence who is using the route and how the route is used.

It may also be of benefit to understand whether other route treatments have been implemented along the route and whether these may be influencing behaviours.

National Highways' Social Research and Behaviour Change Centre of Excellence (within the Customer, Strategy and Communications directorate) can support with identifying existing evidence related to road users' behaviours and support with selecting the most appropriate route safety treatments to address target behaviours. They should be engaged as part of the route treatment process (SR&BCTeam@nationalhighways.co.uk) and can provide support to aid the development of interventions.

Once the factors that are influencing road users' behaviour have been identified, the most appropriate route safety treatment(s) can be selected, understanding that certain intervention types are more effective than others, depending on the factors influencing behaviours. The route safety treatments that are most likely to be effective for each of the factors in the COM-B model are shown in Table 5, where they are defined as:

- **Engineering** - Making changes to the physical environment, including changes to the road environment, infrastructure and technology. This may also involve increasing the means of, or removing barriers to, performing the desired behaviour.
- **Education** – Providing information and guidance to improve individuals' knowledge and skills.
- **Enforcement** – Using regulations and sanctions (such as penalties and fines) to discourage undesirable behaviours.

In practice, it is rare that only one factor within the COM-B model is influencing an individual's behaviour and any resulting safety outcomes.

The same behaviour may be influenced by different factors for different road users and these factors may vary over time or between journeys. Behavioural science theory and tools can be used to optimise selected interventions and maximise their effectiveness. It may also be beneficial to use a combination of route safety treatments to target the range of factors at play for each behaviour.

Table 3: COM-B model factors

COM-B model factors	Route Safety Treatments		
	Eng.	Education	Enforcement
Physical capability	✓		
Psychological capability	✓	✓	
Physical opportunity	✓		
Social opportunity	✓	✓	
Reflective motivation		✓	✓
Automatic motivation	✓		✓

The Social Research and Behaviour Change Centre of Excellence at National Highways have developed a step-by-step guide (DRIVES) to support colleagues with developing and delivering behavioural interventions. The Centre of Excellence is also able to support with selecting the most appropriate route safety treatments to address target behaviours.

Stakeholder engagement

Introduction

Stakeholder engagement is important given the need to secure support for specific scheme objectives and understanding of the route treatment concept.

It will often be necessary to consult with a wide range of people and organisations as a route may pass through several Local Authority areas (County, District, and Parish Councils), impact a wide range of users (drivers and vehicle occupants, motorcyclists, cyclists, pedestrians, horse riders) and have implications for emergency services, businesses and the wider community. Figure 32 shows a range of potential stakeholders, but these will change on a scheme-by-scheme basis.

The level of consultation and range of stakeholders will be dependent on the nature of the scheme and the design stage. A Stakeholder Engagement Plan may assist in managing this task.

Why undertake stakeholder engagement?

The main objective of stakeholder engagement is to give stakeholders an understanding of the identified road safety problem and the proposed route treatment(s) that are being put forward to address it. It enables stakeholders to provide feedback relevant to their organisation / user group and for this feedback to be reviewed and responded to or acted upon through design.

By engaging stakeholders early in the process, before exploring solutions to the problem, it may be easier to gain their recognition that there is a problem and 'buy-in' to intervention measures.

Some stakeholders require statutory engagement and any statutory notification procedures should be complied with.

How are stakeholders engaged?

Once stakeholders have been identified, appropriate ways to engage with them will need to be established.

There are a wide range of options to engage with stakeholders; a variety of methods are likely to be required to ensure that views from across the spectrum of stakeholders are captured. Options include:

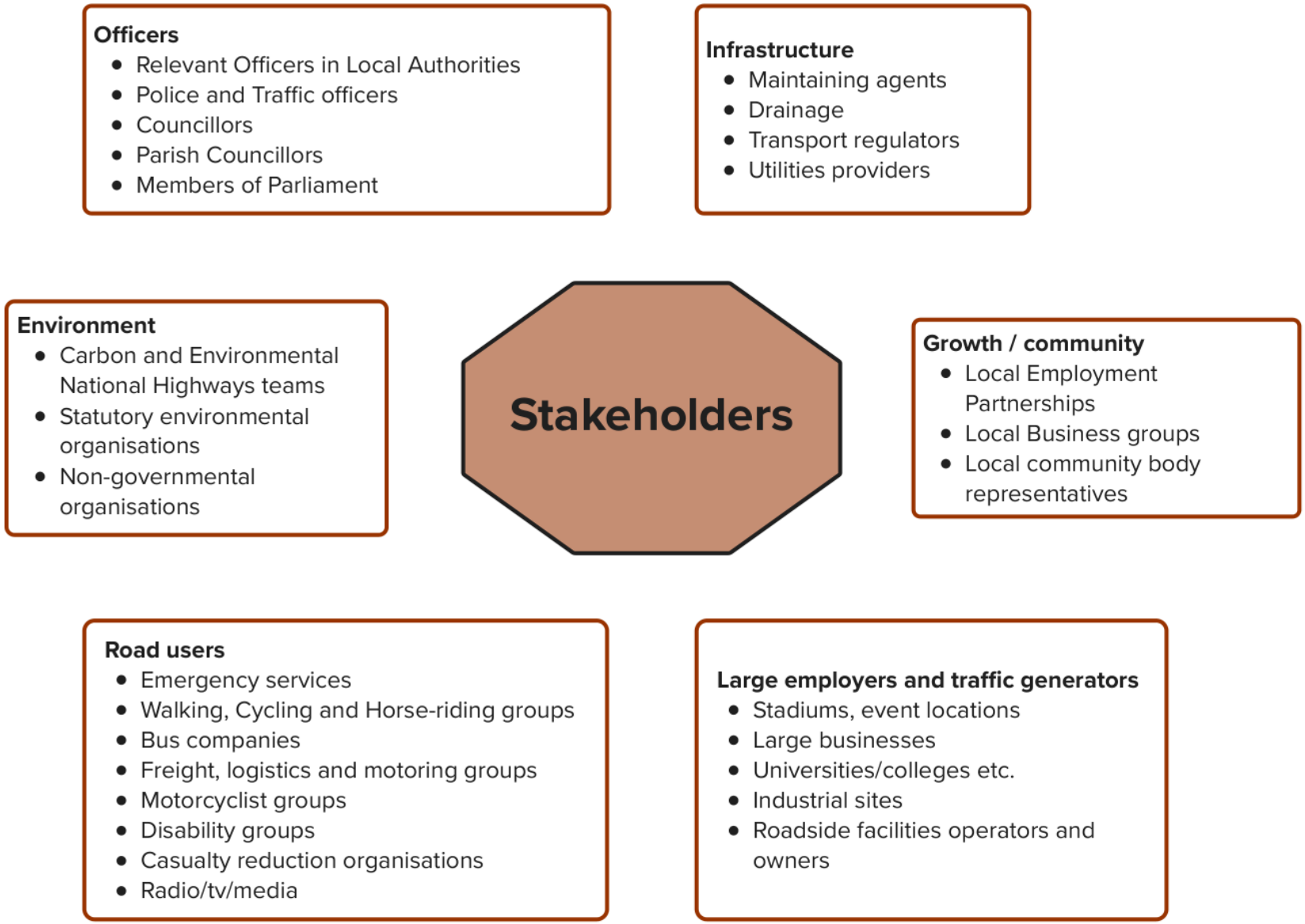
- Face to face events
- Online events
- Web pages / social media and online feedback forms
- Emails
- Letter / leaflet drops
- Forums
- Workshops
- Technical meetings
- Print, radio or television media

Stakeholder engagement can occur at various stages of the project timeline and for different purposes. Early in a project lifecycle, engagement may be to inform stakeholders of the project and process (aiding early 'buy in'), but, as a project develops, specific feedback should be sought. This can then be recorded, analysed and acted upon, with the results ultimately communicated to stakeholders.

Technical engagement with relevant bodies may occur in a more fluid and continuous manner.

During consultation it may be more efficient and effective to bring a number of groups together, rather than have individual meetings with separate groups. This can allow collaborative thinking and ensure understanding and balancing of concerns from different groups.

Figure 32: Potential stakeholders



Stakeholder discussions

Any consultation exercise or stakeholder engagement needs to be mindful of the need to ensure ease of access and be held at convenient times and locations to ensure maximum attendance and participation. A series of consultation exercises along a route may be considered, to minimise the distance consultees might be expected to travel. The anticipated costs of stakeholder engagement should also be considered at the planning stage of the project to ensure that sufficient funds are available to undertake the appropriate level of consultation.

Figure 33: Consultation meeting

Guide to Road Safety Route Treatments
Part 2 – Road Safety Route Treatments

Road Safety Route Treatments

General

Part 2 of The Guide details road safety route treatments that are available to designers to help address road safety issues. A case study of the A21 Route Safety Scheme, which followed The Guide's approach, is also provided.

As detailed in Part 1, treatments are generally aligned to the Safer Roads and Safer Speeds components of the Safe System and are largely engineering based, although a smaller number of treatments are enforcement and education based.

When applied consistently along a route, the treatments presented in this document can help provide a consistent safety message to road users, which is key to road safety route treatments. In creating a Safe System, the ethos is to proactively eliminate the opportunity for fatal or serious collisions. Proactive treatment of risk along a route is important irrespective of the collision history, as historical collisions may not be an indicator of where future collisions will occur.

The treatment measures available have been split into eight categories:

- **Traffic Signs**
- **Road Markings**
- **WCH Facilities**
- **Speed Policy & Enforcement**
- **Surface Treatments**
- **Junction Treatments**
- **Lane Treatments**
- **Multi Section Treatments**

The following sections include information on:

- Treatment measures
- Route Decimal Star Rating impact
- Impact of the treatment at an individual site (100m iRAP section) by use of Star Rating Score matrices
- Typical iRAP carriageway layouts
- Individual measures within the above categories, with details of where they can be most effectively used.

The information provided for each treatment also includes an indication of its effectiveness for different users, in the form of an anticipated impact on the Route Decimal Star Rating, reduction in risk and subsequent fatal and serious injury. The exact values must always be sought through use of the Route Review Tool (RRT).

Figure 34: Example Star Rating

Treatment Measures

Introduction

The treatment measures included in The Guide are not exhaustive but are intended to provide a selection of the most commonly used and effective measures available to help address road safety problems.

Other road safety treatment measures that are not detailed can be included in a road safety route treatment scheme if they align with applicable technical guides and / or standards (or have an approved Departure from Standard prior to implementation) and are used consistently throughout the route. In addition, road safety enforcement and education measures could be utilised as standalone treatment methods, or to enhance and support engineering based measures.

The treatment measure information included within this part of The Guide contains the following details:

- Measure description
- Identified risk / collision type
- Associated (technical) guides and standards
- Potential impact on Route Decimal Star Rating
- Images of treatment measures
- Impact on the Star Rating Score for a representative 100m location.

Prior to the individual treatment measure information pages, a summary matrix is included which cross references the treatment measures identified in The Guide with applicable road types.

The matrix also details whether the treatments are spot treatments or route treatments and the anticipated impact on iRAP Route Decimal Star Rating for each user group, colour coded so that the measures with the potential for the greatest impact are easily identifiable.

Star Rating impact

The Decimal Star Rating impact of each treatment option, where it is able to be modelled in iRAP, has been assessed using the iRAP model (version 3.10).

In order to establish the impact of treatments, a selection of typical road layouts was required (further details on the test layouts are presented later in this section) and then each treatment was considered separately for each relevant layout.

In the Route Review Tool, the Decimal Star Rating is provided at the route level rather than individual location level. The Decimal Star Rating is the flow weighted average for the entire route. For testing purposes the typical road layouts were set at 3km lengths for rural roads and 1km lengths for urban roads, which matches the smoothed Star Rating lengths in ViDA.

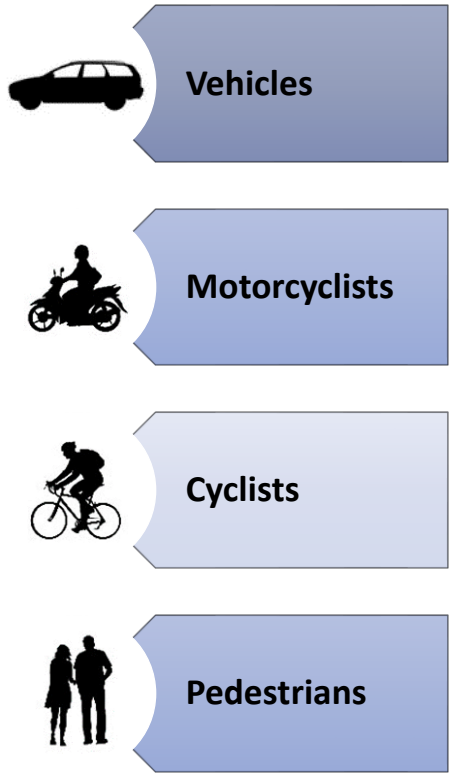
Some treatments described in this document are location specific, i.e. improvements at a junction, a pedestrian crossing, or sign clutter removal, as opposed to length based treatments along a route. As such, these location specific (spot) treatments have been modelled either at one location (e.g. junction treatments) or at several locations along the route (e.g. for sign clutter removal) as appropriate. As these types of treatments are only normally applied at individual or sporadic locations, the impact on the Route Decimal Star Rating may show as low or in some cases as zero impact.

However, this does not mean that the treatment is not reducing risk at those locations, it just means that the impact is not observable to one decimal place of a Decimal Star Rating, smoothed over the route length. If for example, one junction over a 3km route was improved, then the overall impact on the Route Decimal Star Rating would be low or even zero. If five junctions over a 3km length were improved, then the overall impact of all the junction improvements would result in a clear improvement for the Route Decimal Star Rating.

A matrix table is provided at the end of each treatment category to provide a guide to the effectiveness of each treatment. This impact matrix table indicates the change in Star Rating Score for the iRAP collision types. The Star Rating Score (SRS) is calculated for each 100m segment of road and represents the relative risk of death and serious injury for vehicle occupants, motorcyclists, pedestrians and cyclists. The Star Rating Scores underpin Star Ratings. A reduction in SRS equates to a **reduction in the relative risk of death and serious injury**.

The impacts on the Decimal Star Ratings have been modelled separately for each of the iRAP user groups shown below. It is important to note that in order for modelled benefits to be realised, the user group needs to be present. For example, a predicted reduction in Star Rating Score for pedestrians in any given scenario will only be beneficial if pedestrians are present.

Figure 35: iRAP user groups



At the time of publication of The Guide, it was not possible to model some treatments in iRAP (for example Variable Message Signs), therefore the potential impact of these treatments on the iRAP Route Decimal Star Rating for any given scheme cannot be calculated. Treatments that cannot currently be modelled in iRAP can still be implemented as part of route

treatment schemes if they can help address known or potential collisions, reduce the potential severity of collisions or be shown to reduce risk in other ways (e.g. speed reduction).

An example table, illustrating a treatment's impact on iRAP star rating, by user groups, is shown below:

Table 6: Example of Star Rating impact

User	Star Rating Impact
 Vehicle Occupants	0.1
 Motorcyclists	0.2
 Cyclists	0.0
 Pedestrians	0.1

The information in table 6 could then be used to show what the indicative star rating for a road section could be with and without the treatment in place (see table 7).

Table 7: Road section Star Rating

User	Road section Star Rating:	
	Without treatment	With treatment
 Vehicle Occupants	3.5	3.6
 Motorcyclists	3.2	3.4
 Cyclists	0.8	0.8
 Pedestrians	1.3	1.4

Treatment measures are unlikely to be implemented individually and will most commonly be part of a wider scheme that incorporates multiple treatment measures. For example, a route with a number of sharp bends may see the bends treated with vehicle activated signs, reflectorised marker posts, re-surfacing and edge of carriageway markings.

In this type of scenario, the Route Decimal Star Rating impact needs to take account of the impact of multiple treatments. The Route Decimal Star Ratings detailed in this Guide must not be totalled to manually establish the impact of multiple treatments. The RRT must be used as this takes account of the cumulative impact of multiple countermeasures.

The RRT allows road safety practitioners to apply combinations of road safety engineering and speed countermeasures to determine their likely impact on Star Ratings (including Route Decimal Star Rating) and expected Fatal and Serious Injuries for all road user groups.

The tables provided in this Guide represent a basic impact on the Route Decimal Star Rating for the typical road layouts and are likely to vary as actual road layouts themselves differ.

Typical layouts

To provide users of The Guide a better understanding of the Route Decimal Star Ratings of various road layouts, as well as the potential impact of treatments on them, typical road layouts have been created in iRAP.

Five road layouts have been created that best reflect common road layouts within the National Highways and wider UK road network. These are:

- Motorway with a grade separated junction
- Dual carriageway in a rural environment with a grade separated junction
- Dual carriageway in an urban environment with a grade separated junction
- Single carriageway in a rural environment with a T junction
- Single carriageway in an urban environment with a T junction

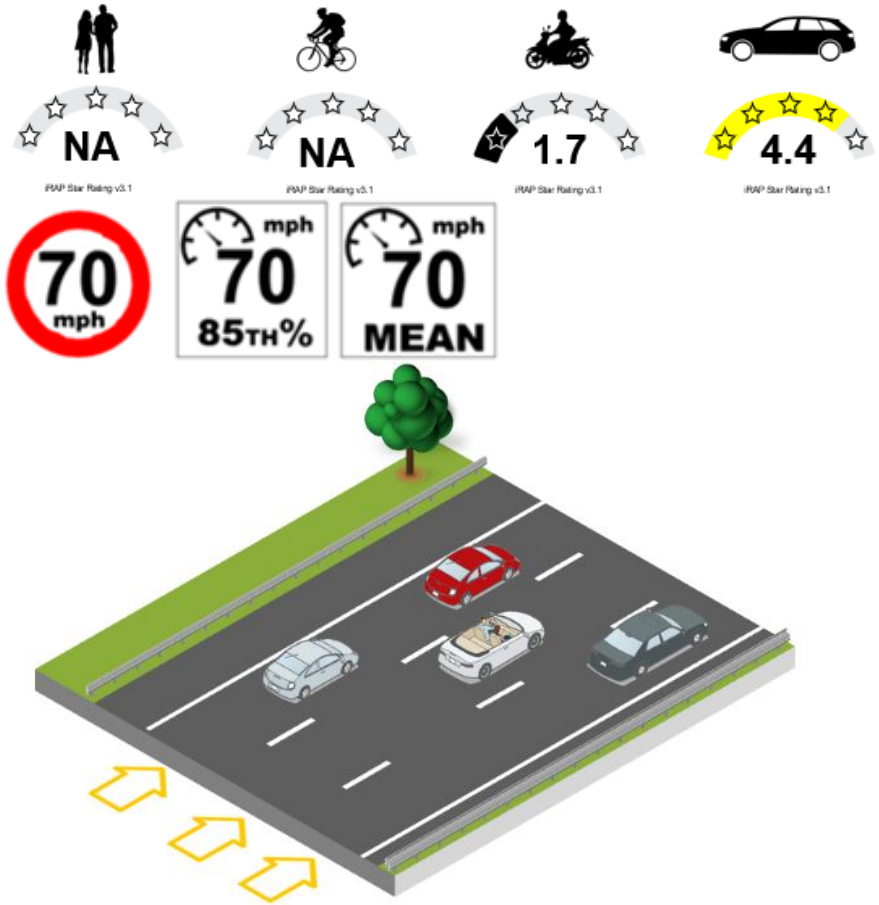
It should be noted that urban and rural classification is based on the iRAP terminology, not the DMRB road type.

For each layout, a short description of key features, Star Rating for each iRAP user group, speed limits, operational speeds as well as an illustration have been provided. This helps to provide context for Star Ratings and show iRAP users how they vary between each typical layout.

They can also be used to provide an initial indication of whether certain existing routes are falling below the typical 'norm' / average Star Rating for a particular type of layout.

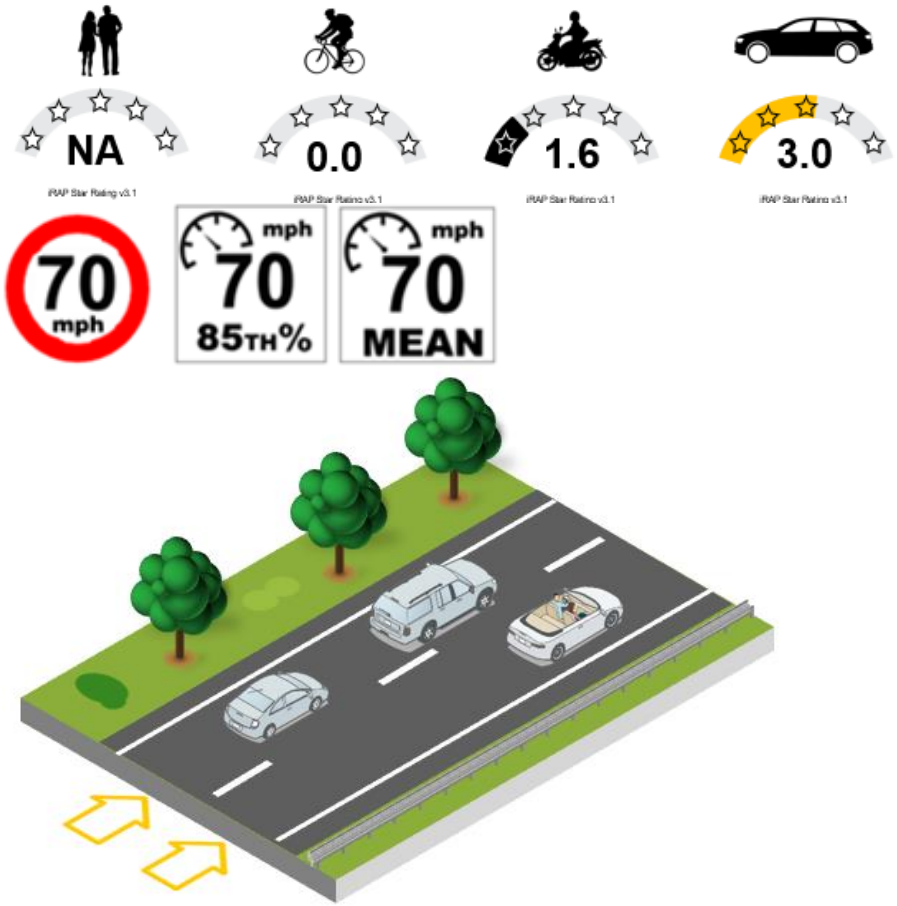
Typical Motorway layout with a grade separated junction

Divided, three lanes, with nearside and central metal vehicle restraint with wide (> 2.4m) nearside hard shoulder and narrow offside hard strip, wide lanes and raised edge profile markings.



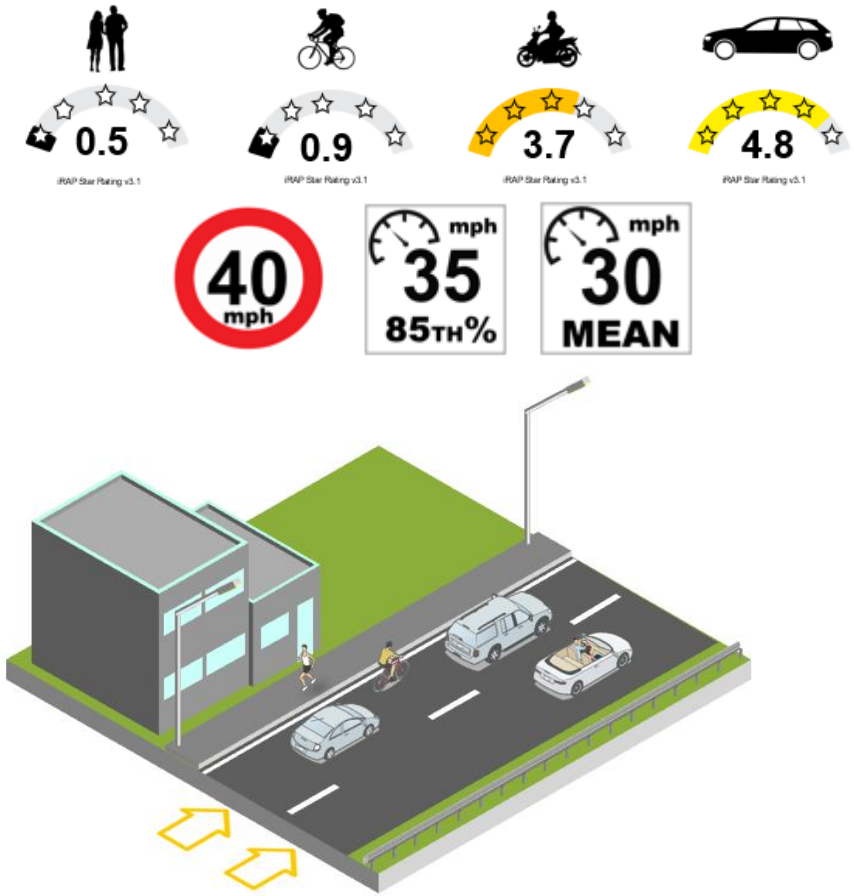
Typical Dual rural layout with a grade separated junction

Divided, two lanes, with trees present on the nearside (1 to <5m), central metal vehicle restraint, narrow hard strips with raised edge profile markings.



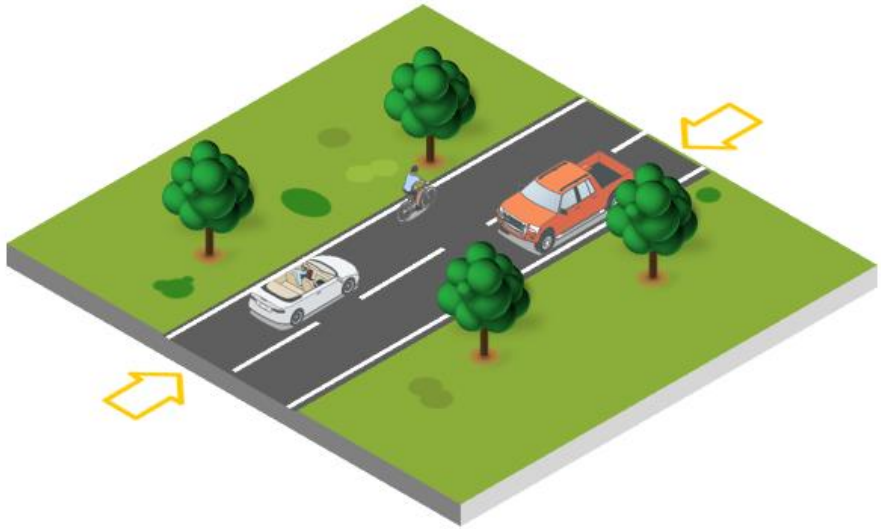
Typical Dual urban layout with a grade separated junction

Divided, two lanes, with lighting columns on the nearside (1 to <5m), central metal vehicle restraint, no offside hard strip, with a footway adjacent to the carriageway.



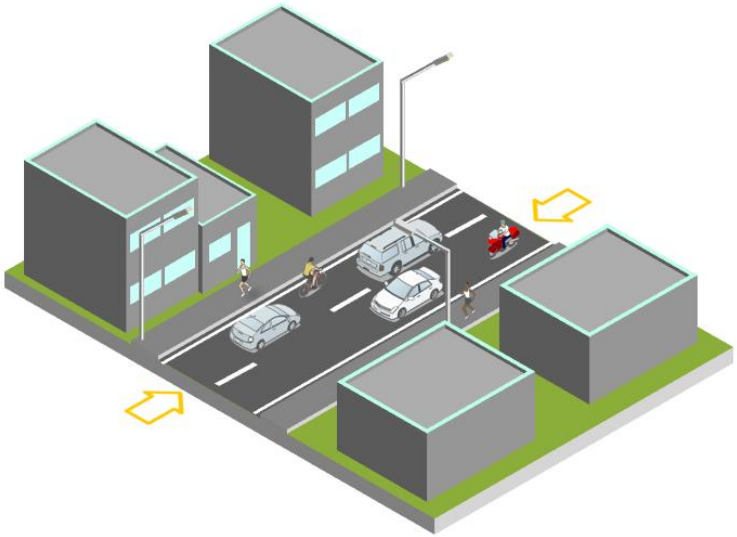
Typical Single rural layout with a T junction

Single carriageway, with trees present on both sides (1 to <5m), centre line and edge of carriageway marking with no pedestrian or cycle facilities.



Typical Single urban layout with a T junction

Single carriageway with lighting columns on both sides of the road (1 to <5m), centre line and edge of carriageway marking with a footway adjacent to the carriageway on both sides of the road.



Treatment Matrix

Site based treatments (e.g. Junction improvements) and those applied at intervals (e.g. sign clutter removal) will only have a marginal impact on the Route Decimal Star Rating (calculated for 1 or 3km), although they will be impactful at the locations where they are applied. The Route Decimal Star Rating impact must be considered alongside the Star Rating Score Matrix provided at the end of each treatment category section which details the impact on the 100m iRAP section (site).

The Route Decimal Star Rating detailed in this Guide must not be totalled to manually establish the impact of multiple treatments. The RRT must be used as this takes account of the cumulative impact of multiple countermeasures.

	Treatment	Spot or Route Treatment	Treatment applicable for:					iRAP Route Decimal Star Rating impact			
			Motorway	Dual rural	Dual urban	Single rural	Single urban	Vehicle Occupants	Motorcyclists	Cyclists	Pedestrians
Traffic Signs	A1 - General Traffic Signs	Route	✓	✓	✓	✓	✓	0.1	0.1	0.1	0.1
	A2 - Bend Ahead and Chevron Signs	Route	✓	✓	✓	✓	✓	0.1 - 0.2	0.2	0 - 0.1	0.1
	A3 - Vehicle Activated Signs	Route	-	✓	✓	✓	✓	0.1	0 - 0.1	0 - 0.1	0.1
	A4 - Variable Message Signs	Route	✓	✓	✓	✓	✓	Not able to be modelled in iRAP			
	A5 - Reflectorised Marker Posts / Bollards	Route	-	✓	✓	✓	✓	0.1 - 0.2	0.1 - 0.2	0	0 - 0.1
	A6 - Countdown Markers on the Approach to Roundabouts	Spot	-	✓	-	✓	✓	0	0	0	0
	A7 - Reducing Sign Clutter	Spot	✓	✓	✓	✓	✓	0.1	0	0	0
	A8 - Where You Look is Where You Go (WYLIWYG)	Route	-	✓	✓	✓	✓	0.2	0.2	0	0
Road Markings	B1 - Carriageway Text	Route	✓	✓	✓	✓	✓	0 - 0.2	0 - 0.2	0 - 0.1	0.1 - 0.2
	B2 - Vehicle Separation Road Markings	Route	✓	✓	-	-	-	Not able to be modelled in iRAP			
	B3 - Lane Separation Marking Width	Route	✓	✓	-	-	-	Not able to be modelled in iRAP			
	B4 - Edge of Carriageway Markings	Route	✓	✓	✓	✓	✓	0.1	0	0	0
	B4a - Edge of Carriageway Markings- Raised Profile Markings	Route	✓	✓	-	✓	-	0.2	0.1	0	0
	B5 - Central Hatching	Route	-	-	-	✓	✓	0.1	0.1	0	0
	B6 - Transverse Yellow Bar Markings	Spot	-	✓	-	-	-	0	0	0.1	0.1
	B7 - Rumble Devices	Route	-	✓	-	✓	-	0.2	0.2	0	0.1
	B8 - Double White Lines	Route	-	-	-	✓	✓	0.1	0.1	0	0
	B9 - High Visibility Markings	Route	✓	✓	✓	✓	✓	0.4	0.4	0	0.1
	B10 - Village Gateway	Spot	-	-	-	✓	✓	0.2	0 - 0.1	0.1	0
	B11 - Road Studs	Route	✓	✓	✓	✓	✓	0.4	0.4	0	0.1
	B12 - Legacy / heritage marking removal	Route	✓	✓	✓	✓	✓	0.2	0.1	0.1	0.3
WCH Facilities	C1 - New / improved Footways	Route	-	✓	✓	✓	✓	0	0	0	0.5 - 1.1
	C2 - Facilities for Cycle Traffic	Route	-	✓	✓	✓	✓	0 - 0.7	0 - 0.2	1 - 3.2	0-0.5
	C3 - Equestrian Facilities	Route	-	✓	✓	✓	✓	Not able to be modelled in iRAP			
	C4 - Road Crossings and Road Crossings Islands / Refuges	Spot	✓	✓	✓	✓	✓	0	0	0	0 - 3.1

Colour coding legend:			
<0	0 to 0.5	0.6 to 1	>1

Site based treatments (e.g. Junction improvements) and those applied at intervals (e.g. sign clutter removal) will only have a marginal impact on the Route Decimal Star Rating (calculated for 1 or 3km), although they will be impactful at the locations where they are applied. The Route Decimal Star Rating impact must be considered alongside the Star Rating Score Matrix provided at the end of each treatment category section which details the impact on the 100m iRAP section (site).

The Route Decimal Star Rating detailed in this Guide must not be totalled to manually establish the impact of multiple treatments. The RRT must be used as this takes account of the cumulative impact of multiple countermeasures.

	Treatment	Spot or Route Treatment	Treatment applicable for:					iRAP Route Decimal Star Rating impact			
			Motorway	Dual rural	Dual urban	Single rural	Single urban	Vehicle Occupants	Motorcyclists	Cyclists	Pedestrians
Speed policy & enforcement	D1 - Speed Limit Reduction / Strategy	Route	✓	✓	✓	✓	✓	0.2 - 0.4	0.2 - 0.4	0.2 - 0.4	0.3 - 0.4
	D2 - Spot Cameras	Spot	✓	✓	✓	✓	✓	0.2	0.3	0.1	0.1
	D3 - Average Speed Enforcement Cameras	Route	✓	✓	✓	✓	✓	0.6	0.7	0.8	0.4
	D4 - Enforcement bays / lay-bys	Spot	-	✓	✓	✓	✓	0.1	0.1	0	0
Road Surface	E1 - High Friction Surfacing (HFS and High-PSV)	Route	✓	✓	✓	✓	✓	0.5	0.5	0.3	0.5
	E2 - Coloured Surfacing	Route	-	✓	✓	✓	✓	0.1	0.1	0.1	0.5
	E3 - Re-surfacing	Route	✓	✓	✓	✓	✓	0.2	0.2	0.1	0.2
Road Geometry	F1 - Slip Road Merge / Diverge Improvement	Spot	✓	✓	✓	-	-	Not able to be modelled in iRAP			
	F2 - Ghost Island Right Turn Lanes	Spot	-	-	-	✓	✓	0 - 0.1	0 - 0.1	0	-0.1 - 0
	F3 - New / Improved Roundabout	Spot	-	✓	✓	✓	✓	0.3	0	-0.1	-0.2
	F4 - New / Improved Traffic Signals	Spot	-	✓	✓	✓	✓	0 - 0.2	0 - 0.1	0 - 0.1	0 - 0.1
	F5 - Hamburger roundabouts	Spot	-	-	✓	-	✓	Not able to be modelled in iRAP			
	F6 - Visibility screens	Spot	-	✓	✓	✓	✓	0.1	0	0.1	0.1
	F7 - Prohibition of Turns	Spot	-	✓	✓	✓	✓	Not able to be modelled in iRAP			
	F8 - Junction delineation and signing	Spot	✓	✓	✓	✓	✓	0	0	0	0.3
	F9 - Mini roundabout	Spot	-	-	-	-	✓	0	0	0	-0.1
Lane Treatments	G1 - Single Lane Widening - No Additional Lanes	Route	-	✓	✓	✓	✓	0.3 - 0.6	0.2 - 0.5	0 - 0.1	-0.1 - 0
	G2 - Wide Single 2+1 Carriageway	Route	-	-	-	✓	✓	0.2	0.2	-0.1	-1
	G3 - Climbing Lane	Route	-	-	-	✓	✓	0.1	0.2	0	-0.9
	G4 - Narrowing / Lane Drop	Route	-	✓	✓	✓	✓	0.1 - 0.2	0.1 - 0.2	0.1 - 0.2	0 - 0.1
	G5 - HGV Overtaking Bans	Route	-	✓	✓	-	-	Not able to be modelled in iRAP			
Multi-section Treatments	H - New / Replacement Street Lighting	Route	✓	✓	✓	✓	✓	0	0	0.1	0.3
	I - Passively Safe Fixtures	Spot	✓	✓	✓	✓	✓	0.1	0.1	0	0
	J - Road Restraint Systems	Route	✓	✓	✓	✓	✓	0.6 - 1.8	0.2 - 0.4	0	0.1 - 0.3
	K - Fencing	Spot	✓	✓	✓	✓	✓	0	0	0	0
	L - Vegetation Clearance	Route	✓	✓	✓	✓	✓	0	0	0.1	0.4
	M - New / Improved Lay-by Provision	Spot	✓	✓	-	✓	-	Not able to be modelled in iRAP			
	O - Treatment Options for Deer	Spot	✓	✓	-	✓	-	Not able to be modelled in iRAP			
	P - Wrong Way Driving	Spot	✓	✓	✓	-	-	Not able to be modelled in iRAP			
	Q - Drainage improvements	Spot	✓	✓	✓	✓	✓	Not able to be modelled in iRAP			
	R - Operational technologies	Route	✓	✓	-	-	-	Not able to be modelled in iRAP			
	S - Vertical and horizontal deflection	Route	-	-	-	-	✓	0.4 - 0.5	0.5 - 0.6	0.7 - 0.8	0.4

Click to return to engineering measures matrix

Treatment category

Example Treatment Page

Image of the treatment

Description
Description of the treatment and relevant information.

This may include details on where it can be used, how it may impact road users, other treatments that may complement it and advice that may aid the tretament's design, effectiveness and maintenance.

Image of the treatment

Description (continued)
Description (continued).

Identified risk / collision type
List of identified risks and collision types that the treatment can be used to help address.

Associated (technical) guides and standards
List of technical guides related to the treatment, including references to DMRB standards, Traffic Signs Manual etc.

Image of the treatment

Potential Impact on Star Rating
Table showing the potential impact the treatment may have on iRAP Route Decimal Star Rating for each of the four user groups.

Note that the Route Decimal Star Rating impact must be considered alongside the Star Rating Score Matrix provided at the end of each treatment category section which details the impact on the 100m iRAP section (site).

User	Star Rating Impact
Vehicle Occupants	Value
Motorcyclists	Value
Cyclists	Value
Pedestrians	Value

Click to return to engineering measures matrix

Traffic Signs

A1 - General Traffic Signs

Description

Traffic signs warning of features such as junctions ahead, traffic signals or locations where there may be unexpected queues ahead, can make road users more aware of the road environment and have a material impact on reducing the number of collisions along a route.

Installing appropriate warning, regulatory and directional signs can reduce the number of collisions caused by road users travelling at inappropriate speeds, over-shooting give way markings or braking late to turn into a junction.

When treating a route as a whole, a consistent approach to signing, including the use of suitable ‘x’ heights, backing boards and sign faces will enable road users to anticipate the nature of the oncoming hazard and encourage a change in speed or prompt a different manoeuvre.

Description (continued)

When installing new and consistent signing along a route, removing historic and redundant signs should be considered. A reduction of irrelevant or repeated information can assist in improving road user focus of other more important and relevant signs and help to improve the star rating.

Any new signs should be positioned to reduce the likelihood of them being struck by errant vehicles and should take into account any existing VRS. Visibility splays should also be considered when installing new signs, ensuring that adequate forward visibility for the speed limit (and observed vehicle speeds) is provided. Vegetation often impacts visibility to traffic signs, therefore areas of vegetation that could impact sign faces should be regularly maintained as part of a maintenance programme.

Identified risk / target collision type

Various.

Associated (technical) guides and standards

Traffic Signs Manual, Chapters 2, 3, 4 & 7

TSRGD

CD 146 Positioning of signalling and advance direction signs

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0.1
Cyclists	0.1
Pedestrians	0.1

Click to return to engineering measures matrix

Traffic Signs

A2 - Bend Ahead and Chevron Signs

Description

Traffic signs warning of approaching sharp bends can have a significant effect in reducing loss of control and speed related collisions on bends. The greatest impact may be achieved at locations where drivers / riders find it difficult to negotiate a bend. This could be for a variety of reasons including higher than optimal approach speeds, reduced forward visibility to the bend or due to the bend's layout or angle.

In addition to warning signs, chevron signs can be used where a more distinct visual aid is required through the length of the bend and a bend warning sign alone is considered insufficient.

These measures combined can improve road users' understanding of the layout ahead of them as well as the perception of the severity of an approaching bend, guiding them through the hazard safely.

Description (continued)

Bend ahead and chevron signs will have the greatest impact along the length of a route when they are used consistently, as this reduces the risk at all hazardous bends, not just bends that already have a history of collisions.

Where chevron signs are to be used and continued through a bend, the size of the sign face should be suitable for the 85th percentile speeds of vehicles on the approach to the bend (see Traffic Signs Manual Chapter 4).

Chevron signs should be located away from the likely path of an errant vehicle if possible. Where this may reduce the effectiveness of the signing and potentially create a greater risk of injury, then the use of passively safe posts or passively safe versions of chevron signs, that are designed to recover when struck, should be considered.

Identified risk / target collision type

Loss of control and speed related collisions on bends

Associated (technical) guides and standards

Traffic Signs Manual, Chapter 4, Section 3

Traffic Signs Regulations and General Directions

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1 – 0.2
Motorcyclists	0.2
Cyclists	0 – 0.1
Pedestrians	0.1

Click to return to engineering measures matrix

Traffic Signs

A3 - Vehicle Activated Signs

Description

Vehicle Activated Signs (VAS) can be an effective tool for highlighting permanent hazards on a route. Historically, they have been most commonly used on single carriageway roads in order to help make drivers aware of upcoming hazards.

VAS are usually activated in one of two ways. Firstly, as a vehicle approaches the sign, either at any speed or above a predetermined speed threshold, the VAS displays a sign and / or a warning message to the oncoming road user.

Secondly, a VAS can be activated when a certain set of circumstances are met, such as when a vehicle approaches a side road junction, the VAS can display a warning message to road users on the main carriageway warning approaching drivers of the possibility of vehicles turning into or out of an adjacent side road junction.

Description (continued)

One of the benefits of VAS is that they provide ‘real time’ warnings for road users and can attract their attention more successfully than static signing. The signs can also be used in an advisory capacity to reinforce speed limits.

Another advantage of VAS is that they can be solar powered in rural locations where connecting traditional signs to electricity may have been considered too expensive.

Traffic Advisory Leaflet 1/03 states that VAS should only be considered when there is a collision problem associated with vehicle speed that has not been satisfactorily remedied by standard signing and where a safety camera is not considered a cost effective solution. For addressing other collision types, it should be noted that, if used correctly, VAS will only be illuminated for a proportion of targeted drivers.

Identified risk / target collision type

Collisions associated with inappropriate speeds and manoeuvres, particularly where not remedied by traditional signing.

Associated (technical) guides and standards

Traffic Advisory Leaflet 1/03

Traffic Signs Regulations and General Directions

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0 – 0.1
Cyclists	0 – 0.1
Pedestrians	0.1

Click to return to engineering measures matrix

Traffic Signs

A4 - Variable Message Signs

Description

Variable Message Signs (VMS) are predominantly used to convey specific real time information to motorists regarding traffic management and warn of special events that may cause disruption to the highway network, or are used to highlight temporary or seasonal hazards.

The aim is to raise driver awareness and allow road users to slow down, amend their driving style or re-route before they reach the hazard.

Messages presented on the signs should be concise, whilst being fully comprehensible to road users. They should, in general, not convey more than eight words or six units of information and may include lane layouts, warning signs etc.

It is unlawful to display messages that require multiple displays ('paging') or utilise scrolling text.

Description (continued)

VMS can be considered a relatively costly option compared to static traffic signs and should only be used where static signing is ineffective or not appropriate.

However, VMS can, in some areas, save money, as less time is spent installing and removing Temporary Traffic Management signs at ground level.

The effects of using VMS on road workers' safety should be considered, as should the positioning of the VMS to minimise any potential hazard to road users (e.g. too close to the carriageway or within VRS working width).

Identified risk / target collision type

Collision problems associated with temporary hazards such as areas prone to fog, debris in the road, events, seasonal issues or roadworks.

Associated (technical) guides and standards

Traffic Advisory Leaflet 01/15 Variable Message Signs

Traffic Signs Regulations and General Directions

CD 146 Positioning of signalling and advance direction signs

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Traffic Signs

A5 - Reflectorised Marker Posts / Bollards

Description

Marker posts, placed in the verge, can be used to draw road users' attention to certain features and hazards as well as improving conspicuity of the road alignment. These measures are particularly effective in unlit areas as the reflectorised strips can provide a conspicuous outline of the carriageway extents and guide drivers through a changing or more hazardous road alignment. Marker posts may also be a cost effective way of discouraging road users from stopping in hazardous locations or providing warning of a segregation island located between the carriageway and a lay-by.

When used as part of a road safety route treatment scheme, the repetitive application of marker posts at similar features such as ditches, bends or accesses can increase a road user's anticipation and comprehension of the road conditions ahead.

Description (continued)

If the marker posts are located at a high risk location, self-righting versions can be installed.

Physical obstructions such as bridge structures can also be highlighted using black and yellow striped markers.

Designers should give due consideration to Passive Safety (see Measure I) and BS EN 12767 when proposing the installation of marker posts and bollards.

Reflectorised marker posts / bollards can be used on their own or with a package of measures to treat collisions. If being used to treat collisions occurring during the hours of darkness, marker posts and other complementary treatment measures may be more appropriate, and cost effective, than providing street lighting.

Identified risk / target collision type

Loss of control, misreading the alignment, night-

time / dark collisions, discouraging stopping in hazardous locations and run-off incidents.

Associated (technical) guides and standards

Traffic Signs Manual, Chapter 4. Section 15 Hazard Markers.

CD 169 The design of lay-bys, maintenance hardstandings, rest areas, service areas and observation platforms.

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1 - 0.2
Motorcyclists	0.1 - 0.2
Cyclists	0
Pedestrians	0 - 0.1

Click to return to engineering measures matrix

A6 - Countdown Markers on the Approach to Roundabouts

Traffic Signs

Description

Countdown markers may be beneficial where further emphasis is needed on a high speed approach to a roundabout on dual carriageways. These markers provide indication to drivers that the roundabout is approaching and speed should be reduced accordingly.

Countdown markers should be sited 300, 200 and 100 yards from the give way line. The background colour shall be green when used on a primary route, and white (with black symbols and border) on a non-primary route.

The signs should normally be mounted in pairs on each side of the carriageway, ensuring that drivers in both approach lanes have visibility to the signs. Care should be taken to ensure that sign arrangements are passively safe and / or suitably protected.

Description (continued)

When a roundabout includes the provision of a Segregated Left Turn Lane, countdown signs should only be provided on the approach to the roundabout when there is no risk of confusion between the distance to the commencement of the Segregated Left Turn Lane and the distance to the roundabout give way line.

Countdown markers can also be used alongside other treatment measures, which may result in a greater impact on the targeted collision types. This includes with Transverse Yellow Bar Markings (See Treatment Measure B6).

Identified risk / target collision type

Shunt type collisions caused by a failure to stop.

Side impact collisions as a result of overshooting onto the roundabout circulatory.

Associated (technical) guides and standards

CD 116 Geometric design of roundabouts

Traffic Signs Manual, Chapter 4, Section 2.

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0
Motorcyclists	0
Cyclists	0
Pedestrians	0

Click to return to engineering measures matrix

Traffic Signs

A7 - Reducing Sign Clutter

Description

Over-provision of traffic signs can have a detrimental impact on the environment and can dilute the most important messages if road users are overloaded with information.

The appropriate use and layout of traffic signs and road markings is vital to their effectiveness, in terms of both guiding users and regulating their movements when required.

Non-essential street furniture also provides an unnecessary additional hazard to road users should they lose control of their vehicle and leave the carriageway.

Traffic sign clutter can occur over time, where additional signing is provided without consideration of any existing signing. It can also occur where information to road users is unnecessary or excessively signed, or as a result of excessive and / or no longer required temporary signing.

Description (continued)

Good sign design and consideration of existing signage can prevent clutter happening in the first place. Integration of signing requirements into the early design stages of a scheme can help ensure the number of signs is kept to the minimum needed without compromising on the messages they need to deliver. Careful design of the signs themselves can also help to avoid clutter by reducing their size and by combining signs onto fewer separate structures.

Reducing sign clutter can also have road safety, environmental, cost and maintenance benefits.

Identified risk / target collision type

A wide variety of collisions, as the target collision type depends on the message(s) of the key sign faces in place and the ability to reduce the potential for driver confusion.

Associated (technical) guides and standards

Traffic Signs Manual Chapter 3

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0
Cyclists	0
Pedestrians	0

Click to return to engineering measures matrix

Traffic Signs

A8 - Where You Look is Where You Go (WYLIWYG)

Description

Motorcycle trainees are often taught that 'Where You Look Is Where You Go' (WYLIWYG). The principle is that if a rider can see around the bend to its vanishing point, generally this will be the adopted line, but if distracted by a road side object in the sight line ahead there is a possibility of loss of control due to a tendency to veer towards the object ahead. This may also be referred to as 'target fixation'.

Where there are safety concerns of road users losing control on a bend, the WYLIWYG principle can be introduced. This uses a series of hazard marker posts to draw the focus of motorcyclists and drivers to the vanishing point of the bend and prevent distraction by road side objects. The posts are placed in the verge at regular intervals, extending both around the bend as normal, but also for some distance after the bend until the vanishing point starts to move away from the rider's view as the carriageway straightens.

Description (continued)

WYLIWYG is most commonly introduced on unlit rural roads. Designers are required to give due consideration to BS EN 12767 when proposing the installation of hazard marker posts. The position of other signs and infrastructure should also be considered to reduce the likelihood of them being struck.

Maintaining vegetation is essential to ensure that hazard marker posts remain visible. Alternatively, planting low-growth species or hardening the surface may prove a more cost-effective solution.The reduction or removal of vegetation can also increase the natural light at the bend to assist forward visibility for road users.

WYLIWYG principles can be used on their own or with a package of measures to treat collisions occurring during the hours of darkness.

Identified risk / target collision type

Motorcycle collisions on bends, but beneficial for all road users at similar hazards.

Associated (technical) guides and standards

Traffic Signs Manual Chapter 4, section 16.

National Highways Guide for Designing for Motorcyclists

www.motorcycleguidelines.org.uk

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.2
Motorcyclists	0.2
Cyclists	0
Pedestrians	0

Click to return to engineering measures matrix

Traffic Sign Treatments – Star Rating Score Impact Matrix

The percentage impact on the Star Rating Score in the table below is provided for a representative 100m location. It is important to consider these impacts relative to the Fatal and Serious Injury (FSI) profile in the Route Review Tool which provides an estimate of FSI by collision type, effectively providing an indication of the scale of the treatment opportunity.

For example, if the FSI profile indicates there are two Junction Vehicle Occupant FSIs at a location, then improvements to Junction Delineation by the introduction of Countdown Markers (A6) can be expected to reduce these by 17%, which equates to 0.34 FSIs.

Engineering Measures	Vehicle Star Rating Score Impact						Cyclist Star Rating Score Impact			
	Run-Off Loss of Control (LOC) Driver-Side	Run-Off LOC Passenger-Side	Head-On LOC	Head-On Overtaking	Junction	Property Access	Along	Junction	Run-Off	Crossing
A1. General Road Signs*[1]	-17%	-17%	-8%	0%	0%	0%	-17%	0%	-17%	0%
A2. Bend ahead warning sign	-20%	-20%	-20%	0%	0%	0%	-29%	0%	-29%	0%
A2. Chevron Alignment signs*[2]	-15%	-15%	-19%	-10%	-10%	-12%	-15%	-8%	-7%	-8%
A3. Vehicle Activated Signs - Curve*[3]	-17%	-17%	-11%	-11%	-17%	0%	-11%	-11%	0%	-11%
A3. Vehicle Activated Signs - Junction*[3]	-17%	-17%	-17%	-17%	-17%	-21%	-14%	-14%	0%	-14%
A3. Vehicle Activated Signs - Speed Limit*[3]	-19%	-19%	-21%	-21%	-19%	-26%	-20%	-20%	0%	-20%
A5. Reflectorised Marker Posts Bollards Curve Delineation	-20%	-20%	-20%	-20%	0%	0%	-29%	0%	-29%	0%
A5. Reflectorised Marker Posts Bollards Delineation	-17%	-17%	-17%	-17%	0%	0%	-17%	0%	-17%	0%
A6. Countdown Markers on the approach	0%	0%	0%	0%	-17%	0%	0%	-17%	0%	0%
A7. Reducing Sign Clutter *[4]	-22%	-45%	0%	0%	0%	0%	0%	0%	-49%	0%
A8. Where you look is where you go	-20%	-20%	-20%	0%	0%	0%	-29%	0%	-29%	0%

*[1] - Improve delineation countermeasure - Junction and Pedestrian Crossing not impacted. These facilities are impacted by facility specific Improving Quality countermeasures
*[2] - Chevron alignment signs impact operating speeds so affect collision types other than Run-off
*[3] - VAS signs impact operating speeds so affect collision types other than the targeted road configuration
*[4] - Assumed spot based treatment as opposed to every 100m

Click to return to engineering measures matrix

Engineering Measures	Motorcyclist Star Rating Score Impact							Pedestrian Star Rating Score Impact		
	Run-Off LOC Driver-Side	Run-Off Passenger-Side	Head-On LOC	Head-On Overtaking	Junction	Property-Access	Along	Along	Crossing Inspected Road	Crossing Intersecting Road
A1. General Road Signs*1	-17%	-17%	-17%	0%	0%	0%	0%	-17%	0%	0%
A2. Bend ahead warning sign	-29%	-29%	-29%	0%	0%	0%	0%	-20%	0%	0%
A2. Chevron Alignment signs*2	-17%	-17%	-23%	-10%	-10%	-12%	-10%	-9%	-7%	-7%
A3. Vehicle Activated Signs - Curve*3	-17%	-17%	-11%	-11%	-17%	0%	-17%	-5%	-10%	-10%
A3. Vehicle Activated Signs - Junction*3	-17%	-17%	-17%	-17%	-17%	-21%	-17%	-7%	-14%	-14%
A3. Vehicle Activated Signs - Speed Limit*3	-19%	-19%	-21%	-21%	-19%	-26%	-19%	-10%	-18%	-18%
A5. Reflectorised Marker Posts Bollards Curve Delineation	-29%	-29%	-29%	0%	0%	0%	0%	-20%	0%	0%
A5. Reflectorised Marker Posts Bollards Delineation	-17%	-17%	-17%	0%	0%	0%	0%	-17%	0%	0%
A6. Countdown Markers on the approach	0%	0%	0%	0%	0%	0%	0%	0%	-17%	-17%
A7. Reducing Sign Clutter *4	-22%	-45%	0%	0%	0%	0%	0%	0%	0%	0%
A8. Where you look is where you go	-29%	-29%	-29%	0%	0%	-29%	0%	0%	0%	0%

*1 - Improve delineation countermeasure - Junction and Pedestrian Crossing not impacted. These facilities are impacted by facility specific Improving Quality countermeasures
*2 - Chevron alignment signs impact operating speeds so affects collision types other than Run-off
*3 - VAS signs impact operating speeds so affect collision types other than the targeted road configuration
*4 - Assumed spot based treatment as opposed to every 100m

The change in Star Rating Score (SRS) is based upon a representative 100m section to which the treatment is applied and will only be effective where a collision type is present. For example, a Junction SRS reduction will only be applied to 100m where both the collision type and a Junction are present. The percentage reduction in SRS is also relative to the reduction in estimated Fatal and Serious Injury for each collision type within the respective 100m.

Click to return to engineering measures matrix

B1 - Carriageway Text

Description

Carriageway text road markings are often applied in conjunction with lane separation road markings and traffic signs in order to provide guidance to road users as to:

- what lane they should be in; or,
- to warn of an approaching hazard.

The use of clear carriageway text in conjunction with lane separation road markings can encourage better lane discipline and reduce the occurrence of sudden lane changes and therefore side swipes. Cyclists and motorcyclists are particularly vulnerable to these types of collisions.

The use of 'SLOW' road markings can be used to offer repeated warning to road users at locations with an existing identified collision problem or known hazards throughout the route length.

Description (continued)

To ensure that road users are aware of the messages being conveyed by the carriageway text (e.g. why they should be in a certain lane, why they should slow down) it is recommended that the text is used in conjunction with appropriate signing, which could include lane designation signs or warning signs to explain why reduced speeds are appropriate.

Text road markings should, where possible, be located at least as far back from the junction as the longest peak hour queue to ensure stationary vehicles do not block the message. However, care should be taken to ensure that the message does not cause confusion with other junctions nearby.

Special care needs to be taken when using carriageway text at locations where it may present a hazard to motorcyclists, such as on the approaches to bends or within the bend itself, especially on adverse cambers.

Identified risk / collision type

Collisions where inappropriate speeds and / or lane discipline and late lane changes have been a contributory factor.

Associated (technical) guides and standards

Traffic Signs Regulations and General Directions

Traffic Signs Manual Chapter 5

CD 236 Surface course materials for construction

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0 - 0.2
Motorcyclists	0 - 0.2
Cyclists	0 - 0.1
Pedestrians	0.1 - 0.2

Click to return to engineering measures matrix

B2 - Vehicle Separation Road Markings

Description

Vehicle separation road markings are one measure that can improve road user behaviour by encouraging an increased gap to the vehicle in front. The markings are typically placed on the carriageway at 40m intervals.

Vehicle separation road markings were originally prescribed for motorway use only, but may now be used on all-purpose roads, although they should normally be confined to dual carriageways with grade separated junctions that are subject to the national speed limit of 70mph.

It should be noted that “Keep apart 2 chevrons”, “Check your distance” and “Keep your distance” signs shall also be installed as part of this measure (see Traffic Signs Manual Chapter 5 for full guidance).The effectiveness of Vehicle Separation Road Markings on sections of motorway with very high traffic flows is unknown and therefore it is recommended that caution is

Description (continued)

exercised before installing these road markings. Successful trials occurred where traffic flows did not exceed 4,000 vehicles per carriageway during the peak hours. The distance between successive series of chevrons should generally be between 40km and 55km, although this need not be complied with rigidly, as specific site criteria are of greater importance.

Studies by TRL found that the markings had the biggest impact in reducing single vehicle collisions, despite the measures commonly being used to reduce collisions involving two vehicles. It is considered that this is due to the road marking making road users more aware of their speed and providing drivers with something that breaks up the routine and monotony of a route.

The potential risk to road operatives during the installation and maintenance of vehicle separation markings needs to be considered and mitigation measures put in place.

Identified risk / collision type

Nose to tail collisions associated with close following.

Single vehicle and loss of control collisions.

Associated (technical) guides and standards

Traffic Signs Regulations and General Directions

Traffic Signs Manual, Chapter 5, Section 11

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Road Markings

B3 - Lane Separation Marking Width

Description

An increase in the lane separation road marking width can be used to increase the prominence of the road marking and increase separation between vehicles on multi-lane roads or roads with a carriageway width of over 10m.

The TSRGD allows the use of a wider, 150mm lane separation marking in place of the standard 100mm wide road marking. The wider line is visible at a greater distance and should be used where this might be beneficial, such as at a particularly hazardous site or for centre lines on single carriageway roads with more than two lanes.

On concrete roads the wider road marking can help improve the prominence of road markings and the use of enhanced luminance paint can also assist in making the road marking more distinct, particularly in wet conditions.

Description (continued)

However, this advice regarding lane separation marking width shall not render the carriageway incompatible with the CD 127 “Cross-Sections and Headrooms” standard for lane widths, as minimum lane widths shall be maintained unless a Departure from Standard is obtained. This requirement applies to both improvement and maintenance schemes, although different line widths should not be used for adjacent lanes.

Consideration should be given to the justification of the use of the wider road marking as its overuse will devalue its effect.

Identified risk / collision type

Locations where lane discipline has been a contributory factor in collisions, including incidents at night or during inclement weather.

Associated (technical) guides and standards

Traffic Signs Regulations and General Directions

Traffic Signs Manual, Chapter 5, Section 2

BS EN 1436:2018 Road marking materials - road marking performance for road users and test methods (Incorporating corrigendum April 2018)

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

B4 - Edge of Carriageway Markings

Description

A solid white road marking at the edge of the carriageway can help road users to comprehend the road layout ahead, particularly at night or during inclement weather. It can also improve road user positioning by encouraging the adoption of a driving line closer to the carriageway edge, which provides safer negotiation through a bend and therefore reduces the potential for head-on conflicts.

Edge of carriageway markings can be used on a variety of road types, but at locations where the carriageway is particularly wide, a solid edge line located further from the edge of the carriageway can be introduced to form a hardstrip (see DMRB Standard CD 127). This can also improve road user positioning within the carriageway.

A broken white edge line road marking can be used on the edge of carriageway to highlight private accesses, increasing their conspicuity.

Description (continued)

It is important to consider whether there is a need for enhanced performance road markings. Whilst these road markings require more capital cost, they can make road markings more durable, require less maintenance and provide additional road safety benefits. An additional maintenance consideration for these markings is the collection of detritus at the edge of the carriageway, which can impact performance.

Edge of carriageway markings can be used on their own or with a package of measures (such as with road studs, signs or marker posts) to treat collisions occurring during the hours of darkness, and in some situations will be more appropriate than providing street lighting where currently no street lighting is provided.

Identified risk / collision type

Loss of control collisions, head-on collisions on bends, collisions at night or in inclement weather, turning conflicts at side accesses.

Associated (technical) guides and standards

Traffic Signs Regulations and General Directions

Traffic Signs Manual Chapter 5, Section 2

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0
Cyclists	0
Pedestrians	0

Click to return to engineering measures matrix

B4a - Edge of Carriageway Markings- Raised Profile Markings

Road Markings

Description

Raised profile edge lines consist of a continuous line (as described in measure B4) with raised horizontal ribs to provide an audible vibratory warning to drivers should they stray from the carriageway and run onto the marking. They also stand clear of the water film in wet conditions, improving retroreflective performance under headlight illumination.

These road markings can be used on both motorways and all-purpose trunk roads and are effective at reducing fatigue and loss of control related collisions.

The road marking is typically constructed from specialist thermoplastic material and can also be used to enhance visibility of the marking on wet road surfaces during the hours of darkness.

In order to provide good surface water drainage, a drainage channel should be included within the continuous line at predetermined intervals.

Description (continued)

The impact of raised edge lines on pedestrians, cyclists and motorcyclists should be considered before their use. They should be discontinued where pedestrians and cyclists cross the road (e.g. at refuges) or at other places where cyclists are likely to cross them. When laid on a curve of less than 1,000m radius, motorcyclists can be destabilised if they have to cross the marking.

Raised rib edge of carriageway markings can be used on their own or with a package of measures (such as with road studs, signs or marker posts) to treat collisions occurring during the hours of darkness and in some situations will be more appropriate than providing street lighting where currently no street lighting is provided.

Identified risk / collision type

Loss of control collisions, collisions at night or in inclement weather, incidents involving fatigue, turning conflicts at side accesses.

Associated (technical) guides and standards

Traffic Signs Regulations and General Directions

Traffic Signs Manual Chapter 5, Section 2

CD 127 Cross-sections and headrooms

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle occupants	0.2
Motorcyclists	0.1
Cyclists	0
Pedestrians	0

Click to return to engineering measures matrix

Road Markings

B5 - Central Hatching

Description

Central hatching introduces a degree of separation between opposing lanes on a carriageway. It should only be used where the carriageway is wide enough to accommodate the hatching and still provide compliant lane/hardstrip widths for both directions (see DMRB Standard CD 127).

Some of the benefits associated with introducing central hatching are:

- it can give the visual effect of narrowing the carriageway, which can encourage reduced vehicle speeds;
- it can improve lane discipline and discourage overtaking;
- it can improve negotiation of bends; and
- emergency service vehicles can utilise the area to overtake slow moving or stationary vehicles.

Description (continued)

If there is sufficient width available, the central hatched area can also accommodate a dedicated right turning facility for vehicles turning into or out of a side road (although reference should be made to DMRB Standard CD 123). This reduces the risk of turning conflicts and nose to tail collisions, commonly associated with these manoeuvres.

Coloured surfacing can be used within the central hatched area to place greater emphasis on the central hatched area and further emphasise the segregation.

It should be noted that central hatching can have a negative effect on cyclist and motorcyclist safety due to vehicle poistioning, or if the hatched areas are used for overtaking.

Identified risk / collision type

Speed related collisions and head-on collisions.

Associated (technical) guides and standards

Traffic Signs Regulations and General Directions

Traffic Signs Manual, Chapter 5, Section 2

CD 127 Cross-sections and headrooms

CD 236 Surface course materials for construction

CD 123 Geometric design of at-grade priority and signal-controlled junctions

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0.1
Cyclists	0
Pedestrians	0

Click to return to engineering measures matrix

Road Markings

B6 - Transverse Yellow Bar Markings

Description

Transverse yellow bar markings (also referred to as Lateral bars) can be provided where the following criteria are met:

- the carriageway is on the approach to a roundabout on a motorway or dual carriageway road
- there is at least 3km of dual carriageway in advance of the site, with no major intersections or bends with a horizontal radius less than the desirable minimum for a 120kph design speed
- the road is subject to the national speed limit
- the collision record for the roundabout includes at least three collisions involving personal injury during the preceding three years, in which speed on the relevant approach was a contributory factor.

Description (continued)

The TSRGD and Chapter 5 of the Traffic Signs Manual provides guidance and a layout for the use of these road markings where the spacing between each bar decreases on the approach to a roundabout give way line. This provides road users with the visual illusion that they are travelling at a higher speed and encourages road users to slow down.

Due consideration should be given to using durable materials, such as MMA (Methyl Methacrylate) paint which lasts approximately twice as long as other road marking material.

The impact of transverse yellow bar markings on motorcyclists should be considered before their use, as they could be destabilised or at increased risk of skidding under braking. Where there is a significant number of cyclists, a gap of 750mm can be provided between the edge of the running carriageway and the bar markings.

Identified risk / collision type

Overshoot, failure to give way and nose to tail collisions.

Associated (technical) guides and standards

Traffic Signs Manual, Chapter 5, Section 11

Traffic Signs Regulations and General Directions

CD 116 Geometric design of roundabouts

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0
Motorcyclists	0
Cyclists	0.1
Pedestrians	0.1

Click to return to engineering measures matrix

B7 - Rumble Devices

Description

Rumble devices encompass a variety of features such as:

- rumble strips
- rumble bars
- rumble areas

The aim is to encourage road users to slow down on the approach to the hazard by increasing its conspicuity and providing a vibratory effect. A consistent route approach will result in drivers learning to identify the hazard in advance. Rumble strips and bars are generally cheaper than rumble areas but to maximise their effectiveness they should be applied in a series of groups, positioned closely together on the immediate approach to a hazard.

Rumble devices are likely to result in only modest reductions in speed (typically 3mph, see LTN 1/07), but do help to increase the attention and awareness of road users.

Description (continued)

Rumble areas are only recommended on roads with an 85th percentile speed of between 30mph and 45mph. There should usually be a minimum distance of 30m to the nearest building as they can create noise and vibrations, although this may need to be extended depending on specific ground conditions at each site (see Traffic Advisory Leaflet 1/05 Rumblewave Surfacing).

Consideration should be given to cycle traffic and motorcyclists. In the case of rumble bars, this could include leaving gaps (between 750mm and 1,000mm) between the end of the bars and the nearside road edge. For a rumble area, a smooth strip can be provided near to the carriageway edge to allow cycle traffic to pass over the feature with minimum discomfort.

Rumble devices should not be used on bends as they may create a hazard for motorcyclists at these locations.

Identified risk / collision type

Shunt type collisions and conflict with vulnerable road users due to inappropriate speeds.

Associated (technical) guides and standards

Local Transport Note 1/07 Traffic Calming

Traffic Advisory Leaflet 11/93 Rumble Devices

Traffic Advisory Leaflet 1/05 Rumblewave Surfacing

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.2
Motorcyclists	0.2
Cyclists	0
Pedestrians	0.1

Click to return to engineering measures matrix

Road Markings

B8 - Double White Lines

Description

A double white line road marking within the centre of a road prohibits vehicles from overtaking when travelling in either direction. The road marking also helps to highlight the alignment of the road ahead and encourages road users not to cross the centre line when negotiating bends. It should be noted that road studs shall also be included in all double white lining systems.

These road markings should only be used on sections of road where forward visibility is insufficient to overtake safely. Chapter 5 of the Traffic Signs Manual provides guidance regarding the maximum forward visibility and road width allowed when considering using this road marking. However, where a significant collision history has been identified, it is permissible to use this road marking even if forward visibility is better than the prescribed maximum.

Description (continued)

Care needs to be taken not to use this marking at inappropriate locations, as this may lead to road users ignoring the road marking, resulting in an increase in inappropriate overtaking manoeuvres at other dangerous locations.

Guidance states that where forward visibility is sufficient, but overtaking could still present a danger, a warning line road marking should be used, or consideration given to central hatching (see treatment measure B5).

Identified risk / collision type

Generally addressing overtaking collisions or head-on collisions at bends due to poor lane positioning.

Associated (technical) guides and standards

Traffic Signs Manual Chapter 5, Section 5

Traffic Signs Regulations and General Directions Schedule 9, Part 6, Item 23, Diagram 1013.1

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0.1
Cyclists	0
Pedestrians	0

Click to return to engineering measures matrix

Road Markings

B9 - High Visibility Markings

Description

High visibility white road markings can provide an enhanced guidance system for road users both in wet and adverse weather conditions as well as during the hours of darkness. They may also bring benefits to roads on an east-west alignment that may cause difficulties for road users travelling towards a low sun.

On concrete carriageways, it is recommended that high visibility road markings are used instead of the standard lines that are utilised on black surface treatments.

An additional benefit of high visibility road markings is the reduced need for maintenance; however, this is dependent on its application, thickness and material type. The reduced maintenance costs may be offset as the initial outlay for these road markings is approximately twice as expensive as the cost of normal road markings.

Description (continued)

High visibility markings can be used on their own or with a package of measures to treat collisions occurring during the hours of darkness and in some situations will be more appropriate than providing street lighting where currently no street lighting is provided.

Identified risk / collision type

Night-time, dark, wet and adverse weather related collisions.

Collisions on roads with an east-west alignment that may cause difficulties for road users travelling towards a low sun.

Associated (technical) guides and standards

Traffic Signs Manual (2009) Chapter 5 “Road Markings”

BS EN 1423 “Road marking materials. Drop on materials. Glass beads, antiskid aggregates and mixtures of the two.”

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.4
Motorcyclists	0.4
Cyclists	0
Pedestrians	0.1

Click to return to engineering measures matrix

B10 - Village Gateway

Description

Gateways can provide a clearly defined boundary for road users on the approach to a village or settlement located on a route. They can help to emphasise a changing environment and the need to adopt associated behaviour, including a reduction in vehicle speed.

Features of this nature are well suited to road safety route treatment schemes, as treating the entry to each village similarly provides a consistent message to road users of an upcoming change in route characteristics.

Gateways can comprise a package of measures including signing, speed limit reduction, physical features, coloured surfacing, carriageway narrowing, and road markings.

Gateways should be positioned as close to the settlement extents as possible, although consultation with parish councils and other key stakeholders may result in some local variations.

Description (continued)

A clear sight line on approach to the gateway is a key requirement, ideally at least the stopping sight distance for the 85th percentile approach speed. Conspicuity of the gateway could be enhanced by replicating the gateway features on each side of the carriageway. Any features used should be passively safe if associated with potentially high approach speeds.

Generally, using a package of measures can have greater impact than measures in isolation, however it is important that the use of these measures are justified to prevent excessive visual intrusion on the rural environment.

Identified risk / collision type

Speed-related collisions on entry to and through rural and semi-rural settlements. These collisions may be more likely to involve vulnerable road users within these settlements.

Associated (technical) guides and standards

LTN 1/07 Traffic Calming

Road Safety Good Practice Guide, DTLR 2001

Traffic Advisory Leaflet 1/04 Village Speed Limits

Setting local speed limits, DfT

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.2
Motorcyclists	0 – 0.1
Cyclists	0.1
Pedestrians	0

Click to return to engineering measures matrix

B11 - Road Studs

Description

Road studs are a particularly effective way of enhancing forward visibility of the road layout on unlit roads during the hours of darkness or during inclement weather. The most suitable type of stud for the road in terms of the required performance and durability should be considered. Where traditional road studs may be ineffective, light emitting (active) road studs should be considered.

Light emitting (active) road studs include an internal light source, generally using a solar panel to provide a power supply. Instead of relying on a vehicle's headlights to illuminate the stud, the LEDs generate a continuous, brighter and more conspicuous feature. Active road studs are only usually introduced in areas where headlights may not be able to illuminate a traditional road stud sufficiently (e.g. due to poor vertical and horizontal alignment) and can extend visibility of the road layout ahead.

Description (continued)

Road studs can be used on their own or with a package of measures to treat collisions occurring during the hours of darkness and in some situations will be more appropriate than providing street lighting where currently no street lighting is provided.

Identified risk / collision type

Night-time and adverse weather related collisions, including loss of control, run-off incidents and head-on collisions.

Associated (technical) guides and standards

Traffic Signs Manual, Chapter 5, Section 4

CS 126 - Inspection and assessment of road markings and road studs

Traffic Signs Regulations and General Directions

Manual of Contract Drawings for Highway Works, Volume 3

BS EN 1463-1:2021 "Road marking materials. Retroreflecting road studs - Initial performance requirements"

BS EN 1463-2:2021 "Road marking materials. Retroreflecting road studs - Road test performance specifications"

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.4
Motorcyclists	0.4
Cyclists	0
Pedestrians	0.1

Click to return to engineering measures matrix

B12 - Legacy / heritage marking removal

Description

In areas where the road layout has been permanently changed, or where TTM resulted in temporary changes, there can be legacy road markings that could cause confusion for drivers and vehicle technology (such as lane assist). These issues can be exacerbated during wet and / or dark conditions.

When removing markings, the aim is that following the works, the legacy markings are not visible, reflectivity is removed and the remaining surface is left in a suitable condition.

A number of removal methods are available for the effective removal of legacy markings. These methods may vary depending on the type of marking, the surface, the surrounding environment and proximity to the public.

Description (continued)

Methods include, but may not be limited to:

- Hydroblasting
- Forced Air Abrasive (Shot blasting)
- Diamond blasting
- Scabbling
- Hot compressed air
- Chemical removal
- Resurfacing

In order to get the most effective result, some removal methods can be used in combination.

The method of removal may also have to consider ecological and environmental impacts due to the use of chemicals and the noise and debris that may be created.

It is recommended that pavement specialists are consulted in relation to marking removal and that competent contractors are engaged.

Identified risk / collision type

Collision types influenced by road markings, including lane changes, junction overshoots and rear end shunts due to confusion.

Associated (technical) guides and standards

MCHW Volume 2

PD CEN/TR 16958:2017 Road marking materials. Conditions for removing/masking road markings

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.2
Motorcyclists	0.1
Cyclists	0.1
Pedestrians	0.3

Click to return to engineering measures matrix

Road Markings Treatments – Star Rating Score Impact Matrix

The percentage impact on the Star Rating Score in the table below is provided for a representative 100m location. It is important to consider these impacts relative to the Fatal and Serious Injury (FSI) profile in the Route Review Tool which provides an estimate of FSI by collision type, effectively providing an indication of the scale of the treatment opportunity.

For example, if the FSI profile indicates there are two 'Junction vehicle occupant' FSIs at a location, then improvements to Junction Delineation (B1) can be expected to reduce these by 17%, which equates to 0.34 FSIs.

Engineering Measures	Vehicle Star Rating Score Impact						Cyclist Star Rating Score Impact			
	Run-Off LOC Driver-Side	Run-Off LOC Passenger -Side	Head-On LOC	Head-On Overtaking	Junction	Property Access	Along	Junction	Run-Off	Crossing
B1. Carriageway text - Curve Delineation*1	-20%	-20%	-20%	0%	0%	0%	-29%	0%	-29%	0%
B1. Carriageway text - Junction Delineation*2	0%	0%	0%	0%	-17%	0%	0%	-17%	0%	0%
B4. Edge of Carriageway Markings	-5%	-5%	0%	0%	0%	0%	0%	0%	0%	0%
B4a. Edge of carriageway raised edge	-20%	-20%	0%	0%	0%	0%	-20%	0%	0%	0%
B5. Central Hatching	0%	0%	-17%	-18%	0%	0%	0%	0%	0%	0%
B6. Transverse Yellow Bar Markings*2	0%	0%	0%	0%	-17%	0%	0%	-17%	0%	0%
B7. Rumble Devices*3	-18%	-18%	-18%	-18%	-18%	-18%	-23%	-23%	0%	-23%
B8. Double White Lines	0%	0%	-5%	0%	0%	0%	0%	0%	0%	0%
B9. High Visibility Markings*4	-33%	-33%	-17%	0%	0%	0%	-40%	0%	-40%	0%
B10. Village Gateways Physical treatment	-27%	-27%	-27%	-27%	-27%	-27%	-27%	-27%	0%	-27%
B10. Village Gateways - Between physical treatment	-5%	-5%	-5%	-5%	-5%	-5%	-3%	-3%	0%	-3%
B10. Village Gateways Signs and Markings	-27%	-27%	-27%	-27%	-27%	-27%	-27%	-27%	0%	-27%
B10. Village Gateways - Between signs and Markings	-5%	-5%	-5%	-5%	-5%	-5%	-3%	-3%	0%	-3%
B11. Road Studs*4	-33%	-33%	-17%	0%	0%	0%	-40%	0%	-40%	0%
B12. Legacy heritage marking removal*1*2	-17%	-17%	-8%	0%	-17%	0%	-17%	-17%	-17%	0%

*1 - Improve curve delineation countermeasure, treatment would only be effective if existing iRAP coding is poor
*2 - Improve junction delineation countermeasure. treatment would only be effective if existing iRAP coding is poor
*3- Treatment impacts on operating speed and therefore impact majority of Crash Types
*4- Improved delineation on straight and through curvature, treatment would only be effective if existing iRAP coding is poor

Click to return to engineering measures matrix

Engineering Measures	Motorcyclist Star Rating Score Impact							Pedestrian Star Rating Score Impact		
	Run-Off LOC Driver-Side	Run-Off Passenger-Side	Head-On LOC	Head-On Overtaking	Junction	Property-Access	Along	Along	Crossing Inspected Road	Crossing Intersecting Road
B1. Carriageway text - Curve Delineation*1	-29%	-29%	-29%	0%	0%	0%	0%	-20%	0%	0%
B1. Carriageway text - Junction Delineation*2	0%	0%	0%	0%	-17%	0%	0%	0%	-17%	-17%
B4. Edge of Carriageway Markings	-5%	-5%	0%	0%	0%	0%	0%	0%	0%	0%
B4a. Edge of carriageway raised edge	-20%	-20%	0%	0%	0%	0%	0%	0%	0%	0%
B5. Central Hatching	0%	0%	-17%	-18%	0%	0%	0%	0%	0%	0%
B6. Transverse Yellow Bar Markings*2	0%	0%	0%	0%	-17%	0%	0%	0%	-17%	0%
B7. Rumble Devices*3	-18%	-18%	-18%	-18%	-18%	-18%	-18%	-11%	-11%	-11%
B8. Double White Lines	0%	0%	-5%	0%	0%	0%	0%	0%	0%	0%
B9. High Visibility Markings*4	-40%	-40%	-40%	0%	0%	0%	0%	-17%	0%	0%
B10. Village Gateways Physical treatment	-27%	-27%	-27%	-27%	-27%	-27%	-27%	-27%	-27%	-27%
B10. Village Gateways - Between physical treatment	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-3%	-3%	-3%
B10. Village Gateways Signs and Markings	-27%	-27%	-27%	-27%	-27%	-27%	-27%	-27%	-20%	-20%
B10. Village Gateways - Between signs and Markings	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-3%	-3%	-3%
B11. Road Studs*4	-40%	-40%	-40%	0%	0%	0%	0%	-17%	0%	0%
B12. Legacy heritage marking removal*1*2	-17%	-17%	-17%	0%	-17%	0%	0%	-17%	-17%	-17%

*1 - Improve delineation countermeasure - Junction and Pedestrian Crossing not impacted. These facilities are impacted by facility specific Improving Quality countermeasures
*2 - Chevron alignment signs impact operating speeds so affects collision types other than Run-off
*3 - VAS signs impact operating speeds so affect collision types other than the targeted road configuration
*4 - Assumed spot based treatment as opposed to every 100m

The change in Star Rating Score (SRS) is based upon a representative 100m section to which the treatment is applied and will only be effective where a collision type is present. For example, a Junction SRS reduction will only be applied to 100m where both the collision type and a Junction are present. The percentage reduction in SRS is also relative to the reduction in estimated Fatal and Serious Injury for each collision type within the respective 100m.

Click to return to engineering measures matrix

WCH Facilities

C1 - New / improved Footways

Description

Where pedestrian demand and desire lines exist, footways should be provided. They can provide crucial links to facilities and local demand generators.

Provision of suitable crossing locations should be assessed when providing new or improving existing footways. At grade crossing facilities on pedestrian desire lines are generally preferred as they provide the most direct route, however, where this is not possible, footbridges / subways can be provided.

Where new footways are introduced, these should be included within routine maintenance programmes to ensure that they are kept free of vegetation, and kept clean and attractive to encourage use.

In rural areas where pedestrian related collisions have been identified and no facilities are present, a new footway could result in a reduction in collisions with pedestrians.

Description (continued)

Depending on the environment, it may also be necessary to separate the footway and the road, for example in areas where there is a greater density of traffic or high speeds; this can be done using physical measures or by providing an appropriate margin strip between the footway and the carriageway.

Pedestrian guardrail can be used, where suitable, to guide pedestrians towards formal crossing points or away from potential hazards, however it should only be used where there are no other feasible options.

Identified risk / collision type

Collisions involving pedestrians, caused by inadequate pedestrian facilities.

Associated (technical) guides and standards

GG 142 Walking, cycling and horse-riding assessment and review

CD 143 Designing for walking, cycling and horse-riding

CD 239 Footway and cycleway pavement design

DfT LTN 2/09 Pedestrian Guard-railing

Traffic Signs Manual Chapter 6 Traffic Control

BS 7818 Specification for pedestrian restraint systems in metal

CD 377 Requirements for road restraint systems

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0
Motorcyclists	0
Cyclists	0
Pedestrians	0.5 – 1.1

Click to return to engineering measures matrix

C2 - Facilities for Cycle Traffic

WCH Facilities

Description

Cycle facilities on and off carriageway are intended to provide cycle traffic with an alternative route from the main traffic lanes and reduce the risk of conflict with other road users. They can also raise awareness to road users of the likelihood of cyclists within the area.

There are a number of examples of cycle facilities including:

- Segregated cycle track (may be used in conjunction with separate footway provision)
- Mandatory or advisory on carriageway cycle lanes
- Segregated on carriageway cycle lane (for example light segregation)
- Shared footway / cycleway

Cycle facilities can also be provided on the approach to, and through, junctions to give

Description (continued)

priority to cyclists and allow safer movements through the junction.

Consideration is required when introducing cycle facilities to ensure that it is the most appropriate facility for the environment. For instance, providing on or off carriageway cycle facilities with insufficient width can introduce new hazards to either cyclists or other road users.

DMRB CD 143 (Designing for walking, cycling and horse-riding) and CD 195 (Designing for cycle traffic) provide in depth guidance on what the most appropriate provision should be and detail how to design effective facilities for cyclists.

Identified risk / collision type

Collisions involving cyclists that may result from a lack of, or inadequate, on or off carriageway cycle facilities.

Associated (technical) guides and standards

GG 142 Walking, cycling and horse-riding assessment and review

CD 143 Designing for walking, cycling and horse-riding

CD 195 Designing for cycle traffic

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0 – 0.7
Motorcyclists	0 – 0.2
Cyclists	1 – 3.2
Pedestrians	0 – 0.5

Click to return to engineering measures matrix

WCH Facilities

C3 - Equestrian Facilities

Description

A number of methods can be used in order to improve equestrian facilities. Guidance states that where practicable, horse-riders should be routed away from the immediate vicinity of roads. However, where road and / or verge width permits, space could be reallocated for horse-riders to provide them with a segregated off-carriageway route. Where equestrian routes meet high speed roads, a bridleway bridge may be necessary so that horse-riders can cross safely.

Where there is sufficient equestrian demand and vehicle speeds and carriageway widths are appropriate, a 'Pegasus crossing' could be considered. Often Pegasus crossings include a fenced holding area and a wider crossing, so that horses crossing the road are further away from traffic than pedestrians and cyclists. It is also recommended that high friction surfacing on the carriageway is provided to prevent the horses from slipping.

Description (continued)

Signs such as TSRGD diagrams 550.1 and 550.2 can also be used to offer advance warning to other road users that horse-riding occurs on this route.

On roads with an 85th percentile speed of above 50mph, serious consideration should be given to the introduction of speed reduction measures before installing stand-alone crossings.

Identified risk / collision type

An above average number of collisions involving horse-riders, caused by inadequate facilities.

Associated (technical) guides and standards

GG 142 Walking, cycling and horse-riding assessment and review

CD 143 Designing for walking, cycling and horse-riding

Traffic Advisory Leaflet 3/03 - Equestrian Crossings

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

WCH Facilities

C4 - Road Crossings and Islands / Refuges

Description

There are a number of potential pedestrian crossings that can be considered:

- Uncontrolled / informal crossings
- Zebra crossings
- Puffin crossings
- Pegasus crossings (designed to be used by horse-riders, cyclists and pedestrians)
- Toucan crossings (designed to be used by cyclists and pedestrians together)
- Parallel crossings (designed to be used by cyclists and pedestrians alongside each other)

Where it is proposed to introduce a controlled crossing, a sufficient volume of users are necessary to justify delays to traffic. An infrequently used crossing can result in regular road users becoming complacent about not needing to stop

Description (continued)

at the crossing, which can result in road users failing to stop when a pedestrian has right of way.

Refuge islands can be provided in order to provide a safe place for pedestrians to wait whilst crossing the carriageway and to reduce the distance to be crossed in one movement. This can be particularly useful in areas with a higher than average number of less mobile pedestrians. Careful design is required as they can become obstacles for approaching road users and limit the room for vehicles and cyclists.

New or improved crossing facilities can be used in conjunction with other measures, such as warning signs and central hatching.

Identified risk / collision type

Collisions involving pedestrians, cyclists and horse-riders.

Associated (technical) guides and standards

Traffic Signs Manual Chapter 6 Traffic Control

CD 123 Geometric design of at-grade priority and signal-controlled junctions

CD 116 Geometric design of roundabouts

CD 143 Designing for WCH

CD 377 Requirements for road restraint systems

Traffic Advisory Leaflet 5/05 Pedestrian Facilities at Signal Controlled Junctions

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0
Motorcyclists	0
Cyclists	0
Pedestrians	0 – 3.1

Click to return to engineering measures matrix

WCH Facilities Treatments – Star Rating Score Impact Matrix

The percentage impact on the Star Rating Score in the table below is provided for a representative 100m location. It is important to consider these impacts relative to the Fatal and Serious Injury (FSI) profile in the Route Review Tool which provides an estimate of FSI by collision type, effectively providing an indication of the scale of the treatment opportunity.

For example, if the FSI profile indicates there are two 'Pedestrian crossing the inspected road' FSIs at a location, then providing a Puffin crossing without refuge (C4) can be expected to reduce these by 96%, which equates to 1.92 FSIs.

Engineering Measures	Vehicle Star Rating Score Impact	Motorcyclist Star Rating Score Impact	Pedestrian Star Rating Score Impact			Cyclist Star Rating Score Impact			
	Run-Off LOC Passenger-Side	Run-Off Passenger-Side	Along	Crossing Inspected Road	Crossing Intersecting Road	Along	Junction	Run-Off	Crossing
C1. Footway - Adjacent to the Road	0%	0%	-46%	0%	0%	0%	0%	0%	0%
C1. Footway - 1m to 3m from road	0%	0%	-66%	0%	0%	0%	0%	0%	0%
C1. Footway - 3m from road	0%	0%	-87%	0%	0%	0%	0%	0%	0%
C1. Footway with road restraint system	0%	0%	-97%	0%	0%	0%	0%	0%	0%
C2. Cycle Facilities (On road cycle lane)	0%	0%	0%	0%	0%	-60%	-17%	0%	0%
C2. Cycle Facilities (Off Road Track)	0%	0%	0%	0%	0%	-95%	-17%	0%	0%
C2. Cycle Facilities (Shared)	0%	0%	-46%	0%	0%	-92%	-17%	0%	0%
C2. Cycle Facilities (VRS Off Road Track)*1	-80%	-50%	0%	0%	0%	-100%	-17%	-29%	0%
C4. Pedestrian bridge or underpass (through road)	0%	0%	0%	-100%	0%	0%	0%	0%	-40%
C4. Puffin or toucan crossing with a refuge (through road)	0%	0%	0%	-98%	0%	0%	0%	0%	-40%
C4. Puffin or toucan crossing without a refuge (through road)	0%	0%	0%	-96%	0%	0%	0%	0%	-40%
C4. Raised zebra with a refuge (through road)	0%	0%	0%	-80%	0%	0%	0%	0%	0%
C4. Zebra crossing with a refuge (through road)	0%	0%	0%	-67%	0%	0%	0%	0%	0%

*1 - Assumed new VRS for footway protection would provide protection for motorised traffic.

Click to return to engineering measures matrix

Engineering Measures	Vehicle Star Rating Score Impact	Motorcyclist Star Rating Score Impact	Pedestrian Star Rating Score Impact			Cyclist Star Rating Score Impact			
	Run-Off LOC Passenger-Side	Run-Off Passenger-Side	Along	Crossing Inspected Road	Crossing Intersecting Road	Along	Junction	Run-Off	Crossing
C4. Raised zebra without a refuge (through road)	0%	0%	0%	-60%	0%	0%	0%	0%	0%
C4. Refuge Island (through road)	0%	0%	0%	-50%	0%	0%	0%	0%	0%
C4. Zebra crossing without a refuge (through road)	0%	0%	0%	-33%	0%	0%	0%	0%	0%
C4. Pedestrian bridge or underpass (side road)	0%	0%	0%	0%	-100%	0%	0%	0%	0%
C4. Puffin or toucan with a refuge (side road)	0%	0%	0%	0%	-98%	0%	0%	0%	0%
C4. Puffin or toucan without a refuge (side road)	0%	0%	0%	0%	-95%	0%	0%	0%	0%
C4. Raised zebra with a refuge (side road)	0%	0%	0%	0%	-80%	0%	0%	0%	0%
C4. Flush crossing with a refuge island (side road)	0%	0%	0%	0%	-70%	0%	0%	0%	0%
C4. Zebra crossing with a refuge (side road)	0%	0%	0%	0%	-67%	0%	0%	0%	0%
C4. Raised zebra without a refuge (side road)	0%	0%	0%	0%	-60%	0%	0%	0%	0%
C4. Zebra crossing without a refuge (side road)	0%	0%	0%	0%	-33%	0%	0%	0%	0%
C4. Flush crossings without a refuge (side road)	0%	0%	0%	0%	-98%	0%	0%	0%	0%
C4. Refuge Island (side road)	0%	0%	0%	0%	-50%	0%	0%	0%	0%

*1 - Assumed new VRS for footway protection would provide protection for motorised traffic.

The change in Star Rating Score (SRS) is based upon a representative 100m section to which the treatment is applied and will only be effective where a collision type is present. For example, a Junction SRS reduction will only be applied to 100m where both the collision type and a Junction are present. The percentage reduction in SRS is also relative to the reduction in estimated Fatal and Serious Injury for each collision type within the respective 100m.

Click to return to engineering measures matrix

Speed Policy & Enforcement

D1 - Speed Limit Reduction / Strategy

Description

A speed limit strategy for a route can be used to ensure greater consistency of speed limits. While this is generally linked to lower speed limits, there may be situations where the existing speed limit is found to be inappropriately low, and ineffective, resulting in a need to raise the speed limit.

Lower speed limits can typically be implemented in conjunction with other treatment measures, either throughout the full length or on specific sections of a route.

Lower speed limits can have a positive impact on the safety record of a route by reducing the number of collisions, reducing the severity of collisions, reducing involvement of non-motorised users and / or incidences of loss-of-control and T-bone collisions. When considering a lower speed limit for a route, it is necessary to ensure it is appropriate and balances road safety and the needs of strategic through traffic.

Description (continued)

Speed reduction measures should also consider the potential for increased journey time reliability and driver confidence, but also the possible increase to overall journey times and impact on network efficiency. Physical measures combined with enforcement may be considered where the road environment does not naturally self-regulate the speed limit. The scope for effective enforcement should be considered and discussed with stakeholders during design.

A Traffic Order is required to change a speed limit, therefore early consultation with the police and other stakeholders is essential in ensuring that the scheme is supported. The appropriate regional traffic team should also be contacted to ensure that the order can be implemented in line with the project timescales.

Advisory speed limits can be used in some situations, such as on the approach to sharp bends.

Identified risk / collision type

Speed related collisions.

Associated (technical) guides and standards

Traffic Advisory Leaflet 2/06 Speed Assessment Framework

DfT Circular 01/2013 Setting Local Speed Limits

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.2 - 0.4
Motorcyclists	0.2 - 0.4
Cyclists	0.2 - 0.4
Pedestrians	0.3 - 0.4

Click to return to engineering measures matrix

D2 - Spot Cameras

Description

Spot speed cameras can be used to enforce speed limits, including variable mandatory speed limits on Smart Motorways and at an individual location, by monitoring the speed of vehicles when in view of the camera. Spot speed cameras can either be fixed or mobile and should be used in combination with other route treatment measures.

When the camera has detected a vehicle travelling above the posted speed limit, a photograph is taken which is then reviewed by a law enforcement officer and an infringement notice issued to the registered owner of the vehicle. Spot cameras can also be used to enforce compliance with traffic signals. Traffic light cameras can be triggered when a road user travels through a red signal, either by loops in the ground or by radar technology. Dual cameras are also now available that can be used to

Description (continued)

enforce both red light running and exceeding the speed limit.

Spot speed cameras are not a standalone measure and should only be used in conjunction with other measures, where there is a known history of speeding issues and / or speed related collisions. Along a route, spot speed cameras could be used in a series of villages that have a history of speed related collisions to provide a consistent route approach. Care should be taken to ensure that the installation of a camera at one location will not migrate the safety issue elsewhere along the route.

Some of the benefits associated with spot speed cameras include: a reduction in the instances of vehicles travelling in excess of the speed limit in the vicinity of the cameras and potentially an increased awareness amongst drivers that they are travelling in an area with a road safety issue.

Identified risk / collision type

Vehicles leaving the carriageway due to excessive speed, loss of control, speeding, overtaking and incidents involving red light running.

Associated (technical) guides and standards

CHE Memo 411/17 Use of Speed Cameras on the SRN

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.2
Motorcyclists	0.3
Cyclists	0.1
Pedestrians	0.1

Click to return to engineering measures matrix

Speed Policy & Enforcement

D3 - Average Speed Enforcement Cameras

Description

Average Speed Enforcement Cameras (ASECs) are a route-based road safety treatment that can be used to enforce speed limits along a route by monitoring a vehicle's average speed. The technology can also be used to monitor journey times, bus lane enforcement and for congestion charging.

ASEC schemes consist of cameras in at least two locations. Each vehicle is detected by both an 'entry camera' and an 'exit camera' on a section of road, with a time-stamped photo taken of each vehicle as it enters into the area covered by each camera. Automatic Number Plate Recognition (ANPR) software checks that the vehicle has not exceeded the speed limit, based on the time stamps and the distance between the cameras. If an infringement has occurred, then a local law enforcement official will manually confirm the contravention before an infringement notice is issued to the registered vehicle owner.

Description (continued)

ASECs are considered a long term, permanent solution to reduce speeds and / or ensure compliance with the posted speed limit. They can have greatest impact where there are speed-related collisions spread out along a route or where reduced speeds could have a positive impact on other types of collisions.

The benefits of an ASEC scheme can include a reduction in the number of collisions and casualties along a route, improved journey reliability, a positive impact on driver confidence and improvements to traffic flow and air quality. The systems can also be used to enforce temporary speed limits during long term roadworks.

In the future, these enforcement camera systems may also be able to detect use of 'red x' lanes, mobile phones, poor control of vehicles and failure to wear a seatbelt.

Identified risk / collision type

Vehicles leaving the carriageway, loss of control, speeding and overtaking.

Associated (technical) guides and standards

IAN 113/08 Temporary Automatic Speed Camera System for the Enforcement of Mandatory Speed Limits at Roadworks

CHE Memo 411/17 Use of Speed Cameras on the SRN

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.6
Motorcyclists	0.7
Cyclists	0.8
Pedestrians	0.4

Click to return to engineering measures matrix

Speed Policy & Enforcement

D4 - Enforcement bays / lay-bys

Description

Enforcement bays / lay-bys can be used to observe road users, help enforce speed limits and monitor vehicles by utilising ANPR cameras and similar technology.

Enforcement bays / lay-bys can be provided alongside the carriageway of the all-purpose dual carriageway trunk road and motorway network. Care should be taken not to introduce a re-entry risk for vehicles exiting enforcement bays / lay-bys.

Only authorised organisations can use them; this includes:

- The police
- Driver and Vehicle Standards Agency (DVSA)
- Traffic officers
- Other emergency services and maintenance / vehicle recovery organisations.

Description (continued)

To identify the need for observation platforms, consultation should take place during the early stages of the development of a project with representatives from appropriate authorities such as:

- the police force responsible for the route
- DVSA
- traffic officers
- maintaining organisation
- other interested parties

Identified risk / collision type

Speeding, vehicles leaving the carriageway, loss of control, and overtaking.

Associated (technical) guides and standards

CD 169 The design of lay-bys, maintenance hardstandings, rest areas, service areas and observation platforms

GD 300 Enhanced all-purpose dual carriageways

GD 301 Smart motorways

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0.1
Cyclists	0
Pedestrians	0

Click to return to engineering measures matrix

Speed Policy & Enforcement Treatments – Star Rating Score Impact Matrix

The percentage impact on the Star Rating Score in the table below is provided for a representatie 100m location. It is important to consider these impacts relative to the Fatal and Serious Injury (FSI) profile in the Route Review Tool which provides an estimate of FSI by collision type, effectively providing an indication of the scale of the treatment opportunity.

For example, if the FSI profile indicates there are two 'Vehicle Occupant Head-On Overtaking' FSIs at a location, then providing a Spot Camera (D2) can be expected to reduce these by 31%, which equates to 0.62 FSIs.

Engineering Measures	Vehicle Star Rating Score Impact						Cyclist Star Rating Score Impact			
	Run-Off LOC Driver-Side	Run-Off LOC Passenger -Side	Head-On LOC	Head-On Overtaking	Junction	Property Access	Along	Junction	Run-Off	Crossing
D1. Speed Limit Reduction 10 mph	-15%	-15%	-17%	-17%	-15%	-20%	-16%	-16%	0%	-16%
D1. Speed Limit Reduction over 10 mph	-30%	-30%	-33%	-33%	-30%	-38%	-29%	-29%	0%	-29%
D2. Spot Cameras*[1]	-29%	-29%	-31%	-31%	-29%	-35%	-21%	-21%	0%	-21%
D3. Average Cameras*[2]	-36%	-36%	-32%	-32%	-36%	-35%	-26%	-26%	0%	-26%
D4. Enforcement lay-bys*[3]	-9%	-9%	-9%	-9%	-9%	-11%	-5%	-5%	0%	-5%

*1 - 85th percentile speeds increased by 6 to 10 mph greater than the speed limit and applied one spot camera per typical layout. Base speeds are increased to reflect installation of a treatment at a location with a known speed compliance issue.
*2 - 85th percentile speeds increased by 6 to 10 mph greater than the speed limit and average camera applied for entire length of each typical layout. Base speeds are increased to reflect installation of a treatment at a location with a known speed compliance issue.
*3- 85th percentile speeds increased by 6 to 10 mph greater than the speed limit and applied one enforcement lay-by per typical layout. Base speeds are increased to reflect installation of a treatment at a location with a known speed compliance issue.

Click to return to engineering measures matrix

Engineering Measures	Motorcyclist Star Rating Score Impact							Pedestrian Star Rating Score Impact		
	Run-Off LOC Driver-Side	Run-Off Passenger-Side	Head-On LOC	Head-On Overtaking	Junction	Property-Access	Along	Along	Crossing Inspected Road	Crossing Intersecting Road
D1. Speed Limit Reduction 10 mph	-15%	-15%	-17%	-17%	-15%	-20%	-15%	-18%	-18%	-18%
D1. Speed Limit Reduction over 10 mph	-30%	-30%	-33%	-33%	-30%	-38%	-30%	-37%	-37%	-37%
D2. Spot Cameras*1	-29%	-29%	-31%	-31%	-29%	-35%	-29%	-17%	-17%	-17%
D3. Average Cameras*2	-36%	-36%	-32%	-32%	-36%	-35%	-36%	-25%	-25%	-25%
D4. Enforcement lay-bys*3	-9%	-9%	-9%	-9%	-9%	-11%	-9%	-4%	-4%	-4%

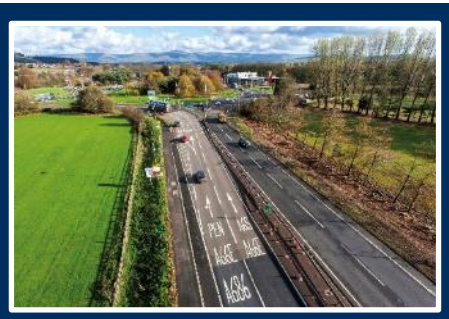
*1 - 85th percentile speeds increased by 6 to 10 mph greater than the speed limit and applied one spot camera per typical layout. Base speeds are increased to reflect installation of a treatment at a location with a known speed compliance issue.
*2 - 85th percentile speeds increased by 6 to 10 mph greater than the speed limit and average camera applied for entire length of each typical layout. Base speeds are increased to reflect installation of a treatment at a location with a known speed compliance issue.
*3- 85th percentile speeds increased by 6 to 10 mph greater than the speed limit and applied one enforcement lay-by per typical layout. Base speeds are increased to reflect installation of a treatment at a location with a known speed compliance issue.

The change in Star Rating Score (SRS) is based upon a representative 100m section to which the treatment is applied and will only be effective where a collision type is present. For example, a Junction SRS reduction will only be applied to 100m where both the collision type and a Junction are present. The percentage reduction in SRS is also relative to the reduction in estimated Fatal and Serious Injury for each collision type within the respective 100m.

Click to return to engineering measures matrix

Road Surfacing

E1 - High Friction Surfacing (HFS and High-PSV)



Description

At locations where there is evidence of loss of control collisions or skidding incidents, high friction road surfacing (HFS) or high Polished Stone Value (PSV) surfacing can be introduced, either specifically as part of a safety scheme or during a period of carriageway renewals. It is commonly used on the approaches to:

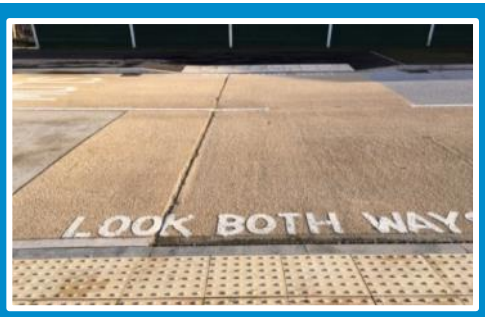
- Pedestrian, cycle & equestrian crossings
- Signalised and non-signalised junctions
- Roundabouts
- Sharp bends

There are a number of types of HFS and it is important to choose the most suitable one in order to achieve the greatest benefits and avoid costly maintenance. Most of these surfaces can also be given a colour to further emphasise to the road user the presence of the potential hazard and the need to reduce speed on approach.

Description (continued)

However, it is important to note that excessive application of coloured surfaces could reduce the impact of this warning feature due to familiarity. Consideration needs to be given to the termination point of HFS to ensure it is extended beyond the braking and acceleration zones.

As an alternative, new surface courses that have a high-PSV aggregate also provide improved skid resistance and can be used as an alternative to HFS. This may prove to be a more effective method at some sites where a coloured treatment is not required and may prove to have a longer lifespan than a HFS treatment. Further advice on this can be found in DMRB CD 236 Surface course materials for construction.



Identified risk / collision type

Loss of control, nose-to-tail collisions, turning conflicts, failure to stop at junctions and collisions involving skidding.

Associated (technical) guides and standards

CD 236 Surface course materials for construction

CS 228 Skidding resistance

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.5
Motorcyclists	0.5
Cyclists	0.3
Pedestrians	0

Click to return to engineering measures matrix

Road Surfacing

E2 - Coloured Surfacing

Description

Coloured surfacing can be used to increase the conspicuity, understanding and compliance of a road layout, providing positive road safety benefits. Coloured high friction surfacing can be used to encourage lower speeds on the approach to a hazard whilst also providing the safety benefits of high friction surfacing.

Coloured surfacing can be achieved through the use of paints or coloured asphalt; this section generally refers to the use of paints, however, similar results can be achieved using coloured asphalt.

There is a range of applications for coloured surface treatments, including highlighting the desired path of vehicles through a junction or section of carriageway, discouraging encroachment on to a particular area of carriageway and providing warning of a potential hazard ahead.

Description (continued)

The most appropriate method of applying colour to the carriageway should be selected to suit specific site conditions in order to maximise conspicuity and avoid excessive maintenance requirements in the future. For example, MMA (Methyl Methacrylate) paint is considered one of the most durable paints in heavy traffic and can therefore decrease the amount spent on maintenance. Consistency is also important when treating an entire route, ensuring the same colours are used for similar purposes throughout the route length.

It should also be noted that coloured surfaces are not a traffic sign or road marking, and are therefore only intended to be used to supplement other signs or road markings. They can be introduced either specifically as part of a safety scheme or as part of a carriageway renewal scheme.

Identified risk / collision type

Various, dependent upon the location where it is applied. Predominantly, loss of control, head-on incidents, junction turning or rear shunt collisions.

Associated (technical) guides and standards

CD 236 Surface course materials for construction

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0.1
Cyclists	0.1
Pedestrians	0.5

Click to return to engineering measures matrix

Road Surfacing

E3 - Re-surfacing

Description

Regular reviews of the carriageway surface are undertaken as part of the routine maintenance regime to ensure that the quality of the surface remains adequate. Where particular safety concerns have been raised, additional inspections should be undertaken.

Where the road surface has deteriorated, it can result in hazards forming such as potholes, which can lead to loss of control collisions. Poor quality road surface can also result in longer stopping distances, and therefore increase the number of nose to tail collisions.

At locations where the road surface has deteriorated, it is recommended that resurfacing is undertaken as part of carriageway renewals. This is unlikely to be funded through the same process as a road safety route treatment as it is likely to be a maintenance activity, unless improvements or upgrades are made.

Description (continued)

However, there may be scope to make use of the TTM provided for the maintenance works to undertake additional route treatment improvements.

The use of materials will be dependent on local factors such as environmental conditions and performance requirements.

When undertaking re-surfacing works, it should be ascertained if any other surfacing treatments can be applied simultaneously, and / or whether the road marking arrangements require alteration.

Whilst re-surfaced roads generally improve stopping distances and can reduce the risk of loss of control collisions, they may also result in an increase in vehicle speeds.

Identified risk / collision type

Loss of control collisions caused by poor road surface condition, nose to tail collisions caused by poor surface.

Associated (technical) guides and standards

CD 236 Surface course materials for construction

CS 228 Skidding resistance

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.2
Motorcyclists	0.2
Cyclists	0.1
Pedestrians	0.2

Click to return to engineering measures matrix

Road Surface Treatments – Star Rating Score Impact Matrix

The percentage impact on the Star Rating Score in the table below is provided for a representative 100m location. It is important to consider these impacts relative to the Fatal and Serious Injury (FSI) profile in the Route Review Tool which provides an estimate of FSI by collision type, effectively providing an indication of the scale of the treatment opportunity.

For example, if the FSI profile indicates there are two 'Vehicle Occupant Run-Off LOC Driver-Side' FSIs at a location, then Re-surfacing (E3) (where the existing surface has been identified as Medium condition) can be expected to reduce these by 17%, which equates to 0.34 FSIs.

Engineering Measures	Vehicle Star Rating Score Impact						Cyclist Star Rating Score Impact			
	Run-Off LOC Driver-Side	Run-Off LOC Passenger -Side	Head-On LOC	Head-On Overtaking	Junction	Property Access	Along	Junction	Run-Off	Crossing
E1. High Friction Surfacing*1	-29%	-29%	-29%	-29%	-29%	0%	-38%	-38%	-38%	-38%
E2. Coloured surfacing*2	-7%	-7%	-17%	0%	-17%	0%	-8%	-17%	-8%	-33%
E3. Re-surfacing*3	-17%	-17%	-17%	0%	0%	0%	-17%	0%	-20%	0%

Engineering Measures	Motorcyclist Star Rating Score Impact							Pedestrian Star Rating Score Impact		
	Run-Off LOC Driver-Side	Run-Off Passenger -Side	Head-On LOC	Head-On Overtaking	Junction	Property-Access	Along	Along	Crossing Inspected Road	Crossing Intersecting Road
E1. High Friction Surfacing*1	-38%	-38%	-38%	-38%	-38%	0%	0%	-29%	-29%	-29%
E2. Coloured surfacing*2	-7%	-7%	-17%	0%	-17%	0%	0%	-22%	-44%	-43%
E3. Re-surfacing*3	-20%	-20%	-20%	0%	0%	0%	0%	-8%	0%	0%

*1 - Skid resistance set to Medium for entire length of all typical layouts and then reverted to Good
*2 - Modelling has assumed use at Junctions and Crossings to improve Quality and on single carriageway roads Delineation was set to Poor then Adequate to represent central hatched area etc.
*3- Road Condition set to Medium for entire length of all typical layouts and then reverted to Good

The change in Star Rating Score (SRS) is based upon a representative 100m section to which the treatment is applied and will only be effective where a collision type is present. For example, a Junction SRS reduction will only be applied to 100m where both the collision type and a Junction are present. The percentage reduction in SRS is also relative to the reduction in estimated Fatal and Serious Injury for each collision type within the respective 100m.

Click to return to engineering measures matrix

Road Geometry

F1 - Slip Road Merge / Diverge Improvement

Description

Slip roads on the merges or diverges of dual carriageways or motorways are associated with a higher than average number of nose-to-tail collisions. This can be a particular issue on diverges as a result of motorists leaving a high speed route and failing to appropriately adjust their speed.

There are a number of enhancements that can be considered to improve their safety, including:

- Signalisation of the exit and entry points of the slip road, in order to create gaps and reduce conflicts on the slip roads and at decision points. The aim of this is to reduce the number of collisions occurring due to road users misjudging gaps. Signalisation can also improve the flow of vehicles, especially during peak periods;

Description (continued)

- Widened and / or lengthened diverge: this can increase the capacity of the slip road and reduce queuing, especially during peak periods;'
- Widening and / or lengthening the merge: this gives motorists a greater amount of time to adjust their speed as they join the main carriageway;
- Landscaping improvements and vegetation clearance: this can improve visibility for road users already on the trunk road as well as on the slip road;
- Resurfacing / high friction surfacing on the diverge: this reduces the likelihood of skidding for road users who may be decelerating quickly;
- Provision of additional lanes; and,
- Introduction of lane destination markings and improved traffic signing.

Any proposed improvements to slip roads should be in accordance with the requirements of the DMRB.

Identified risk / collision type

Rear shunts, lane discipline and side impact.

Associated (technical) guides and standards

CD 122 Geometric design of grade separated junctions

CD 127 Cross-sections and headrooms

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Road Geometry

F2 - Ghost Island Right Turn Lanes

Description

Ghost island junction layouts provide protection for right turning vehicles from the through flow of traffic by providing a dedicated lane in which turning vehicles can slow down and wait to make their manoeuvre. The addition of ghost islands to protect turning vehicles may help to reduce the collision rate at even minor junctions if they have a history of incidents.

However, if opportunities for overtaking are restricted either side of the junction, the installation of a ghost island road marking layout can pose road safety problems as the hatching, additional lane and widened carriageway could be used for overtaking and result in collisions with turning vehicles. At locations where this could be a problem, it may be more appropriate to install physical islands resulting in a single-lane dual carriageway layout.

Description (continued)

It is acknowledged that the installation of ghost island right turn lanes will be a higher cost measure and may also require additional land take. Consequently, it may not always be feasible to treat junctions on a route in this way where there is no history of personal injury collisions. However, where there are junctions on a route with personal injury collisions involving right turn related issues, consideration should be given to treating these sites in a consistent manner.

Within urban environments, increasing the width of the carriageway to accommodate a ghost island lane could make crossing more difficult. Care should be taken to mitigate this, potentially by introducing a refuge island.

Identified risk / collision type

Collisions involving right-turning movements.

Associated (technical) guides and standards

CD 123 Geometric design of at-grade priority and signal-controlled junctions

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0 - 0.1
Motorcyclists	0 - 0.1
Cyclists	0
Pedestrians	-0.1 - 0

Click to return to engineering measures matrix

Road Geometry

F3 - New / Improved Roundabout

Description

New Roundabouts

Evidence suggests that roundabouts can result in fewer and less severe vehicle collisions in comparison to other types of junctions (due to road users having to slow down ready to give way as they join the roundabout circulatory), although they can sometimes have negative impacts on pedestrian and cyclists collisions.

Another benefit of a roundabout is that it can reduce congestion at locations where the approach arms have similar volumes of traffic. However, if there is an uneven density and flow of vehicles then this can increase congestion and collisions due to road user frustration and road users diverting onto less safe roads.

Improvements to Roundabouts

There are a number of options that could improve the safety of existing roundabouts, including:

Description (continued)

- Altering entry path radius to further reduce speeds on the approach to the roundabout
- Vegetation clearance and street furniture de-cluttering to remove obstructions and improve visibility
- Installation of high friction surfacing on the entry path
- Introducing or improving lighting on the approach and within the roundabout
- Clearer signing and road markings
- Reduction in speed limit on approaches
- Adding new, or improving existing, crossing facilities and provisions for pedestrians and cyclists
- Yellow bar markings (when specific criteria are met)
- Provide VRS, avoiding furniture in front of it and / or abrupt changes in its alignment
- Signalisation.

Identified risk / collision type

Collisions at junctions

Collisions involving pedestrians, cyclists and horse-riders

Associated (technical) guides and standards

CD 116 Geometric design of roundabouts

Traffic Signs Manual, Chapters 3, 4 & 7

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.3
Motorcyclists	0
Cyclists	-0.1
Pedestrians	-0.2

Click to return to engineering measures matrix

Road Geometry

F4 - New / Improved Traffic Signals

Description

The main function of traffic signals is to separate opposing traffic movements so that they run at different time intervals in order to remove conflict between different traffic movements or pedestrian and / or cycle movements. Traffic signals are usually vehicle activated or connected to an urban traffic control system, but are not suitable where the 85th percentile speed on the approach road(s) is greater than or equal to 104kph (65mph).

One of the main benefits of traffic signals over roundabouts and priority junctions is that they can interrupt extremely heavy traffic flows to permit the crossing of minor movements. They are also generally preferred as a safer option for cyclists.

They can also be more advantageous to pedestrians as they provide priority over traffic rather than pedestrians relying on gaps or weaving through traffic.

Description (continued)

In general, new or improved traffic signals can provide a number of benefits, including reducing the number of side impact collisions and optimising vehicle flow. Therefore, where a route has a number of junctions with a historic collision problem and congestion issues, the provision of traffic signals along a route may provide a consistent approach that manages driver behaviour and speed, and reduces the number of collisions.

However, consideration needs to be given to the installation, placement and design of traffic signals as they can introduce rear shunt collisions and introduce congestion if improperly timed, both of which can be mitigated through good road and signals design. If traffic signals are used in conjunction with refuge islands then the carriageway lanes may need to be narrowed, which can result in conflicts between cyclists and other road users.

Identified risk / collision type

Collisions at junctions, side impact collisions.

Associated (technical) guides and standards

TS, TD, TA, TM 101 Traffic signalling systems (inspection and assessment)

CD 123 Geometric design of at-grade priority and signal-controlled junctions

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0 – 0.2
Motorcyclists	0 – 0.1
Cyclists	0 – 0.1
Pedestrians	0 – 0.1

Click to return to engineering measures matrix

Road Geometry

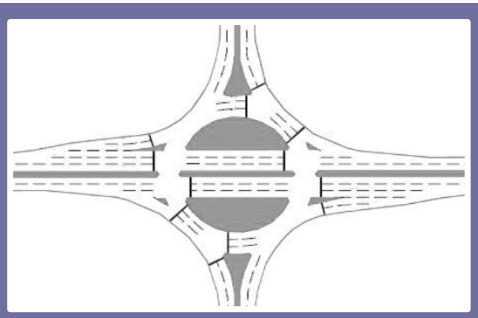
F5 - Hamburger roundabouts

Description

Hamburger roundabouts, also known as through-abouts, allow the major traffic movements to be removed from the potential conflict points on the circulatory. This is done by separating the major traffic flow from the circulating flow at the junction. This separation can provide increased capacity, but is less efficient in handling turning movements than a roundabout.

Hamburger roundabouts require additional infrastructure and traffic signal control compared to standard roundabout layouts.

Through routes on a through-about can require a variety of different design elements, such as signal-controlled junction, highway link and roundabout design, as well as advanced signal technology, to help control approach speeds and optimise capacity. As a result, an 'aspect not covered' departure is necessary to be submitted



Description (continued)

to the Overseeing Organisation for any proposed through-about so that all design elements can be considered holistically.

Due to the different layout of Hamburger roundabouts, which require right turning traffic to be in the left hand lane on the main road approaches, clear directional signage and carriageway markings should be provided both on the approaches to and at the junction. Map type signing can be particularly effective in illustrating the correct routing through the junction to drivers and riders, although at present this requires the use of a non-prescribed sign.

Non-prescribed signs require approval. Application for special authorisation should be made to the Department for Transport.

Identified risk / collision type

Collisions at roundabouts including side impact and rear end shunts on roundabout circulatory.

Associated (technical) guides and standards

CD 116 Geometric design of roundabouts

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Road Geometry

F6 - Visibility screens

Description

In some situations, excessive visibility on approach to junctions, or visibility between adjacent routes, can result in safety problems, collisions and injuries.

Where excessive roundabout approach speeds occur on dual carriageway or high speed single carriageway flared approaches, it can result in high entry speeds, potentially leading to overshoot, single vehicle and motorcyclist collisions. To address this, visibility to the right may be restricted until the approaching vehicle is within 15m of the give way line. This restriction requires drivers to slow down on approach to the roundabout so they can observe vehicles to the right and decide whether to enter the circulatory.

Screening can be used alongside other treatment measures that may have a positive impact on behaviour on approach and through the roundabout.

Description (continued)

Screening should be at least 2m high to ensure that drivers of vehicles with high cabs are not able to see over the screen.

Visibility screens can also be used between adjacent carriageways and between adjacent vehicle and vulnerable road user routes. In these situations screening can remove the potential for headlight glare / dazzling but may also reduce noise, visual impact of a route and the potential for stone chips / debris related incidents.

The type of visibility screen used should be considered on a case by case basis. If the screening could be struck by vehicles, a passively safe / self-righting screen could be used. In some situations established vegetation may be the best form of screening, although consideration of maintenance risks and expense should be considered.

Identified risk / collision type

High speed and junction overshoot collisions at roundabouts. Collisions involving headlight glare / dazzling.

Associated (technical) guides and standards

CD 116 Geometric design of roundabouts

CD 377 Requirements for road restraint systems

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0
Cyclists	0.1
Pedestrians	0.1

Click to return to engineering measures matrix

Road Geometry

F7 - Prohibition of Turns

Description

Where a route has had a number of collisions relating to a particular turning manoeuvre, physically preventing this manoeuvre should be considered. This could be achieved by closing a gap in the central reserve or installing physical infrastructure to restrict a movement.

Where physical treatments cannot be used, the issue could be treated by implementing a Traffic Regulation Order banning the manoeuvre.

Road users shall be informed through traffic signage and road markings that they are prohibited from making a turn. However, in the absence of regular enforcement, drivers may still choose to undertake illegal manoeuvres and, as such, the 'sign only' prohibition may result in a limited reduction in collisions.

Description (continued)

When banning a manoeuvre or closing a central reserve gap, care should be taken to ensure this does not create access problems, result in road users undertaking dangerous U-turn manoeuvres elsewhere, or simply transfer the problem to another junction further along the route.

A potential solution to this is to provide a roundabout near a prohibited turn, allowing road users to access that turn from the correct direction. Alternatively, this measure could be introduced where there is an existing nearby roundabout which would minimise the inconvenience to road users.

When considering prohibiting a manoeuvre, the impact on journey times should be taken into account and consultation with the appropriate stakeholders should be undertaken.

Identified risk / collision type

Turning conflicts at junctions and central reserve gaps.

Associated (technical) guides and standards

Traffic Signs Manual, Chapter 3, Section 4 Compulsory and Prohibited Movements

CD 123 Geometric design of at-grade priority and signal-controlled junctions

CD 116 Geometric design of roundabouts

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Road Geometry

F8 - Junction delineation and signing

Description

Adequate delineation and signing of a junction can help reduce the potential for collisions to occur on the immediate approaches or at the junction itself.

Delineation and signing can be used to direct and inform road users of the junction layout, direct them to it and make them aware of any specific hazards.

While delineation is often closely related to road markings (such as centre lines, lane markings and edge lines), it can also be improved through the use of reflectorised marker posts, road studs, hazard markers and signage.

Alone, or in combination, these interventions can aid drivers' understanding of the junction, improve their positioning and reduce the potential for collisions related to

Description (continued)

misunderstanding, hestitancy or as a result of not being aware of an approaching junction.

Signing can be used to warn of the junction ahead, inform users of lane arrangements and layout, or to warn of particular hazards, such as traffic signals or the presence of vulnerable road users.

Identified risk / collision type

Collisions at junctions

Associated (technical) guides and standards

CD 116 Geometric design of roundabouts

CD 122 Geometric design of grade separated junctions

CD 123 Geometric design of at-grade priority and signal-controlled junctions

Traffic Signs Manual Chapters 3 and 5

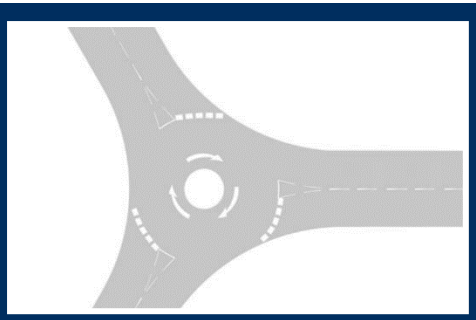
Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0
Motorcyclists	0
Cyclists	0
Pedestrians	0.3

Click to return to engineering measures matrix

Road Geometry

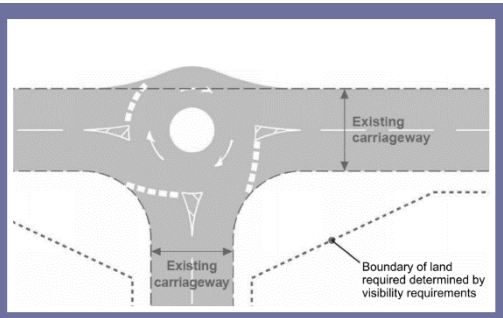
F9 - Mini roundabout



Description

Mini roundabouts can be used at locations where the existing priority junction layout is resulting in collisions, although there are a number of criteria that have to be met:

- The speed limit on all arms is 30mph or less
- The 85th percentile speed is less than 35mph
- It is not a new junction or direct site access for properties
- It is not on a dual carriageway
- It is not a location subject to U-turn manoeuvres
- Minimum flow values on each arm are met
- The mini roundabout has only three or four arms.



Description (continued)

Mini roundabouts may also be unsuitable on routes frequently used by HGVs and / or buses or where there are large volumes of cyclists, motorcyclists, or less experienced cyclists (such as close to schools).

At priority junctions where an existing problem (collisions, difficulty turning etc) exists and where traffic flows and / or turning proportions are similar on all arms, mini roundabouts can help users make turning manoeuvres more easily.

This can in turn maintain the flow of vehicles, reducing driver frustration. They can also help to reduce vehicle speeds, although additional speed reduction related treatment measures may need to be provided in order to help meet the criteria for installation.

Care should be taken to ensure pedestrian routes / desire lines and crossings are retained and / or enhanced.

Identified risk / collision type

Priority junction collisions

Associated (technical) guides and standards

CD 116 Geometric design of roundabouts

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0
Motorcyclists	0
Cyclists	0
Pedestrians	-0.1

Click to return to engineering measures matrix

Road Geometry Treatments – Star Rating Score Impact Matrix

The percentage impact on the Star Rating Score in the table below is provided for a representative 100m location. It is important to consider these impacts relative to the Fatal and Serious Injury (FSI) profile in the Route Review Tool which provides an estimate of FSI by collision type, effectively providing an indication of the scale of the treatment opportunity.

For example, if the FSI profile indicates there are two 'Motorcyclist Junction' FSIs at a location, then providing a Ghost Island Right Turn lane at a signalised junction (F2) can be expected to reduce these by 36%, which equates to 0.72 FSIs.

Engineering Measures	Vehicle Star Rating Score Impact						Cyclist Star Rating Score Impact			
	Run-Off LOC Driver-Side	Run-Off LOC Passenger -Side	Head-On LOC	Head-On Overtaking	Junction	Property Access	Along	Junction	Run-Off	Crossing
F2. Ghost Island Right Turn Lanes - 3 leg signalised*1	0%	0%	0%	0%	-25%	0%	0%	-25%	0%	0%
F2. Ghost Island Right Turn Lanes - 3 leg Unsignalised*1	0%	0%	0%	0%	-19%	0%	0%	-18%	0%	0%
F2. Ghost Island Right Turn Lanes - 4 leg signalised *1	0%	0%	0%	0%	-33%	0%	0%	-30%	0%	0%
F2. Ghost Island Right Turn Lanes - 4 leg Unsignalised*1	0%	0%	0%	0%	-30%	0%	0%	-31%	0%	0%
F3. New / Improved Roundabout*2	0%	0%	0%	0%	-75%	0%	0%	130%	0%	0%
F4. Signal Timing - Approach Speed*3	-37%	-37%	-34%	-34%	-37%	-30%	-25%	-25%	0%	-25%
F4. Signal Timing – Dwell*6 of Red*3	-33%	-33%	-34%	-34%	-33%	-39%	-25%	-25%	0%	-25%
F4. New / Improved Signals - 3 leg with turn lane*4	0%	0%	0%	0%	-31%	0%	0%	-33%	0%	0%
F4. New / Improved Signals - 4 leg with turn lane*4	0%	0%	0%	0%	-38%	0%	0%	-36%	0%	0%
F4. New / Improved Signals - 3 leg no turn lane*4	0%	0%	0%	0%	-25%	0%	0%	-27%	0%	0%
F4. New / Improved Signals - 4 leg no turn lane*4	0%	0%	0%	0%	-35%	0%	0%	-38%	0%	0%
F6. Visibility screens*3	-25%	-25%	-26%	-26%	-25%	-30%	-20%	-20%	0%	-20%
F8. Junction delineation and signing*5	0%	0%	0%	0%	-17%	0%	0%	-17%	0%	0%
F9. Mini-roundabout*2	0%	0%	0%	0%	-22%	0%	0%	0%	0%	0%

*1 - Providing Ghost Island turn lanes at existing 3 and 4 leg junctions
*2 - Converting existing priority junctions to roundabouts
*3 - Treatments impact operating speeds so affects collision types other than Junction
*4 - Upgrading existing priority junctions to signal control
*5 - Increasing the junction quality (conspicuity)
*6 - Dwell of red (or rest-on-red) refers to an additional phase added at signalised intersections so that an all-red phase is displayed when there is no traffic or ped demand.

Click to return to engineering measures matrix

Engineering Measures	Motorcyclist Star Rating Score Impact							Pedestrian Star Rating Score Impact		
	Run-Off LOC Driver-Side	Run-Off Passenger -Side	Head-On LOC	Head-On Overtaking	Junction	Property-Access	Along	Along	Crossing Inspected Road	Crossing Intersecting Road
F2. Ghost Island Right Turn Lanes - 3 leg signalised*1	0%	0%	0%	0%	-36%	0%	0%	0%	9%	9%
F2. Ghost Island Right Turn Lanes - 3 leg Unsignalised*1	0%	0%	0%	0%	-15%	0%	0%	0%	9%	9%
F2. Ghost Island Right Turn Lanes - 4 leg signalised *1	0%	0%	0%	0%	-38%	0%	0%	0%	8%	8%
F2. Ghost Island Right Turn Lanes - 4 leg Unsignalised*1	0%	0%	0%	0%	-38%	0%	0%	0%	8%	8%
F3. New / Improved Roundabout*2	0%	0%	0%	0%	-15%	0%	0%	0%	31%	31%
F4. Signal Timing - Approach Speed*3	-37%	-37%	-34%	-34%	-37%	-30%	-37%	-24%	-24%	-24%
F4. Signal Timing - Dwell of Red*3*6	-33%	-33%	-34%	-34%	-33%	-39%	-33%	-24%	-24%	-24%
F4. New / Improved Signals - 3 leg with turn lane*4	0%	0%	0%	0%	-47%	0%	0%	0%	0%	0%
F4. New / Improved Signals - 4 leg with turn lane*4	0%	0%	0%	0%	-38%	0%	0%	0%	0%	0%
F4. New / Improved Signals - 3 leg no turn lane*4	0%	0%	0%	0%	-30%	0%	0%	0%	0%	0%
F4. New / Improved Signals - 4 leg no turn lane*4	0%	0%	0%	0%	-38%	0%	0%	0%	0%	0%
F6. Visibility screens*3	-25%	-25%	-26%	-26%	-25%	-30%	-25%	-20%	-20%	-20%
F8. Junction delineation and signing*5	0%	0%	0%	0%	-17%	0%	0%	0%	-17%	-16%
F9. Mini-roundabout*2	0%	0%	0%	0%	-38%	0%	0%	0%	18%	18%

*1 - Providing Ghost Island turn lanes at existing 3 and 4 leg junctions
*2 - Converting existing priority junctions to roundabouts
*3 - Treatments impact operating speeds so affects collision types other than Junction
*4 - Upgrading existing priority junctions to signal control
*5 - Increasing the junction quality (conspicuity)
*6 - Dwell of red (or rest-on-red) refers to an additional phase added at signalised intersections so that an all-red phase is displayed when there is no traffic or ped demand.

The change in Star Rating Score (SRS) is based upon a representative 100m section to which the treatment is applied and will only be effective where a collision type is present. For example, a Junction SRS reduction will only be applied to 100m where both the collision type and a Junction are present. The percentage reduction in SRS is also relative to the reduction in estimated Fatal and Serious Injury for each collision type within the respective 100m.

Click to return to engineering measures matrix

G1 - Single Lane Widening - No Additional Lanes

Description

Reduced lane widths can have a negative impact on road safety by forcing vehicles closer to the edge of carriageway (which could be bordered by kerbs, loose verge, pedestrian and cyclist facilities etc.) or closer to lane separation road markings and other vehicles. This can be a particular issue on narrow bends as it can result in vehicles straying into the opposing vehicular lane resulting in head-on collisions. In urban areas narrow lanes can result in cyclists or pedestrians being at risk of being struck by passing vehicles.

Widening the lane width, particularly on the approach to a bend, can increase the time available to road users to adjust their steering input.

Description (continued)

Care needs to be taken to ensure that providing wider lanes does not result in an increase in vehicle speeds.

In order to reduce the potential for increased vehicle speeds, single lane widening can be combined with other measures, such as improved signing, high friction surfacing, Where-You-Look-Is-Where-You-Go, vegetation clearance and educational measures.

Identified risk / collision type

Head on collisions on reduced lane widths

Loss of control collisions on reduced lane widths.

Associated (technical) guides and standards

CD 109 Highway link design

CD 226 Design for new pavement construction

CD 127 Cross-sections and headrooms

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.3 – 0.6
Motorcyclists	0.2 – 0.5
Cyclists	0 – 0.1
Pedestrians	-0.1 - 0

Click to return to engineering measures matrix

Lane Treatments

G2 - Wide Single 2+1 Carriageway

Description

A wide single 2+1 carriageway road consists of two lanes of travel in one direction and a single lane in the opposite direction. This provides overtaking opportunities in the two lane direction.

This layout can help to improve safety on sections of roads where there are few opportunities to overtake slow moving vehicles. Wide single 2+1 roads can only be installed on rural all-purpose single carriageway roads.

When introducing schemes of this type, care should be taken to ensure that road users are not encouraged to illegally overtake when travelling in the single-lane direction or to travel at excessive speeds. This can be done by providing sufficient overtaking opportunities in both directions (by regularly changing the direction of the two lane section) and avoiding situations where forward visibility is excessive. Opposing traffic flows shall be separated by a double white lining system.

Description (continued)

Wide single 2+1 carriageway layouts can often be retrofitted to existing wide single carriageway roads with relatively minor alterations and little or no widening.

Many restrictions apply regarding junctions, accesses, grade separation, gradient and maintenance, so it is important to consider the suitability of this measure on a scheme by scheme basis.

This measure may not be appropriate on routes that have existing or proposed lengths of dual carriageway nearby.

Identified risk / collision type

Poor overtaking manoeuvres due to a lack of appropriate overtaking opportunity.

Associated (technical) guides and standards

CD 109 Highway link design

CD 123 Geometric design of at-grade priority and signal-controlled junctions

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.2
Motorcyclists	0.2
Cyclists	-0.1
Pedestrians	-1

Click to return to engineering measures matrix

G3 - Climbing Lane

Description

A climbing lane is used in order for heavy and slow moving traffic to travel up a steep gradient without slowing other vehicles. To introduce a climbing lane, the route section should have a minimum distance of 500m at a gradient in excess of 2% (3% for dual carriageways). Care should be taken when introducing climbing lanes where the horizontal and / or vertical profile of the road is subject to changes.

While climbing lanes are generally provided on economic grounds, they can in some cases be used as a safety measure as they can create a safer overtaking environment and reduce road user frustration.

Climbing lanes shall include clear and legible signing and road markings, particularly at the start and end of the lane, to ensure that all road users are aware of the changing layout and to

Description (continued)

avoid the potential for different collision types to be introduced to a location.

Clear signing also ensures that the climbing lane operates as efficiently as possible. Opposing lanes shall be separated by a double white line road marking.

Desirable minimum stopping sight distances should be appropriate for the design speed of the road and shall be provided throughout the length of the climbing lane (including tapers).

Identified risk / collision type

Collisions involving inappropriate overtaking manoeuvres to pass slow moving vehicles.

Associated (technical) guides and standards

CD 109 Highway link design

CD 123 Geometric design of at-grade priority and signal-controlled junctions

CD 127 Cross sections and headrooms

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0.2
Cyclists	0
Pedestrians	-0.9

Click to return to engineering measures matrix

G4 - Narrowing / Lane Drop

Description

In some circumstances, narrowing the width of carriageway lanes provides a number of road safety benefits. It can act to slow the speed of vehicles, which can reduce the number of loss-of-control collisions and reduce the severity of injuries sustained. For routes with a higher than expected rate of pedestrian collisions, lane narrowing can also result in additional space for footways, as well as shorter pedestrian crossing distances.

Lane narrowing can be achieved by either physically altering the layout of the carriageway or through the use of road markings and surface treatments. Physically reducing the width of the carriageway is more costly, however there is a greater chance that this will change road user behaviour. Reducing carriageway lane widths through road markings and surface treatments may be considered 'artificial' by some road users and may have limited speed reduction benefits.

Description (continued)

Consideration should be given to all user groups when lane narrowing is investigated as a potential treatment measure. Cyclists can often feel pressured by any reduction of carriageway width; the needs of emergency vehicles (and potentially any abnormal vehicles that require access) will also require careful consideration.

A lane drop is where narrowing occurs to such an extent that the number of lanes decreases. This can assist in providing safer merges onto dual carriageways by preventing vehicles from overtaking within the merge area. However, this can have a negative impact on the capacity of the carriageway. Where lane drops are introduced they should be implemented with clear, legible signing to reduce the potential for late lane changes.

Identified risk / collision type

Collisions caused by inappropriate speeds or poor lane discipline.

Associated (technical) guides and standards

CD 109 Highway link design

CD 122 Geometric design of grade separated junctions

CD 127 Cross sections and headrooms

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1 – 0.2
Motorcyclists	0.1 – 0.2
Cyclists	0.1 – 0.2
Pedestrians	0 – 0.1

Click to return to engineering measures matrix

G5 - HGV Overtaking Bans

Description

Outside lane HGV overtaking bans on all-purpose dual carriageway roads and two-lane sections of motorway can be introduced when either the volume of HGVs or the speed differential between HGVs and other traffic are significant enough that they lead to longer overtaking lengths and congestion.

HGV overtaking bans are known to work most effectively on longer stretches of carriageways without junctions.

The rationale for this treatment measure is mostly economic, although HGV overtaking bans can also improve lane discipline and reduce road user frustration.

In order that the overtaking ban is applied only when it is required, and provides the greatest impact, it can be introduced at specific times of the day when traffic volumes and / or HGV traffic are at their peak.

Description (continued)

HGV overtaking bans do not necessarily gain support from all user groups and, as the introduction of this measure requires a Traffic Regulation Order, it is recommended that early discussions with the police and other stakeholders are undertaken to ensure there is support for the proposal.

Identified risk / collision type

Collisions involving inappropriate overtaking manoeuvres to pass slow moving HGV's.

Associated (technical) guides and standards

Traffic Regulation Order process

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Lane Treatments – Star Rating Score Impact Matrix

The percentage impact on the Star Rating Score in the table below is provided for a representative 100m location. It is important to consider these impacts relative to the Fatal and Serious Injury (FSI) profile in the Route Review Tool which provides an estimate of FSI by collision type, effectively providing an indication of the scale of the treatment opportunity.

For example, if the FSI profile indicates there are two 'Motorcyclist Head-On Overtaking' FSIs at a location, then providing a Wide Single 2+1 Carriageway (G2) can be expected to reduce these by 70%, which equates to 1.4 FSIs.

Engineering Measures	Vehicle Star Rating Score Impact						Cyclist Star Rating Score Impact			
	Run-Off LOC Driver-Side	Run-Off LOC Passenger -Side	Head-On LOC	Head-On Overtaking	Junction	Property Access	Along	Junction	Run-Off	Crossing
G1. Lane widening - greater than 0.5 m*1	-33%	-33%	-33%	0%	0%	0%	-33%	0%	-33%	0%
G1. Lane widening up to 0.5 m*2	-14%	-14%	-17%	0%	0%	0%	-14%	0%	-14%	0%
G2. Wide Single 2+1 Carriageway*3	4%	4%	-10%	-70%	0%	0%	2%	40%	-24%	435%
G3. Climbing Lane*3	4%	4%	-10%	-70%	0%	0%	2%	40%	-24%	435%
G4. Traffic Island narrowing*4	-15%	-15%	-15%	-15%	-15%	-18%	-13%	-13%	0%	-13%
G4. Visual Narrowing*5	-15%	-15%	-19%	-19%	-15%	-30%	-14%	-14%	0%	-14%

*1 - Modelled single carriageway only; DAP and Motorway should not have lanes less than 2.75 m
*2 - Modelled single carriageway; DAP and Motorway should not have lanes less than 3.25 m
*3 - Pedestrian and cyclist crossing significantly impacted by presence of 2+1 layout - additional facilities or measures to restrict crossing may be required
*4 - Added a traffic island to 100m of typical layout with limited impact. Providing more traffic islands within a smoothed length would increase the Smoothed Decimal impact. Measure impacts operating speeds so affects multiple collision types.
*5 - Modelled over entire length of single and DAP typical layouts which is why this provides greater Smoothed Decimal impact than traffic island. Measure impacts operating speeds so affects multiple collision types.

Click to return to engineering measures matrix

Engineering Measures	Motorcyclist Star Rating Score Impact							Pedestrian Star Rating Score Impact		
	Run-Off LOC Driver-Side	Run-Off Passenger -Side	Head-On LOC	Head-On Overtaking	Junction	Property-Access	Along	Along	Crossing Inspected Road	Crossing Intersecting Road
G1. Lane widening - greater than 0.5 m*1	-33%	-33%	-33%	0%	0%	0%	0%	-33%	-11%	0%
G1. Lane widening up to 0.5 m*2	-14%	-14%	-17%	0%	0%	0%	0%	0%	5%	0%
G2. Wide Single 2+1 Carriageway*3	4%	4%	-10%	-70%	0%	0%	-30%	2%	218%	20%
G3. Climbing Lane*3	4%	4%	-10%	-70%	0%	0%	-30%	2%	218%	20%
G4. Traffic Island narrowing*4	-15%	-15%	-15%	-15%	-15%	-18%	-15%	-13%	-5%	-7%
G4. Visual Narrowing*5	-15%	-15%	-19%	-19%	-15%	-30%	-15%	-13%	-13%	-13%

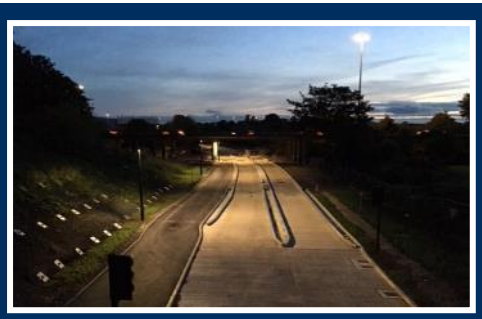
*1 - Modelled single carriageway only; DAP and Motorway should not have lanes less than 2.75 m
*2 - Modelled single carriageway; DAP and Motorway should not have lanes less than 3.25 m
*3 - Pedestrian and cyclist crossing significantly impacted by presence of 2+1 layout - additional facilities or measures to restrict crossing may be required
*4 - Added a traffic island to 100m of typical layout with limited impact. Providing more traffic islands within a smoothed length would increase the Smoothed Decimal impact. Measure impacts operating speeds so affects multiple collision types.
*5 - Modelled over entire length of single and DAP typical layouts which is why this provides greater Smoothed Decimal impact than traffic island. Measure impacts operating speeds so affects multiple collision types.

The change in Star Rating Score (SRS) is based upon a representative 100m section to which the treatment is applied and will only be effective where a collision type is present. For example, a Junction SRS reduction will only be applied to 100m where both the collision type and a Junction are present. The percentage reduction in SRS is also relative to the reduction in estimated Fatal and Serious Injury for each collision type within the respective 100m.

Click to return to engineering measures matrix

Multi-section Treatments

H - New / Replacement Street Lighting



Description

Where there is a high proportion of night time or dark collisions, street lighting can be introduced or upgraded as a road safety related measure along a route as a whole or at specific locations.

Street lighting may not always be the most appropriate measure for an identified darkness collision problem, with reflectorised bollards, edge line road markings, high visibility road markings and road studs potentially offering a more cost effective measure (both in terms of capital cost and maintenance) in many situations.

Before installing, upgrading or replacing street lighting, all proposals should be appraised using DMRB TA 501 Road lighting appraisal and TD 501 Road lighting design, which give requirements for the appraisal and design of lighting.

Description (continued)

If lighting columns are to be replaced, it is suggested that those vulnerable to being struck by an errant vehicle (in particular those on bends or at junctions) are replaced with passively safe columns (where appropriate) to reduce collision severity and / or are protected from being struck.

Installing street lighting is an expensive option, and involves on-going maintenance / power-supply costs. It also creates light pollution, making it less suitable for use in many (particularly rural) areas. It should therefore only be used where the design process shows it can have a positive benefit on road safety.

Identified risk / collision type

Night-time or dark collisions.

Associated (technical) guides and standards

DMRB Vol. 8, Section 3 – Lighting

TA 501 Road lighting appraisal

TD 501 Road lighting design

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0
Motorcyclists	0
Cyclists	0.1
Pedestrians	0.3

Click to return to engineering measures matrix

Multi-section Treatments

I - Passively Safe Fixtures

Description

Passively safe fixtures include items such as signposts and lighting columns. Passively safe versions of these items are designed to reduce the severity of injuries in the event of them being struck. Various designs are available, some of which absorb the energy of impacts through deflection, and some that are designed to shear off at the base when struck.

Passively safe fixtures should be introduced on high speed roads where there is a history of, or potential for, vehicles leaving the carriageway and striking infrastructure. Passively safe fixtures may be more cost effective and appropriate than a vehicle restraint system in some circumstances.

Technical guidance is available which outlines where and when passively safe signposts / lighting columns should be used.

Description (continued)

Care needs to be taken to avoid placing passively safe posts / columns where the deflection / failure of the post could cause a secondary collision, although any risk of this needs to be weighed against the primary risk of the initial collision. An example of this would be the central reserve of a dual carriageway where a struck passively safe column could fall into an opposing carriageway. Another example may be a location where pedestrians and other vulnerable road users may be present and could be struck by debris.

Before considering the installation of a passively safe feature, the first course of action should be to consider if the fixture is actually required or could be relocated to a safer location.

Identified risk / target collision type

Vehicles leaving the carriageway.

Associated (technical) guides and standards

DMRB Vol. 8 TD 89/08

BS EN 12767:2019 Passive safety of support structures for road equipment. Requirements and test methods.

CD 377 Requirements for road restraint systems

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.1
Motorcyclists	0.1
Cyclists	0
Pedestrians	0

Click to return to engineering measures matrix

Multi-section Treatments

J - Road Restraint Systems

Description

Road restraint systems include vehicle related features such as:

- Safety Barriers / Safety Barrier Terminals and Transitions (Vehicle Restraint System)
- Vehicle Parapets
- Crash Cushions

VRS are installed to reduce the risk of injury to vehicle occupants in the event of a vehicle leaving the carriageway. VRS are installed to contain and redirect an errant vehicle from impacting a hazard such as a lighting column, sign post, tree, or from entering an area of injury risk such as a steep embankment or cutting, a fall from height or a body of water.

VRS are generally considered to be a secondary safety feature, intended to minimise the risk and severity of injury – the removal of the hazard, relocating the hazard further from the carriageway and / or

Description (continued)

making the hazard 'passively safe' should all be explored as options before the inclusion or renewal of a VRS. Hazards should also, where possible, be combined to minimise the length of VRS installed.

The DMRB CD 377 (including the associated RRRAP process) should be followed when considering and designing a scheme. Schemes may not be focused on VRS, but the inclusion of new hazards (such as posts or lighting) will require the completion of a RRRAP and compliance with CD 377 to identify whether there is a need for VRS. DMRB CD 377 should be used by designers when addressing hazards and risks along an existing route.

It should be noted that motorcyclist specific protection is available, which can be fitted to new or existing safety barriers to reduce the risk and severity of injury to a motorcyclist when impacting a safety barrier.

Identified risk / collision type

Vehicles leaving the carriageway and impacting a hazard or entering an area of vehicle occupant risk.

Associated (technical) guides and standards

CD 377 Requirements for road restraint systems

CS 461 Assessment and upgrading of parapets

CD 127 Cross sections and headrooms

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.6 – 1.8
Motorcyclists	0.2 – 0.4
Cyclists	0
Pedestrians	0.1 – 0.3

Click to return to engineering measures matrix

Multi-section Treatments

K - Fencing

Description

Fencing includes both boundary fencing of various types and Pedestrian Restraint Systems (PRS) such as parapets and guardrails.

They are generally used to reduce the likelihood of two main collision types; where there is a risk to pedestrians, cyclists and horse-riders (conflict with vehicles, fall from height etc.) or animals straying into the carriageway from adjacent land.

Where there is a risk of animals straying into the carriageway from adjacent land, boundary fencing can be used to restrict access. This fencing can take many different forms depending on the type of animal(s) that are prevalent in a certain area.

Much of the National Highways network is already bordered by fencing, but it is important that this is maintained and that any new routes are constructed with fencing in place if a need is identified.

Description (continued)

Fencing can be used to restrict and direct pedestrian, cyclist and horse-rider access away from the carriageway and towards appropriate alternative routes or dedicated crossings. This reduces the likelihood of pedestrians, cyclists and horse-riders coming into conflict with vehicles.

It should be noted that where a fence is a post and rail construction, the horizontal rails should be located on the back of the post, i.e. away from the traffic so that, if struck, the rails sheer away from the vehicle. This reduces the potential for the horizontal rails to penetrate an errant vehicle in the event of the fence being struck.

Identified risk / collision type

Collisions involving cyclists, pedestrians and horse-riders entering an area of risk.

Animals straying into the carriageway.

Associated (technical) guides and standards

BS 1722: Fences (Various parts)

CD 377 Requirements for road restraint systems

MCHW Series 0300 Fencing

CD 143 Designing for walking, cycling and horse-riding

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0
Motorcyclists	0
Cyclists	0
Pedestrians	0

Click to return to engineering measures matrix

L - Vegetation Clearance

Multi-section Treatments

Description

At locations where there is limited or insufficient forward visibility, there is a greater risk of road users failing to react in time to a hazard. This can result in an increase in the number and severity of collisions.

Vegetation clearance can be one way of resolving this, as well as removing non-passively safe vegetation. Vegetation clearance may be conducted under routine maintenance or through a bespoke scheme designed to permanently alter the landscape to ensure a potential hazard, road layout or sign is not obscured. Where more significant problems are present, vegetation clearance may be required in conjunction with road realignment. In some locations it may be appropriate to consider clearing and replacing the existing vegetation type, and its inherent maintenance issues, with a lower growing plant species. This may help with safe operation of the

Description (continued)

road whilst maintaining vegetation cover to the adjacent verges.

Road layouts should aim to fit with the local landscape character and this will include reflecting the predominant vegetation patterns and species. This is important not only for reducing the impact of the road corridor on the landscape but also in benefiting the road user experience. Furthermore, it is understood that drivers often respond positively to natural landscapes and this may help reduce road user stress and in some cases improve road safety. Vegetation clearance should therefore only be targeted at locations where there is an identified safety problem.

Additionally, consideration should be given to the ecological and landscaping impacts, with specialists and stakeholders consulted.

Identified risk / collision type

Nose to tail impacts, junction collisions and those involving vehicles leaving the carriageway.

Associated (technical) guides and standards

LD 117 Landscape design

DMRB Sustainability and Environment

CD 123 Geometric design of at-grade priority and signal-controlled junctions

CD 116 Geometric design of roundabouts

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0
Motorcyclists	0
Cyclists	0.1
Pedestrians	0.4

Click to return to engineering measures matrix

M - New / Improved Lay-by Provision

Multi-section Treatments

Description

Lay-bys are designated stopping areas adjacent to the main carriageway that serve multiple safety and operational functions on the strategic road network.

They can provide safe refuge areas for vehicle breakdowns and emergencies, but also enable drivers to take rest breaks, reducing the potential for fatigue-related incidents.

They can also provide safe, off carriageway locations to enable activities to be undertaken that cannot be done while driving, such as eating, drinking or making a mobile phone call more safely.

Lay-bys can also be used by the emergency services and they reduce the risk of slow / stationary vehicles remaining on the main carriageway in the event of a breakdown or mechanical issue.

Description (continued)

When positioning new lay-bys, the following issues should be taken into consideration:

- Distance from existing lay-bys and service areas
- Proximity to major junctions or interchanges
- Historical breakdown data for the route
- Alternative facilities in the vicinity

For both existing and new lay-bys, the following requirements should be assessed:

- Lay-by type
- Need for lay-by
- Entry and exit tapers with adequate SSD
- Gradients and carriageway alignment
- Ground conditions and drainage capability
- Available highway boundary width
- Lighting requirements assessment
- Environmental constraints

- Collision history
- Presence of underground / overhead utilities

Identified risk / collision type

Collisions involving driver fatigue and vehicles stopped in inappropriate locations.

Associated (technical) guides and standards

CD 169 The design of lay-bys, maintenance hardstandings, rest areas, service areas and observation platforms

GD 300 Enhanced all-purpose dual carriageways and GD 301 - Smart motorways

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Multi-section Treatments

O - Treatment Options for Deer

Description

There are a number of routes across the network where deer collisions are a continuous or seasonal safety issue. There are a number of treatment options that can specifically target the reduction of collisions between vehicles and deer (or other animals) which include:

- High tensile road fencing - this aims not to stop deer crossings altogether but channels animals to safer crossing locations such as under passes.
- Provide / improve warning signs to advise road users of the presence of the deer. This can take the form of static signs (wild animals signs), VMS, or VAS.
- Vegetation clearance to ensure forward visibility is improved in areas where dense woodland is adjacent to the carriageway. This can improve the opportunity for a road user to identify a deer and slow down.

Description (continued)

- Optical wildlife warning reflectors - this works on the principle that lights from approaching cars will shine on a reflector which then reflects into the verge to alert deer to the traffic. This measure is only effective on routes with low volumes of traffic, as deer will become less frightened of the reflective light over time.
- Public awareness information / educational campaigns.
- Working with local stakeholders to manage the deer population to sustainable levels.
- A trial in Scotland has been undertaken in locations where deer are prominent using speed-activated deer warning signs, which flash red lights when approached by vehicles travelling above the sign posted speed limit.

Identified risk / collision type

Collisions involving vehicles striking deer or other animals in the road.

Associated (technical) guides and standards

www.thedeerinitiative.co.uk

www.deeraware.com

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Multi-section Treatments

P - Wrong Way Driving

Description

The term ‘wrong way driving’ is used to describe a vehicle being driven in the opposing direction (against the flow of traffic) along a one way street or carriageway. In order for this to occur, the vehicle must have first turned the wrong way onto the network.

While instances of wrong way driving on the SRN are rare, the consequences can be severe. When a collision involves wrong way driving, it is twice as likely to result in someone being killed or seriously injured. It is understood that most occurrences follow the misuse of slip roads or turning the wrong way from a side road at an at-grade dual carriageway junction.

To address the problem, the ability and potential for drivers to turn the wrong way onto the network must be reduced. To do this, National Highways have developed a wrong way driving mitigation toolkit.

Description (continued)

The mitigation toolkit provides a process to help National Highways and the supply chain prioritise sites, assess risk and select an appropriate level of mitigation at each site. This can include making improvements to existing junctions.

The toolkit can also be used to inform the design process of new schemes and major projects, and help ensure that the risk of wrong way driving is mitigated as far as is reasonably practicable.

Identified risk / collision type

Head-on collisions.

Associated (technical) guides and standards

Highways England Strategic Road Network Initial Report (2017)

CHE Memorandum 405/17 ‘Wrong Way Driving: Mitigation Toolkit’

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Multi-section Treatments

Q - Drainage improvements

Description

Adequate drainage infrastructure is essential for maintaining road safety and preventing water-related hazards. Drainage improvements encompass a range of interventions designed to effectively manage surface water runoff and prevent standing water on carriageways.

Improvements could be related to the existing drainage provision, or the addition of new drainage. Improvements could be made to:

- Surface water channels and gullies which collect and direct runoff
- Carrier drainage systems which transport water away from the highway
- Soakaways and infiltration systems which manage water discharge
- Cross-drains to prevent water accumulation at low points
- Filter drains to manage sub-surface water

Description (continued)

The implementation of effective drainage solutions can provide the following safety benefits:

- Minimises aquaplaning hazards by preventing surface water accumulation
- Reduces spray from vehicles, improving visibility for all road users
- Protects road surface integrity by preventing water ingress
- Maintains consistent skid resistance in wet conditions
- Reduces the risk of ice formation during cold weather

Drainage improvements could also benefit vulnerable road users, particularly on dedicated routes and at carriageway crossing locations.

Identified risk / collision type

Collisions on wet road surfaces, such as those resulting from aquaplaning. Slip, trip, fall collisions involving vulnerable road users.

Associated (technical) guides and standards

CG 501 Design of highway drainage systems

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Multi-section Treatments

R - Operational technologies

Description

Operational technologies comprise of dynamic traffic management systems that enable real-time control and communication with road users. These systems enhance safety through adaptive responses to changing road conditions, incidents and traffic flows. Examples of operational technologies include:

Variable Speed Limits

- Dynamically adjusted speed restrictions
- Helps maintain steady traffic flow and reduce stop-start conditions
- Enforced through automatic speed detection systems

Variable Message Signs displaying real-time information relating to:

- Upcoming hazards, incidents or road works
- Journey times and delays
- Weather warnings

Description (continued)

Lane management

- Dynamic lane closure capabilities for incident management
- Red X signals to close lanes during emergencies or maintenance
- Queue protection through advance warning systems
- Emergency area management for smart motorways

The effectiveness of operational technologies relies on collaboration of a number of systems, including stopped vehicle detection, central control room monitoring and management, CCTV and traffic monitoring systems, automated incident detection systems, weather monitoring and real-time traffic flow data.

Identified risk / collision type

Speed related collisions, weather related collisions, rear end shunt collisions when approaching a queue, collisions with vehicles exiting a lay-by, secondary collisions.

Associated (technical) guides and standards

GD 300 Enhanced all-purpose dual carriageways

GD 301 Smart motorways

Potential Impact on Star Rating

Treatment measure not currently able to be modelled in iRAP.

Click to return to engineering measures matrix

Multi-section Treatments

S - Vertical and horizontal deflection

Existing M6 Junction 10 layout prior to works starting

Description

Road geometry modifications can encompass strategic changes to both the horizontal alignment and vertical alignment of carriageways to enhance safety through improved design.

These modifications can range from minor adjustments to complete realignment.

Horizontal alignment adjustments can include:

- Smoothing of sharp bends to provide more consistent radii
- Improved superelevation through curves to better accommodate design speeds
- Enhanced visibility through bends by removing unnecessary curvature
- Standardisation of curve transitions using appropriate spiral lengths
- Elimination of compound curves and improved coordination between consecutive curves where practical.

New M6 Junction 10 layout after work has finished

Description (continued)

Vertical alignment adjustments can include:

- Reduction of steep gradients to improve vehicle control
- Enhancement of crest curves to increase stopping sight distance
- Improvement of sag curves for better drainage and driver comfort
- Coordination of vertical and horizontal curves to avoid visual distortions
- Modified approach gradients at junctions and roundabouts

Depending on the location, road geometry modifications can have an impact on all road users, and may have greatest impact on motorcyclists and cyclists.

Identified risk / collision type

Loss of control collisions

Associated (technical) guides and standards

CD 109 Highway link design

CD 192 The design of crossovers and changeovers

Potential Impact on Star Rating

User	Star Rating Impact
Vehicle Occupants	0.4 – 0.5
Motorcyclists	0.5 – 0.6
Cyclists	0.7 – 0.8
Pedestrians	0.4

Click to return to engineering measures matrix

Mid-section treatments – Star Rating Score Impact Matrix

The percentage impact on the Star Rating Score in the table below is provided for a representative 100m location. It is important to consider these impacts relative to the Fatal and Serious Injury (FSI) profile in the Route Review Tool which provides an estimate of FSI by collision type, effectively providing an indication of the scale of the treatment opportunity. For example, if the FSI profile indicates there are two 'Bicyclist Run-Off' FSIs at a location, then providing New street lighting (H) can be expected to reduce these by 20%, which equates to 0.4 FSIs.

Engineering Measures	Vehicle Star Rating Score Impact						Cyclist Star Rating Score Impact			
	Run-Off LOC Driver-Side	Run-Off LOC Passenger-Side	Head-On LOC	Head-On Overtaking	Junction	Property Access	Along	Junction	Run-Off	Crossing
H. New street lighting	0%	0%	0%	0%	-13%	0%	-20%	-20%	-20%	-20%
I. Passively Safe Systems*1	0%	-56%	0%	0%	0%	0%	0%	0%	-49%	0%
J. Road Restraint Systems - Concrete - Divided Cway*2	25%	-66%	0%	0%	0%	0%	0%	0%	-50%	0%
J. Road Restraint Systems - Concrete - Undivided Cway*2	-75%	-75%	0%	0%	0%	0%	0%	0%	-58%	0%
J. Road Restraint Systems - MC Friendly - Divided Cway*2	0%	-70%	0%	0%	0%	0%	0%	0%	-56%	0%
J. Road Restraint Systems - MC Friendly - Undivided Cway*2	-80%	-80%	0%	0%	0%	0%	0%	0%	-67%	0%
J. Road Restraint Systems - Metal - Divided Cway*2	0%	-70%	0%	0%	0%	0%	0%	0%	-45%	0%
J. Road Restraint Systems - Metal - Undivided Cway*2	-80%	-80%	0%	0%	0%	0%	0%	0%	-50%	0%
J. Road Restraint Systems - Wire Rope - Divided Cway*2	-25%	-74%	0%	0%	0%	0%	0%	0%	-45%	0%
J. Road Restraint Systems - Wire Rope - Undivided Cway*2	-85%	-85%	0%	0%	0%	0%	0%	0%	-50%	0%
J. Road Restraint Systems - Physical to Metal Median*3	-80%	-80%	0%	0%	0%	0%	0%	0%	-50%	0%
K. Fencing	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
L. Vegetation Clearance*4	0%	0%	0%	0%	-30%	0%	-30%	-30%	-14%	-30%
S. Horizontal deflection*5	-43%	-43%	-43%	-43%	-43%	-43%	-57%	-57%	0%	-57%
S. Vertical deflection*5	-38%	-38%	-38%	-38%	-38%	-38%	-51%	-51%	0%	-51%

*1 -Rural typical layouts modelled 300 m of removing Posts at 1-5 m to new hazard at 5-10 m. Urban typical layouts all Posts at 1-5 m replaced with Rigid Structure at 5-10m.
*2 - Installation of Road Restraint System on Divided and Undivided carriageway types modelled separately due to varying Driver Side configurations. For all Divided Carriageways it is assumed that existing Metal VRS is updated to the variant VRS. Where VRS is installed on the passenger side where a footway is present then the footway was modelled as being upgraded to VRS protected.
*3 - Modelled DAP layouts with Physical Median with Posts present to introduce Metal VRS in the Median (Driver Side) and Passenger Side.
*4 - Sight distance (obstruction removal) modelled through curvature and at Junctions.
*5 - Modelled on single urban layout, assumed measures introduced in each 100m. Measure impacts operating speeds so affects multiple collision types.

Click to return to engineering measures matrix

Engineering Measures	Motorcyclist Star Rating Score Impact							Pedestrian Star Rating Score Impact		
	Run-Off LOC Driver-Side	Run-Off Passenger -Side	Head-On LOC	Head-On Overtaking	Junction	Property-Access	Along	Along	Crossing Inspected Road	Crossing Intersecting Road
H. New street lighting	0%	0%	0%	0%	-13%	0%	0%	-20%	-20%	-20%
I. Passively Safe Systems*1	0%	-56%	0%	0%	0%	0%	0%	0%	0%	0%
J. Road Restraint Systems - Concrete - Divided Cway*2	-17%	-53%	0%	0%	0%	0%	0%	-48%	0%	0%
J. Road Restraint Systems - Concrete - Undivided Cway*2	-58%	-58%	0%	0%	0%	0%	0%	-48%	0%	0%
J. Road Restraint Systems - MC Friendly - Divided Cway*2	-33%	-59%	0%	0%	0%	0%	0%	-48%	0%	0%
J. Road Restraint Systems - MC Friendly - Undivided Cway*2	-67%	-67%	0%	0%	0%	0%	0%	-48%	0%	0%
J. Road Restraint Systems - Metal - Divided Cway*2	0%	-46%	0%	0%	0%	0%	0%	-48%	0%	0%
J. Road Restraint Systems - Metal - Undivided Cway*2	-50%	-50%	0%	0%	0%	0%	0%	-48%	0%	0%
J. Road Restraint Systems - Wire Rope - Divided Cway*2	0%	-46%	0%	0%	0%	0%	0%	-48%	0%	0%
J. Road Restraint Systems - Wire Rope - Undivided Cway*2	-50%	-50%	0%	0%	0%	0%	0%	-48%	0%	0%
J. Road Restraint Systems - Physical to Metal Median*3	-50%	-50%	0%	0%	0%	0%	0%	-95%	0%	0%
K. Fencing	0%	0%	0%	0%	0%	0%	0%	0%	-10%	-10%
L. Vegetation Clearance*4	0%	0%	0%	0%	-30%	0%	0%	-30%	-30%	-30%
S. Horizontal traffic calming*5	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%	-43%
S. Vertical traffic calming*5	-38%	-38%	-38%	-38%	-38%	-38%	-38%	-37%	-37%	-37%

*1 -Rural typical layouts modelled 300 m of removing Posts at 1-5 m to new hazard at 5-10 m. Urban typical layouts all Posts at 1-5 m replaced with Rigid Structure at 5-10m.
*2 - Installation of Road Restraint System on Divided and Undivided carriageway types modelled separately due to varying Driver Side configurations. For all Divided Carriageways it is assumed that existing Metal VRS is updated to the variant VRS. Where VRS is installed on the passenger side where a footway is present then the footway was modelled as being upgraded to VRS protected.
*3 - Modelled DAP layouts with Physical Median with Posts present to introduce Metal VRS in the Median (Driver Side) and Passenger Side.
*4 - Sight distance (obstruction removal) modelled through curvature and at Junctions.
*5 - Modelled on single urban layout, assumed measures introduced in each 100m. Measure impacts operating speeds so affects multiple collision types.

The change in Star Rating Score (SRS) is based upon a representative 100m section to which the treatment is applied and will only be effective where a collision type is present. For example, a Junction SRS reduction will only be applied to 100m where both the collision type and a Junction are present. The percentage reduction in SRS is also relative to the reduction in estimated Fatal and Serious Injury for each collision type within the respective 100m.

Case Study

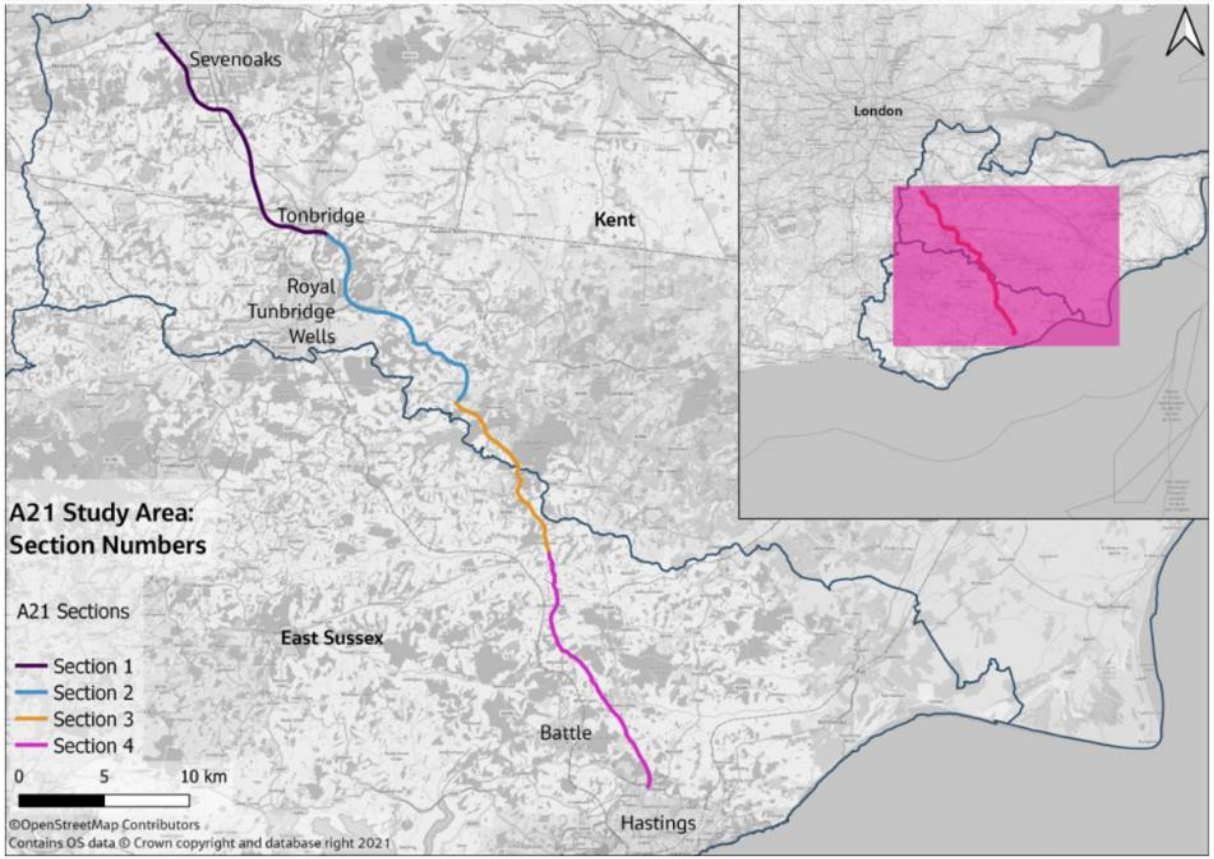
Introduction

The approach outlined in The Guide represents new ways of identifying, assessing and applying route treatment techniques to road safety problems. As the iRAP and Safe System aligned approach is relatively new, there is not an extensive list of route safety projects that have already adopted this approach. One example is the A21 Safety Package, which broadly followed the new approach.

A21 Safety Route Treatment Overview

The A21 between the M25 (Junction 5) in Kent and Hastings, East Sussex has previously been identified as a route having poor operational safety performance. The A21 is approximately 37 miles long, with approximately half of this distance being a dual carriageway (from the M25 J5 to Kippings Cross – 15.5 miles – and the 1.5 miles long Lamberhurst bypass) and the remaining sections being a single carriageway with a mix of rural and urban areas.

Figure 36: A21 location



The Route Strategy undertaken in 2016 and Route Option Assessment Report (OAR) in 2018 identified high-risk locations and potential mitigation measures. Funding for the A21 Safety Package was approved by the Department for Transport (DfT) in 2020 for an accelerated programme into RIS2 instead of RIS3.

The A21 has a historic collision problem. The study corridor had 1.57 collisions per km per year compared to 1.37 as an average for A Trunk Roads (2012-2016). The Fatal or Seriously Injured (FSI) history exceeded the national SRN average on all sections of the A21 study corridor. The collision rate per km for the A21 study area was 18.97 compared to 8.50 as an average for A Trunk Roads (National Incident Liaison Officers (NILO) record 2013 - 2017).

The A21 Safety Package developed interventions based on the Safe System principles, aligning to both UK Government and National Highways policies. To help identify higher risk locations on the A21, as well as model intervention success, the whole of the scheme extents were modelled using iRAP. At the time of writing this case study the scheme is still under development, with some treatments already being constructed, while others are in the design stage.

Figure 37: Aerial view of A21

A21 in iRAP

iRAP[1] was incorporated in the A21 Safety Package from the early development stage. It was used to identify a baseline, inherent safety risks and potential interventions to treat those risks. The model was used to establish the anticipated Star Rating improvement and reduction in expected KSI collisions. The iRAP was used in line with the following steps:

1) A21 baseline set up utilising the five year coding data requested from the Road Safety Foundation.
2) The iRAP trained team members reviewed the iRAP model and updated it to reflect any differences between the model and the actual A21 road. This included any schemes that could have been implemented between the survey period and 'now' and all recent surveys that occurred along the network (such as speed of traffic, flows etc.) so that the final baseline model best reflected the current layout and characteristics of the road.
3) Identify potential interventions through the analysis of the iRAP baseline model and proposed treatments (referred to as 'countermeasures' in iRAP). These were then assessed by the design team in terms of buildability and then proposed to the National Highways Project Sponsor.

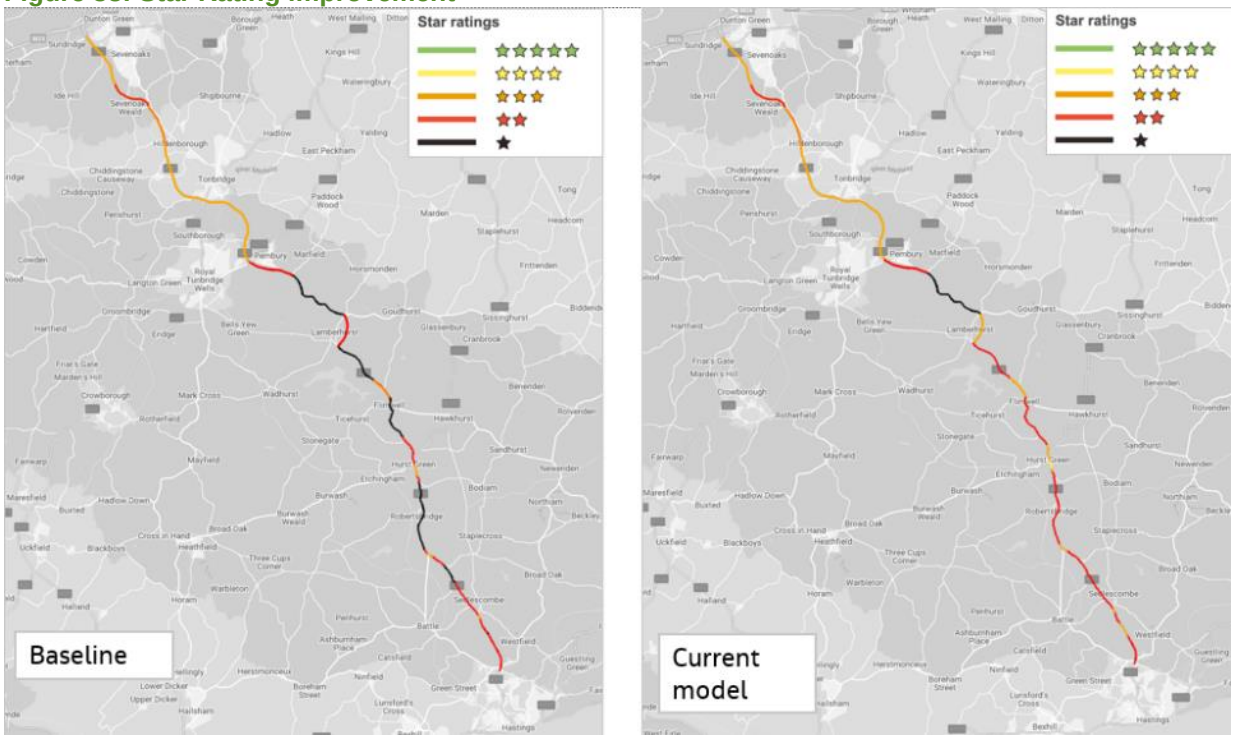
[1] Note that the Route Review Tool was not available for use at the time of this study, so the full iRAP model was used.

4) Any new interventions being considered were run within the iRAP ‘Demonstrator’ to identify the improvement in Star Rating that could be achieved.
5) As the scheme developed, all interventions were incorporated into the project model. This included all physical changes to the infrastructure as well as predicted impacts on the speed of vehicles (85th percentile as well as mean speed), traffic flows, and flows of vulnerable road users along and across the road.

Steps 3, 4 and 5 are continued as the scheme develops, and data such as traffic flows and vulnerable road user flows are updated if more current data becomes available. A final ‘after’ iRAP model will be completed as the project comes to an end, to identify the actual impact the A21 Safety Package has had on the network.

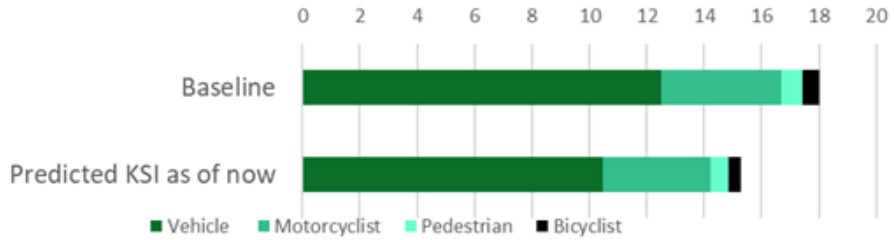
The expected Star Rating improvement is shown on Figure 5, with the Star Rating of 3 and above increasing from 45.4% to 56.0%.

Figure 38: Star Rating improvement



The baseline killed or seriously injured (KSI) rate on the network was established as 18.0 per year, while the KSI rate for the route (including all safety improvements as of January 2023) was modelled as 15.3, showing a reduction of 2.7 KSI per year (Figure 6).

Figure 39: Modelled KSI improvement of A21



Identification of A21 treatments

At the start of the study, a 'Gap analysis' was undertaken to identify the key types of interventions that would have a positive impact on road safety along the A21. The analysis concluded the following actions:

- Analysis which reviews previous interventions; undertake a Route Safety Review and prepare a scope of works for future interventions.
- Speed Limit Review aiming to reduce the number of changes in limit and improve consistency of speed limits through the whole of the A21 and appropriateness of limits for each location.
- Signage and Line Marking Review of the route including the previously identified intervention measures.
- A road user perception and behaviour review considering the previously proposed interventions to establish whether they are likely to deliver casualty reduction, including change in collision frequency and targeting to collision causes.

Following this, collision analysis was undertaken of the A21 study route to identify collision clusters (total number of collisions, collisions in darkness or not dry road surface, at lay-bys and with 'driver fatigue' as a contributory factor). Subsequently, conflict studies were undertaken at a number of locations; these consisted of 7-day video surveys to understand the 'real life' issues. The surveys also captured the traffic counts and conflicts identified with several sites also gathering data on pedestrian movements or operational speeds of vehicles. Analysis of the survey data and video footage led to the most relevant and beneficial solutions to improve road safety being proposed. Conflict studies were also undertaken at sites where stakeholders had identified a particular concern.

The results of speed surveys, the number, type and distribution of collisions, and comments received in respect of the A21 led to the proposal of a new speed limit strategy along the A21. The speed limit study focused on the southern part of the A21, from Lamberhurst to Hastings, where speed limit variability was identified. A speed limit assessment was undertaken to assess the actual speed of vehicles. This allowed the creation of a speed limit strategy for the A21 where the speed limits are aligned and consistent

along the whole length of the route. The proposed changes were estimated as being likely to increase journey times between Lamberhurst and Hastings by approximately 2 minutes. However, the proposed speed limit strategy has reduced the number of speed limit changes, provided a more consistent and less variable journey experience for drivers, and provided a consistent message of what is an appropriate speed when travelling through villages along the A21.
The following treatments have been incorporated / are within the design stage across the project, either as longer route treatments or localised (but consistent) interventions:

- A1 - General Traffic Signs
- A2 - Bend Ahead and Chevron Signs
- A3 - Vehicle Activated Signs
- A5 - Reflectorised Marker Posts / Bollards
- A7 - Reducing Sign Clutter
- B1 - Carriageway Text
- B3 - Lane Separation Marking Width
- B4 - Edge of Carriageway Markings
- B4a - Edge of Carriageway Markings- Raised Profile Markings
- B5 - Central Hatching
- B8 - Double White Lines
- B9 - High Visibility Markings
- B10 - Village Gateway
- B11 - Road Studs
- B12 - Legacy / heritage marking removal
- C1 - New / improved Footways
- C4 - Road Crossings and Road Crossings Islands / Refuges
- D1 - Speed Limit Reduction / Strategy
- D3 - Average Speed Enforcement Cameras
- E1 - High Friction Surfacing (HFS and High-PSV)
- E2 - Coloured Surfacing
- E3 - Re-surfacing
- F2 - Ghost Island Right Turn Lanes
- F3 - New / Improved Roundabout
- F4 - New / Improved Traffic Signals
- F7 - Prohibition of Turns
- F8 - Junction delineation and signing
- H - New / Replacement Street Lighting
- I - Passively Safe Fixtures
- J - Road Restraint Systems
- L - Vegetation Clearance
- Q - Drainage improvements

Figure 40: Marley Lane Vehicle Activated Sign

Safe System on A21

The Safe System approach seeks to achieve its goals through five components of action: safe roads, safe speeds, safe road users, post-collision care, and safe vehicles. The A21 Safety Package aligns mainly with three of these: safe roads, safe speeds, safe road users.

The safe roads component has been improved through the introduction of various infrastructure improvement treatments, from junction improvements, road signing and road marking review and improvements, provision of safer verges through passively safe signs and lighting columns as well as provision of vehicle restraint system and adding new and

improving existing facilities for vulnerable road users.

The safe speed component has been applied to the project through the scheme wide speed limit analysis that led to provision of more appropriate speed limits that are consistent and aligned along the whole length of the road.

The safe road users component has been applied to the A21 through the improvement of facilities for pedestrians and through the use of vehicle activated signs to influence driver behaviour when approaching junctions and schools.

Summary and next steps for A21 Safety Package

The A21 Safety Package project is still ongoing (January 2025), with some interventions already delivered but others still awaiting delivery or within the design and optioneering stage. The project team will continue working on improving safety along the A21, providing users with a predictable road environment, which encourages drivers / riders to adopt appropriate behaviours.

The A21 Safety Package project has been honoured and acknowledged on several occasions:

- National Highways Industry Awards 2023 – Winner
- The Chartered Institution of Highways & Transportation (CIHT) Road Safety Award 2023 – shortlisted
- CIHT Road Safety Award 2024 - Highly Commended
- Highways Awards Road Safety Scheme of the Year Award 2024 – shortlisted
- The Institute of Highway Engineers (IHE) Mercia Branch Award 2024 Team of the Year – shortlisted

Figure 41: National Highways Industry Awards 2023 – Winner

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