



# ERASER

## Road Authority Pilot and Feasibility study

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## Executive summary

This deliverable describes a draft version of a tool that has been developed within ERASER Work Package 3 (Road authorities pilot) to help European road authorities make decisions to improve the safety and 'self-explainingness' of their roads.

For this tool, the concept of self-explaining roads (SER) has been taken forward in relation to speed: the design of a road can provide explicit cues to road users about what the speed limit might be, and may also implicitly and intuitively evoke a sense of appropriate speed. It is suggested that various characteristics of a road may act as accelerators or decelerators, giving road users the impression of a faster or slower road; a self-explaining road will have characteristics that are in line with the speed limit on the road and the speed limit will therefore be credible.

The aim of the tool is not just to make roads and their speed limits more credible or self-explaining, but also to ensure that speed limits are safe. The tool is grounded in the 'safe system' approach. In Sweden and the Netherlands, where the safe system approach has already been embraced, 'safe' speeds have been defined in order to improve the 'system' such that crashes are survivable.

The tool that has been developed requires that road characteristic data are entered and, on this basis, the tool calculates what would be a 'safe speed' (i.e. survivable) and assesses whether the speed limit is credible.

This deliverable describes the variables that could be used in a tool for self-explanatory and safe roads, and details the basis upon which a safe speed and credible speed assessment can be made.

For this project, the ERASER tool has been developed to be used on rural roads, since these roads have been the focus of the ERA-Net programme. Care was also taken to develop a tool that did not require intensive data collection (in recognition that not all road authorities are ready for GIS-based tools that require significant data). As such the data required is relatively light and this version works on a road-by-road basis rather than across a whole network.

In order to gain feedback on the direction of the development of the tool, a functionality and usability check was undertaken to better understand how the tool might be used by road authorities, what functionality should be included and whether the tool was useable. The functionality and usability check found that most authorities were content with the basis and style of the tool. Suggestions were made for changes, however, most of these suggestions were in the direction of more detail and more fine-tuning, which might be taken into account in a next version of the tool.

The road authority representatives did not always agree in their comments: some road authorities plead for more detail in order to be more precise, others were more in favour of less detailed options. This may highlight the need for future work to be tailored to the needs of specific road authorities and in accordance with data availability. It may be feasible in the future to progress two different tools – one that has relatively light data requirements, and one that requires more detail, but can provide more accurate outputs.

Based on the comments of the road authorities, the ERASER tool has been improved by improving the precision of data requirements and improving the indication of categories within the data-input where needed. Other suggestions that were made – for instance the wish to include more speed comparisons and a network-wide approach - might be taken into account if a more extended version of the tool will be developed.

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## 1 Introduction

*“ERA-NET ROAD – Coordination and Implementation of Road Research in Europe” was a Coordination Action funded by the 6th Framework Programme of the EC. The partners in ERA-NET ROAD (ENR) were United Kingdom, Finland, Netherlands, Sweden, Germany, Norway, Switzerland, Austria, Poland, Slovenia and Denmark ([www.eranetroad.org](http://www.eranetroad.org)). Within the framework of ENR this joint research project was initiated. The funding National Road Administrations (NRA) in this joint research project are Austria, Belgium, Finland, Hungary, Germany, Ireland, Netherlands, Norway, Slovenia, Sweden and United Kingdom.*

*In most European countries road categorization is based on road network planning. Usually, network planning considers several aspects such as hierarchical structure, functional structure and a general channelization of traffic flows. Thus, administrative and engineering aspects are taken into account together with political targets regarding the development of traffic in the future.*

*Indisputably, these aspects are important and essential for road network planning. However, the complex road categorization system has finally led to a high number of different road categories. These mirror the complexity of the road network structure from the technical point of view but do not meet road users’ requirements.*

*With the stated aim of the European Union to diminish road accidents, the concept of self-explaining roads (SER) has become widely known. Whereas a road section can be self-explaining, redesigning entire road networks along self-explaining principles is regarded as additional prerequisite to safer European roads. In Europe, several countries have already implemented or are currently implementing such SER approaches. However, because the SER concept mainly provides rather generic principles, the actual implementation differs largely between countries. Furthermore, little is known about how each of these approaches affects road user behaviour and subsequently road safety. Thus, a discussion is needed of what makes a road and a road network self-explaining. From this discussion, criteria have to be derived along which SER approaches can be compared and evaluated. In order to do so, the term SER has to be defined in a way which allows the further steps to be derived.*

### 1.1 Overview of the project ERASER

The ERASER-project consists of five work packages (WPs). In WP1, a State of the art study (SoA) has been performed on different approaches to SER and SER networks. As described in the SoA, a successful SER approach should include at least two components: First, the roads need to be designed in a way that elicits relatively safe behaviour, e.g. appropriate speed for the given road design and traffic situation. Secondly, the road network needs to be designed along the self-explaining principles, in order to support the construction and persistence of expectations. This requires that roads have to be heterogeneous in design between road categories and homogenous in design within road categories.

The WP 2 ‘Road User Pilots’ made a next step towards bridging the gap between fundamental knowledge concerning self-explaining roads and the practical, hands-on knowledge that road authorities require. As described in ERASER deliverable 2 ‘Road User Pilots in different European countries’ two empirical studies have been conducted to identify effects of specific road features on speed behaviour. The results of WP 2 can be to identify behaviourally relevant rural road design elements in different European countries.

In the present deliverable the development of a decision support tool for Road Authorities (ERASER tool) is specified (‘Road Authorities Pilot’). In order to improve acceptance by road authorities as a target group of the tool, WP4 is directed at a usability and functionality check of the tool. (‘Feasibility Check by users’). The results of this check are also presented in this deliverable. Finally, WP 5 (‘Knowledge Dissemination’) is directed at preparing products that

can be used to disseminate the knowledge that has been gathered in the ERASER project.

## 1.2 Content of this deliverable

The SER-concept is not only implemented in several different ways, as the State of Art-study shows (Weller, Dietze et al. 2010), the SER-concept is also aimed at several different elements that are related to behaviour and expectations. Examples are: “Can I expect bicyclists here?” or “How does the road run ahead?”, “What is the speed limit here?”. In the Road User Pilot (Houtenbos, Weller et al. 2011), it is explained why the SER-element of speed has been chosen to elaborate further in this ERASER project:

- Speed can be influenced by a self-explaining road design
- Speed (appropriate speed and speed limit) is an important issue for drivers
- Speed is strongly related to road safety

These issues are also related to each other in the following way: safety can be improved, when drivers choose a speed that fits to the conditions and design of the road. Speed choice can be influenced by design by acting on psychological principles that are related to speed choice of drivers. By making their roads more self-explaining for the appropriate driving speed, road authorities can in this way also contribute to road safety.

To help road authorities throughout Europe in the process of assessing their roads and improving the self-explainingness of their roads, one of the aims of ERASER was to deliver a tool that should support this process. Chapter 2 provides the theoretical basis of the tool that is directed at SER and system safety. It also describes links with the other ERASER WPs. Chapter 3 gives an overview of data that can be used in a tool that is directed at SER and also takes into account system safety. The set-up of the ERASER tool and the data used are described in Chapter 4. As the tool should also allow for cost-effectiveness assessments, this issue is also addressed.

Finally, the tool should be the starting point in a feasibility study among road authorities. The usability of the tool and functionality checks are addressed in Chapter 5. The report concludes with challenges for the futures.

## 2 Background of a tool for road authorities

There are a number of public issues that have their effect on the speed that authorities perceive to be appropriate. Such public issues include travel time, comfort, environmental and health effects and safety (see e.g. Aarts, van Nes et al. 2009). These issues are sometimes in harmony with each other, in other instances they may compete. This competition and the different views on what should have priority, make it hard to develop a tool that takes everything into account. Because the main aim of SER is to improve safety, the safety issue of speed is taken into account explicitly; other issues are out of the scope of this project and are left to the consideration of the road authority.

Ideally, SER would not only evoke appropriate expectations of drivers, it would also evoke appropriate (safe) behaviour. With regard to speed, the question then is: what is a 'safe' speed? One could say that a 'safe' speed can only be 0 km/h, but there are some other bases for defining 'safe' speeds, by accepting that motion is a core element of traffic. These notions of 'safe' speeds derive from safe system approaches such as evocated by Sweden (Vision Zero, e.g. Tingvall and Haworth 1999) and the Netherlands (Sustainable Safety, e.g. Wegman and Aarts 2006). They define 'safe' speeds in relation to human tolerances of different crash types.

So, in order to address SER in such a way that it will contribute maximally to road safety, both SER and physical safety issues related to speed are addressed in the tool.

### 2.1 *Speed criteria in relation to safety*

When a road authority has one or more roads that have been judged to need improved credibility, the next question is: Which speed is appropriate and should be explained and evoked by the road design?

Given the fact that traffic at least requires some speed, a number of approaches are possible to define what is a 'safe' speed. First of all, there is the general rule that the higher the speed, and the larger the speed dispersion, the larger the probability of a crash (Aarts and Schagen 2006), and the greater the severity outcome. However, this general rule is hard to relate to design characteristics and to the question what is an appropriate (= safe) speed somewhere. Two approaches can be taken to review speed limits such that they are 'safe'.

A reactive approach can be taken where crashes are analysed to find locations with relatively high proportions of speed-related crashes. For these locations, speed is regarded as too high, and improvements can be made by adapting the design or lowering the speed limit – or both. Taking such an approach as a starting point, authorities need to wait for crashes to determine what might be wrong in order to prevent future crashes. It is very easy to get public support for this kind of safety policy, but it is only possible where a relatively high number and concentration of crashes have occurred.

Where crash concentrations have become sparse (or where crash data are of poor quality or not readily available), it is necessary to take a proactive approach whereby known relationships between road characteristics and crash likelihood and severity are used to determine locations that have the potential to become problematic in the future. A safe system approach can be very useful in this regard since it is possible to identify locations where there is the potential for crashes to be severe and the system to fail.

A proactive approach is no less evidence based than a reactive approach; however it is not focussed on evidence related to a specific situation on a single section, rather it takes more general rules derived from research into account.

The safe system approach of Sweden (Vision Zero, e.g. Tingvall and Haworth 1999) and the Netherlands (Sustainable Safety, e.g. Wegman and Aarts 2006), have incorporated this

proactive approach. Based on research available, they have defined speeds that are considered to be relatively 'safe' in the following conditions (see Table 1):

**Table 1 'Safe' speeds as defined in the safe system road safety visions of Sweden (Tingvall and Haworth 1999) and the Netherlands (Wegman and Aarts 2006).**

Road types in combination with permitted road users	'Safe' speed
Roads with possible conflicts between cars and unprotected road users	30 km/h; 20 mph
Intersections with possible transverse conflicts between cars	50 km/h; 30 mph
Roads with possible frontal conflicts between cars	70 km/h; 45 mph
Roads with no possible frontal or transverse conflicts between road users	≥100 km/h; ≥60 mph

For this definition, 'safe' means that there is a 90% probability that road users normally will survive a crash without getting severely injured when colliding with a modern car driving at such a speed, and – if relevant - using all safety equipment on board (Tingvall and Haworth 1999).

The 'safe' speeds are derived from crash tests, such as the 30-km/h (20 mph) rule from Ashton & Mackay (1979). Later studies found somewhat higher speeds (40 to 50 km/h Rosén, Stigson et al. 2011), and also EuroNCAP crash tests ([www.euroncap.com](http://www.euroncap.com)) use a standard of 40 km/h (25 mph) for frontal collisions between car and pedestrian. The fact remains that speeds have to be very low in situations where vulnerable road users mix with motorised traffic. The 'safe' speed of 50 km/h (30 mph) for side-impacts is related to the EuroNCAP crash test norms for such impacts. For frontal collisions, the EuroNCAP crash test norms are somewhat lower than 70 km/h (45 mph), but this speed can be regarded as an average between this norm and speed limits that are generally posted on rural roads with undivided separation of driving directions. The safe speed of > 100 km/h (or 60 mph) should be regarded as 'high speed', and can only be considered as 'safe' when all design conditions are facilitating high speeds in a safe way, which means: no side impacts, no frontal conflicts and no conflicts with vulnerable roads users.

Further research on the survivability of crashes with roadside obstacles at different distances from the road can also be used to inform safe speeds for run-off road crashes (e.g. results from the RISER project).

## **2.2 SER in relation to speed: accelerators and decelerators**

In relation to speed, the SER-concept can be understood in several ways. One way is to convert SER into explicitly learnable rules about characteristics of a particular road type which are linked to a particular speed limit or preferred speed. So road users come to recognize different road categories and their respective speed limits. Examples of this can typically be found in the Netherlands, where the principle of 'predictable and recognisable roads' is implemented in such a way, as phasing solution to get a really sustainable safe system. In this case, you may encounter roads with a green centre marking that refer to the rule: "green means 100 km/h". This is – when drivers get used to it – self-explaining, as was shown by several studies (e.g. Aarts and Davidse 2007; Stelling-Konczak, Aarts et al. 2011).

A second way to understand SER is to make use of the effect that the look and feel of a road have on behaviour and expectations in a more implicit and intuitive way. In relation to speed, a good fit between the road design and the posted speed limit or required speed will normally

lead to the majority of drivers exhibiting appropriate speed behaviour. In the literature, such a fit between road design and speed limit is also known as 'realistic' (Fildes and Lee 1993), 'acceptable' (Risser and Lehner 1998), or 'credible' (e.g. Goldenbeld and van Schagen 2007).

There are a number of advantages of this last approach over the first one. First of all, the 'credibility approach' affects the behaviour of the majority of drivers in a natural way. Second, the 'credibility approach' is not dependent on explicitly learned rules, which may not be familiar to all drivers (e.g. foreigners), can be forgotten and can be violated more easily. Third, the 'credibility approach' can be linked more easily to principles of physical safety, which are – besides the principle of SER or predictability and recognisability - very important in a safe system approach.

As was summarised in the introduction of the Road User Pilot (Houtenbos, Weller et al. 2011), credibility of speed limits has been found to be influenced by primary and secondary factors (van Nes, Houwing et al. 2007). Primary credibility factors influence speed choice mainly by physical factors that create discomfort and danger when they are not treated in an appropriate way (e.g. roundabouts, speed humps). Secondary credibility factors influence the speed choice more indirectly via the (mainly visual) information that is more or less consciously processed (e.g. optic flow effects by discontinuous marking). Each feature can have accelerating or decelerating effects, depending on the appearance. Known accelerators are (e.g. van Nes, Houwing et al. 2007; Houtenbos, Weller et al. 2011):

- Wide roads
- Straight stretches of road
- High quality road surface
- Open road environment

Decelerators are the antitheses of these accelerators, known as:

- Narrow roads
- Bendy roads
- Low quality road surface
- Densely build-up area or densely planted trees close to the road

What accelerators and decelerators are most relevant on a road may depend on the road type and may also be context dependent (see Houtenbos, Weller et al. 2011). Speed humps, for instance, are not used on high speed roads, but are very effective on lower speed roads (see also next paragraph on 'safe' speeds). When accelerators and decelerators are quantified in accordance with speed limit, they are very useful to bridge the gap between theory and practice in a tool for road authorities (Aarts, van Nes et al. 2009; Aarts, van Nes et al. 2010).

### 3 Relevant data for a SER tool directed at speed

In general, the basic structure of a tool is: input → assessment → output. The assessment needs relevant characteristics to calculate a meaningful output. The relevant characteristics are gathered via the input. This chapter contains an inventory of the input variables that are known to be relevant for credible speed limits (SER related to speed) and proactive safety ('safe' speeds; see Chapter 2). The ERASER tool that has been developed uses the majority of these variables, based on importance and availability for most European road authorities. More information on the tool can be found in Chapter 4. In the longer term the tool could be developed to require further data as they become readily available to road authorities. The variables in this chapter may raise attention to this and may result in improved databases.

As the previous chapter has shown, variables that are relevant for SER not only concern the road design itself, but also the road environment. Another issue that is relevant for both SER and proactive safety are the road-related traffic rules, such as speed limits and traffic related restrictions. Setting such rules is mostly within the jurisdiction of the road authorities.

#### 3.1 *The fundamentals*

When designing a decision support tool for road authorities, there are several fundamental decisions that need to be taken. They are described in the following paragraphs.

##### 3.1.1 Network-wide GIS tool versus simple single road tool

Generally, there are two ways to organise the input variables: in a high-end version road authorities can investigate their roads by taking all relevant input variables of a whole network into account. This can for instance be combined with a Geographic Information System (GIS). Appendix 1 shows how a database for a network-approach could look like. This is, however, not always available for all European road authorities. A more basic version of the decision supporting tool, is to assess only single roads or road segments. This can be a good solution for a first prototype, making it available and accessible for all road authorities, independent from their state of data organisation. If required data are missing, it should be relatively easy to collect additional data for a road segment.

##### 3.1.2 Dynamic segmentation of roads versus 'typical road layout' assessment

Another important general starting point is how to handle the homogeneity of characteristics along a road in the assessment. Ideally, a road should be divided into sections with each section having a set of identical characteristics over the whole length of the section. This means that, if one of the characteristics changes (for instance, a separate bicycle path changes into a bicycle lane), a new section is defined automatically. This way of dividing a road in homogenous sections can be done by dynamic segmentation. A more basic version would be to assess the typical road layout, which is the set of characteristics that are the most common along the road. One clear advantage is that road authorities can choose their own segmentation that perhaps they already have developed for other purposes. A further advantage of using typical layout is that road authorities do not need to assess all detailed changes along their roads; a disadvantage is that authorities may miss those segments in the road that are not typical but critical. This issue is especially relevant in relation to safety (see Chapter 4).

### 3.1.3 Road type definition

A high-end version of a tool could address all possible road types. The State-of-Art study (Weller, Dietze et al. 2010) shows an overview of common road types in Europe. Apart from a few general distinctive road types, such as higher-order and lower-order roads, there is a great diversity of road types. A more basic solution could be to start with one common road type, such as non-motorway rural roads.

### 3.1.4 Scope of speed management measures

Other measures, such as police enforcement and campaigns, can help to move driving speeds towards appropriate and safe standards. Since such measures are outside of the control of most road authorities, the tool does not explicitly deal with these. However, it is recognised that where speed limits are not credible, and there is limited opportunity to improve the road itself to elicit safe speeds, enforcement is an important intervention.

## 3.2 Road-related traffic rules and driving restrictions

### Speed limits

One of the first elements to manage speed is setting speed limits. When speeds are too high, speed limits can be set to a lower value. This will not mean, however, that speeds are reduced with the same amount: speed limit reductions have shown to reduce speeds with about 25 to 50% (Wilmot and Khanal 1999).

Speed limit setting is not only to reduce the speed of traffic, also homogeneity of speeds are important (Aarts and Schagen 2006). From the perspective of a safe system approach, low speeds are required where fast traffic mixes with vulnerable road users (e.g. Wegman and Aarts 2006), but also at higher speeds homogeneity is important. In a lot of countries, there are different speed limits for different types of vehicles, e.g. cars versus vans or even busses. When speed differences between these vehicles that are allowed at the same road become too high, safety conflicts may arise (see also Elvik 2009).

### Access restrictions

Another way to manage differences in speed and pay attention to homogeneity is by introducing access restrictions for certain types of vehicles or traffic participants (Wegman and Aarts 2006). Where speeds are too high for particular traffic modes (e.g. more than 30 km/h (20 mph) for pedestrians and cyclists and more than 50 km/h (30 mph) for mopeds), access restrictions prevent conflicts between slow and fast traffic. In relation to SER, access restrictions for vulnerable road users and other slow traffic like agricultural vehicles may suggest a higher speed limit to drivers.

### Overtaking restrictions

Other types of restrictions that are commonly applied on roads can be overtaking restrictions, which are mostly explained to drivers by the type of centre marking (continuous versus intermittent). Overtaking restrictions are particularly meant for safety reasons, since overtaking can increase the probability of head-on crashes (e.g. Stefan, Dietze et al. 2011) and even can affect speed: when overtaking is not allowed, driving speed in congested situations will be as high as the slowest moving vehicle. When overtaking is allowed, drivers may speed up in order to perform the manoeuvre smoothly and keep the overtaking moment (driving on the opposite lane) as brief as possible. The road user study which was performed within WP2 revealed that there was generally no effect in speed for roads with intermittent and continuous marking (Houtenbos, Weller et al. 2011).

## **Parking restrictions**

Complementary of parking facilities (see cross-section), also parking restrictions can be set by the road authority to increase safety by reducing the probability of obstacles on the road. This is especially important on higher speed roads, although even on 50 km/h (30 mph) roads, quite a lot of crashes happen with parked vehicles (Elvik and Vaa 2004). Parking restrictions may particularly apply in busy street zones and on higher speed roads. In the last case, restrictions might be associated by drivers with higher order roads that are meant to facilitate high speeds.

### **3.3 Road characteristics**

Behaviour of road users, such as expectations and speed choice are - next to human characteristics such as experience and attitude - strongly influenced by the design of the road. The same holds for system safety. The road design variables that are known to influence behaviour and are important for adequate system safety can be divided into variables related to the cross section of the road, the alignment, the road surface, intersections, and traffic calming measures. The next paragraphs give a brief overview of what is currently known about the influence of these characteristics on SER and 'safe' speeds.

#### **3.3.1 Cross-sectional information**

##### **Separation of driving directions**

The type of separation between opposite driving directions is particularly important for system safety. As was explained in the paragraph on 'safe' speeds, a road with speeds over 70 km/h (45 mph) requires a physical, non-overrideable separation between driving directions. This should prevent the probability of fatal frontal collisions. The 70 km/h (45 mph) norm arrives from Tingvall and Haworth (1999), while EuroNCAP even uses lower crash test requirements of 64 km/h (40 mph) (see [www.euroncap.com](http://www.euroncap.com)).

For self-explainingness of speed limits, the separation of driving directions can be used in two ways: first, the separation can be used as an explicit recognition mark for the type of road drivers are on. This is the way how the centre marking is used in the Netherlands (e.g. Aarts and Davidse 2007), where on regional through roads for instance, a green centre marking means a speed limit of 100 km/h.

The second way in which the separation of driving directions can have a meaning for self-explaining roads is in a more explicit way by influencing the credibility of a speed limit. This is related to road width (see next paragraph): the wider the road or lane, the more likely drivers will speed up (e.g. Martens, Comte et al. 1997; Elliott, McColl et al. 2003; Houtenbos, Weller et al. 2011). A physical separation of driving directions can narrow the road by making only the lanes in the same direction visible (Aarts and Davidse 2008). On the other hand, roads with a physical separation of driving directions might be perceived as higher order roads than roads with centre marking. This would mean that physically separated roads would evoke higher speeds than centre marked roads, which was found in the driver study of WP2 (Houtenbos, Weller et al. 2011). Differences in findings might be related to an interaction with road width.

Another way in which separation of driving directions (or markings in general) can act on speed perception and speed choice is by means of providing 'optic flow'. Interrupted markings provide optic flow, while continuous marking does not. For this reason, roads with interrupted (centre) marking can have a speed reducing effect (e.g. Davidse, van Driel et al. 2004). A more extensive discussion of the use of markings in relation to SER and speed can

be found in Charman et al. (2010).

### **Road width and lanes**

Road width is an important factor for both system safety and SER. For system safety, road width and lane width are relevant to facilitate the nosing which is related to speed. The smaller the road or the lane, the higher the probability of crashes (especially run off roads) (Elvik and Vaa 2004; Stefan, Dietze et al. 2011). However, road and lane width also have a safety effect that acts in the opposite direction: the wider the road, the higher the tendency for drivers to speed up (e.g. Martens, Comte et al. 1997; Elliott, McColl et al. 2003; Elvik and Vaa 2004; Charman, Grayson et al. 2010; Houtenbos, Weller et al. 2011), which is related to higher risks of crashes and more severe injury. Issues that are also relevant in the light of these findings are the number of lanes and the availability of emergency facilities: knowing that small lanes have a speed decreasing effect and lead to a higher probability of run off road crashes, these effects are moderated on roads with more than one lane per driving direction or emergency facilities present. Drivers may also speed up on roads with more than one lane per driving direction because they associate such a road with higher quality (Charman, Grayson et al. 2010). Also temporary narrowing of roads has a speed reducing effect at that spot (see also horizontal traffic calming measures). Results from the driver study of WP2 revealed that the effect of road width is stronger on 1+1 roads than on roads with more than one lane per driving direction (Houtenbos, Weller et al. 2011).

### **Shoulder characteristics**

Related to road width are the characteristics of the shoulder. Hardened shoulders decrease the probability of crashes because they give drivers the chance to recover from steering errors (Elvik and Vaa 2004). When hardened shoulders are wide, they can on the one hand better support recovery behaviour, on the other hand, they might evoke higher speeds, which are related to higher risks of having a crash (Charman, Grayson et al. 2010). The evidence on what is the optimal shoulder width is not yet conclusive (see for an overview Stefan, Dietze et al. 2011).

Another shoulder characteristic that is important in relation to safety is the shoulder drop-off: large drop-offs can be hazardous while they can aggravate loss of vehicle control once a steering error has led to run off road (see Stefan, Dietze et al. 2011). American research shows that a drop-off of more than 50 mm (2,5 inches), requires speeds lower than 90 km/h (55 mph) (Hallmark, Veneziano et al. 2006).

### **Road side**

Absence of hazardous elements along the road side, are important for safety. When the road side is not protected by a functional safety barrier, obstacles or steep slopes that are close to the road are a potential hazard when drivers run off the road. A safe system requires a forgiving road side (e.g. Wegman and Aarts 2006), and therefore, safety barriers or appropriate clear zones are required (for an overview see Stefan, Dietze et al. 2011).

Elements in the road side also have their impact on speed behaviour. More on that can be found in the section on 'road environment'.

### **On street parking facilities**

Especially in urban areas, parking facilities are a common element in the cross-sectional design of a road. In a lot of countries, it is perceived as safe to have parking facilitated when speeds are 50 km/h (30 mph), although still quite a lot of fatal crashes happen on 50 km/h roads with parked vehicles (Elvik and Vaa 2004).

### **Facilities for vulnerable road users and other slow traffic**

Traffic consists of very different vehicles and road user types that – in most cases – have to

travel within the same space together safely. According to the homogeneity principle that is key in safe system approaches (e.g. Wegman and Aarts 2006), speed should be reduced when there is a mixture of vulnerable road users and fast traffic. Only on roads with separate facilities and access restrictions, speeds can be higher (of course taking into account other requirements for high speeds as well). For safety reasons, road design can explicitly facilitate vulnerable road users by giving them dedicated space, for instance by designing separate foot paths, and paths or lanes for cyclists and mopeds. Also service roads can offer a solution to separate the vulnerable road users and slow traffic from the fast moving traffic.

Some studies have looked at the effect of vulnerable road user facilities – mainly cyclist facilities – on driving speed. Most of them did not report a clear effect on speed that could be assigned to the presence of these facilities (e.g. Nilsson 2001).

### 3.3.2 Alignment

#### Horizontal alignment

The horizontal alignment of a road is important for both system safety and SER related to speed. Crash risks are known to be higher with curved roads in comparison to the adjoining tangents (for an overview, see Stefan, Dietze et al. 2011).

For SER in relation to speed, two factors of horizontal alignment are important: first, the frequency of curves which forms the consistency in design along a road – is important for the development of expectations of the driver, making him better able to anticipate appropriate speed and road position on roads where curves are more than incidental (Lamm, Psarianos et al. 1999). The length of tangents are important for credibility of speed limits: long stretches of road evoke speeding behaviour, while short, bendy stretches slow down. As a matter of fact, a short sight length only reduces speed if the sight is blocked over a longer distance and therefore for a longer duration; short disruptions of the sight length do not have any effect.

#### Vertical alignment

Vertical alignment is also important for both safety and SER related to speed. In this case, both are closely connected: research has shown that unexpected variety in gradients and steep grades increase the probability of crashes (see for a more extensive overview Stefan, Dietze et al. 2011). This has to do with (unexpected) variety in speed, especially when different vehicle types (e.g. freight traffic) are involved. Furthermore, downhill roads are known to have higher crash rates than uphill roads (e.g. Elvik and Vaa 2004). Also this might be related to higher speeds that are evoked when driving downhill.

Vertical alignment (gradient or ascent of the road) is more or less important in different countries. In flat countries, vertical alignment might be a more incidental factor, while it is of rather great importance in mountainous areas. In the last case, road ascends and descends are also related to large curvature of the road.

#### Sight distance

Sight distance is also important for system safety: this measure indicates the distance that is available for drivers to stop their vehicle without hitting an object on their path. There are several different components of sight distance (e.g. Stefan, Dietze et al. 2011). Stopping sight distance is one of them. There are also indications that sight distance is important for speed behaviour, especially if sight is blocked over a longer distance (e.g. Liang, Kyte et al. 1998; Charman, Grayson et al. 2010).

### 3.3.3 Road surface

The type and quality of the road surface are important for both safety and speed behaviour. For safety, it is important that the road surface has an appropriate skid resistance, especially in conditions where the probability of skidding is high, such as in curves, downhill slopes and in wet conditions (for an overview see Stefan, Dietze et al. 2011).

For drivers with speeding tendencies, the type and quality of the road surface is important because it causes vehicle vibrations that give haptic and auditory feedback and act on the comfort of the driver. Several studies have shown that a grooved road surface (e.g. cobbles or bricks) reduces speed compared to a more level road surface (e.g. Martens, Comte et al. 1997; van Driel, Davidse et al. 2004; van Nes, Houtenbos et al. 2008). Some research also suggests that not only the type of road surface plays a role in the effect on driving speed, but also the quality of the road surface; for example, renovated asphalt on a road can increase driving speed by a few km/h (e.g. Leden, Hämäläinen et al. 1998).

Furthermore, the use of coloured sections can be used for guidance, raising of alertness and dedicated vehicle lanes and by this affect (anticipatory) speed behaviour (Charman, Grayson et al. 2010).

### 3.3.4 Intersections

The type of intersections, as well as their frequency along a road are particularly important for safety and – depending on the intrusiveness – also for speed behaviour. First of all, roads that should facilitate high speeds relatively safely are required to have either grade separated intersections (with large traffic volumes and high speeds) or speed reducing measures at level intersections (at moderate traffic volumes and moderate speed) (e.g. Wegman and Aarts 2006). When speed is reduced at intersections, a safe speed of maximally 50 km/h (30 mph) is required when no vulnerable road users are involved (www.euroncap.com, Tingvall and Haworth 1999). Furthermore, it is known that more complex and uncontrolled level intersections (e.g. cross-sections, un-signalised) are less safe than less complex and controlled ones (e.g. T-junctions, roundabouts and signalised intersections) (see for an overview Elvik and Vaa 2004; Charman, Grayson et al. 2010; Stefan, Dietze et al. 2011).

A special type of intersection is the access intersection, which can be private (property access) or public (road). Private property access is related to higher probabilities of vulnerable road user interaction and manoeuvring vehicles and requires low speeds (Wegman and Aarts 2006).

The frequency of intersections along a road or intersection density is also important in relation to safety and speed: the higher the frequency, the better lower speeds have to be evoked. Intersection density has also been related to crash frequency per intersection (for an overview see Stefan, Dietze et al. 2011).

### 3.3.5 Traffic calming measures

When the cross section and alignment characteristics of a road do not fit to the speed regime that it required for safety, additional traffic calming measures can be taken. They particularly act on traffic speed and can in this way increase safety by reducing the probability and severity of crashes.

#### Vertical elements

One of the most prominent vertical traffic calming measures are speed humps (see for instance overviews of Martens, Comte et al. 1997; Elliott, McColl et al. 2003). For this

reason, speed humps are implemented especially in domestic areas where safe traffic mixture requires low speeds. Although speed humps and plateaus are known to be very effective, they have to be regarded as less ideal from a user point of view as they are experienced as less part of the natural design of the road.

### **Horizontal elements**

Traffic calming measures that act on the horizontal alignment of a road are measures such as chicanes (road sections) and roundabouts (intersections). They are known to be effective safety measures because they reduce speed (Elvik and Vaa 2004). They can be used when traffic intensities are not too high and speeds have to be reduced to 30 to 50 km/h (20 to 30 mph) to reduce lateral conflicts and conflicts with vulnerable road users.

## **3.4 Road environment**

The road environment, along with the road design provides feedback on driving speed and can therefore influence speeding tendencies. Several studies showed that the presence of trees close to the road reduces speed, whereas an open road environment increases speed (Martens, Comte et al. 1997; Elliott, McColl et al. 2003; Charman, Grayson et al. 2010; Houtenbos, Weller et al. 2011). However, if trees form a tunnel-like barrier for a longer distance, they might even increase speed (Zwieliich, Reker et al. 2001). The type of vegetation also makes a difference: trees have been shown to reduce speed more than bushes (e.g. de Ridder and Brouwer 2002), which might be explained by the perceived hazard of large objects (see also the section on road side). Furthermore, speed is reduced more when there are obstacles at both sides of the road rather than only one side having obstacles.

## **3.5 Road use**

Road use is a factor that can be taken into account in several ways. First of all, road use is often related to the functionality of a road: high traffic intensities are mostly on roads that have a flow function, need high speeds and a high quality design (e.g. Buchanan 1963). The consideration of traffic and local needs allows the development of a functional structure of a road network with respect to their importance (Weller, Dietze et al. 2010). Based on historical developments a road mostly fulfils more than one function (Hafen, Lerner et al. 2005). Monofunctionality of a road is however seen as required standard for a safe system (Wegman and Aarts 2006).

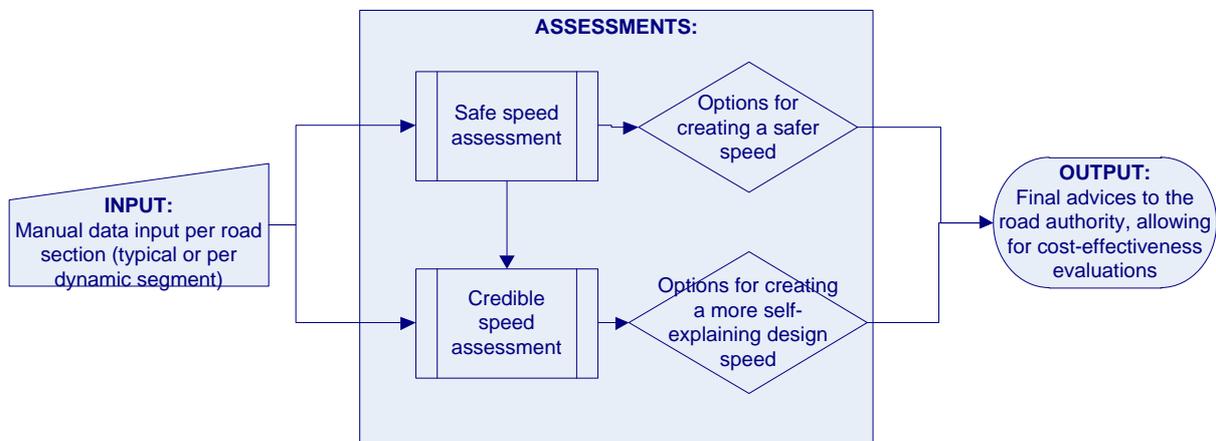
Second, road use and the relation between road capacity (C) and traffic intensity (I) is important for the free flow of traffic, which also relates to speed. When the I/C relationship becomes too high, congestion appears, which reduces the speed and changes the type and severity of crashes that will occur.

A third aspect of road use that is relevant is the priority or cost-effectiveness of measures. On roads with a similar risk, measures are more cost-effective when they have a high use rather than a low use, because in the former case more road users will come in contact with the measure (e.g. Winkelbauer and Stefan 2005). Setting priority for taking measures by taking the road use into account might be particularly important when it concerns particular road user groups (transport modes). Countries that – for instance – have only low cyclist volumes on their roads (low meaning: infrequently used by cyclists), may decide not to implement safety measures directed at cyclists because the cost-effectiveness will be low. In this sense, road use (per road user type) can act as a measure for priority setting of certain measures.

## 4 Structure and content of the ERASER tool

Within WP3 of ERASER – Road authorities pilot – a draft decision support tool has been developed using information from Chapter 3. The tool can be found on the ERASER website ([www.swov.nl/enquete/Eraser/Tool.php](http://www.swov.nl/enquete/Eraser/Tool.php)). The main aim of this tool is to raise the awareness among road authorities how steps can be taken towards a better self-explanatory road design. To be of use for as many road authorities as possible – also for countries that are already quite far with improving their road design, the tool also takes a safe system approach into account and combines this with SER. For road authorities, this could be a new approach which will be beyond their current scope of measures. However, the ideas behind the tool are meant to improve road safety in the future, and can be used to form ideas about what might be changed. The tool allows for comparisons with other tools, speed-related issues (such as functionally and environmental considerations), and more traditional ways of looking at safety (i.e.: by means of analysing crash concentrations) in order to be compatible with current uses.

The tool has been made fairly simple, leaving room for further improvement and extension at a later stage. To make the tool not too complicated and provide a link with the work that was done in other ERASER work packages and even other ERA-Net Road projects (e.g. RISMET and SPACE), the current version of the tool is applicable on rural roads only. The main elements of the tool are depicted in Figure 1:



**Figure 1: Schematic overview of the elements of the current ERASER tool.**

Before this chapter further addresses considerations in relation to the tool and details about the variables that are used, an example is given to show how the tool works (note that this shows the final version). The road that is assessed in this example is shown in Figure 2. This road is a typical ‘regional through road’ in the Netherlands. The the continuous edge marking and green centre marking are explicit cues for road users that the speed limit is 100 km/h.

After the introduction part of the tool, the speed limit is the first characteristic to enter as input in the tool (see Figure 3). Then, four input pages follow (see Figures 4 to 7) for information about road characteristics and characteristics of the direct road environment. The ERASER tool then shows its final page with results about the safety and credibility of the speed limit (see Figure 8). Furthermore, the tool provides information about what measures could be taken with an indication of effectiveness and costs. For credibility, a list of decelerators, accelerators and fine elements is provided. A link to one of the SPACE-deliverable should provide the user more information about what actions could be taken, as this is a complicated matter of balance of measures (i.e. accelerators and decelerators). Urgency of taking actions is addressed as the final issue of the tool.

In this particular example of the road as shown in Figure 2, the first attention point is the safety of the speed limit in combination with the road design (i.e. no physical separation of driving directions, clear zone and shoulders are too small and shoulders are not paved, lateral conflicts should be prevented at high speeds). As the list of decelerators outnumbers the list of accelerators, the speed limit might be too high to be credible (note that this concerns the intuitive speed that drivers would choose, not the speed that is chosen because of explicit cues like 'green is 100 km/h). As a result of moderate use of the road, the urgency of taking action is considered to be low. A combination of these results could mean that downgrading such a road might be a good option. The road authority should however take also other considerations into account, such as network requirements and consistency in order to come to a final decision.



Figure 2: Example of a road that can be assessed in the ERASER tool.

Figure 3: Input of the speed limit in the ERASER tool.

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### Road characteristics (1 of 4)

Please fill in all boxes for the road that you would like to assess.  
For some characteristics, there are three options for you to follow throughout the input:

- Typical (most common) layout: gives a general assessment of the situation;
- Worst situation of the layout: gives a stricter assessment of the situation based on the weakest link;
- Constant characteristic: relevant for assessment of homogeneous road sections (dynamically segmented per changing characteristic);

#### Cross sectional information

##### Separation of driving directions

Type of separation (typical, least physical, or continuous characteristic):

##### Number of lanes

Number of lanes in direction A (typical or continuous characteristic):

Number of lanes in direction B (typical or continuous characteristic):

##### Road width

Width of carriageway (typical, widest section, or continuous characteristic):

Typical lane width (typical, widest section, or continuous characteristic):

**Figure 4: First input page for road characteristics in the ERASER tool: cross sectional information.**

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### Road characteristics (2 of 4)

#### Road side and road environment

##### Road shoulder

Type of road shoulder (typical, lowest quality, or continuous characteristic):

Shoulder width (typical, smallest width, or continuous characteristic):

##### Roadside

Barrier along road side (typical, lowest quality, or continuous characteristic):

Distance to nearest obstacle or ditch from shoulder edge (typical, nearest obstacle, or continuous characteristic):

##### Road environment

Density of the road environment (typical, most open environment, or continuous characteristic):



open



semi open



dense

**Figure 5: Second input page for road characteristics in the ERASER tool: information about the road side and road environment.**

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### Road characteristics (3 of 4)

#### Alignment

**Horizontal alignment**  
Length of tangent (typical, longest tangent, or continuous characteristic):

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**Figure 6: Third input page for road characteristics in the ERASER tool: alignment.**

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### Road characteristics (4 of 4)

#### Road user interaction and use

**Dealing with lateral conflicts in design**  
Intersection type (typical, lowest quality of lateral conflict prevention, or continuous characteristic):

Intersection frequency (typical, highest frequency, or continuous characteristic):

Frequency of accesses to private properties (typical, highest frequency, or continuous characteristic):

**Vulnerable road users**  
Mixture with vulnerable road users (typical, most user types allowed on the road, or continuous characteristic):

**Use of the road**  
General use of the road (motorised traffic; typical, heaviest use, or continuous characteristic):

Pedestrian use of the road (typical, heaviest use, or continuous characteristic):

Cyclist use of the road (typical, heaviest use, or continuous characteristic):

Moped use of the road (typical, heaviest use, or continuous characteristic):

**Figure 7: Fourth input page for road characteristics in the ERASER tool: information about road user interaction and road use.**



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**Results**

The speed limit of your road = 100 km/h; 60 mph  
 The calculated safe speed limit = 50 km/h; 30 mph  
 The speed limit is too high to be credible

**Evaluation details**

**Safe system considerations**

The speed limit is higher than the current safe system standards allow for.  
 You might:

- Decrease the speed limit to 50 km/h; 30 mph.  
 Effectiveness: 5-10%  
 Cost indication: low

Alternatively, you might adapt the failing design elements of the road, which are:

- Clear zone should be > 10m or there should be a safety barrier.  
 Effectiveness: 20-75%  
 Cost indication/km: low-medium
- Shoulders should be present, and well paved for at least 2m.  
 Effectiveness: 15-30%  
 Cost indication/km: low
- Lateral conflicts should be eliminated (grade separate intersections).  
 Effectiveness: 25-55%  
 Cost indication/km: medium-high
- Physical separation of driving directions (e.g. kerb, median or safety barrier) is required.  
 Effectiveness: 15-30%  
 Cost indication/km: low

**Credibility**

**Decelerators**

- No physical separation of driving directions
- Lateral conflicts possible
- Dense or semi-open road environment
- The road is smaller than 18m
- Less than 2 lanes per driving direction

**Credible road features**

- Access restrictions for vulnerable road users and mopeds

**Accelerators**

- Road tangent is larger than 450m

When available, speed data can be a usefull additional source of information. Be aware that speed is influenced by more factors than road design alone.  
 More information about measures that can be taken, can be found in this document of the ERA-Net [SPACE-project](#).

**Urgency**

The urgency of taking actions on your road is: **Low**

[Next road](#)



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Figure 8: Example of a results page of the ERASER tool.

## 4.1 *Input considerations*

Based on earlier experiences - mainly in the Netherlands, where similar tools have been developed - the following options for input have been considered for the ERASER-tool:

- Paper-and-pencil test (see van Nes, Houwing et al. 2007, in Dutch with English summary)
- Web-based application that will run on single-road characteristics
- Web-based application that will run on a database of road characteristics, allowing for GIS-application (see Aarts, van Nes et al. 2010)

A paper-and-pencil test was considered to be not sufficiently practical and more problematic to disseminate, so a web-based application where seen as ideal options for the tool. As it appeared that not all road authorities have data of their roads readily available in databases, allowing for a GIS-system, the most practical and useful form seemed to be a web-based option where road authorities can assess single road sections. This also fits to the idea that the aim of the tool is rather to get familiar with steps that can be taken towards a safer and more self-explanatory road design, rather than as a full-grown tool that can be used everywhere without considerations.

Furthermore, a selection has been made on the characteristics that the tool takes into account, starting from the fact that the tool focuses on rural roads only. Finally, the selection was based on a combination of 1) importance of the characteristic for safe and credible speed limits and 2) availability or effort that would be required to get the data. The following data are taken into account:

- Speed limit (important for both safety and credibility assessment)
- Cross section elements, which are: 1) type of separation of driving direction, 2) number of lanes and 3) road and lane width.
- Road side and road environment, which are: 1) the type and width of the road shoulder, 2) the width of the clear zone or shielding of obstacles and 3) the openness of the road environment.
- Alignment, which takes only the length of the tangent into account in the current version of the tool
- Road user interaction and use, which are: 1) presence and frequency of intersections and type of intersections, 2) access restrictions for vulnerable road users and facilities for pedestrians, cyclists and mopeds, 3) use of the road by general traffic, by pedestrians, cyclists and mopeds (for priority setting of advices of the tool)

Appendix 1 contains an overview of data that could be used in an extended version that is applicable on all roads and that can be used for a tool that runs on a database and allows for GIS applications. The following sections will contain more information about how the input data of the current ERASER tool is used.

## 4.2 *Assessments within the tool*

Another decision that has been made to keep the ERASER tool quite simple at this stage, is to include only those assessments that are within the jurisdiction of most road authorities. This means that the tool assesses the safety of roads and the credibility of the speed limits and does not take into account an assessment on police enforcement (see also Chapter 3). Experiences from a more extended tool that includes police enforcement assessments has learned that data on this issue are hardly available most of the time (Aarts, van Nes et al. 2010).

Figure 9 gives an overview of the assessments that are part of the current ERASER tool.

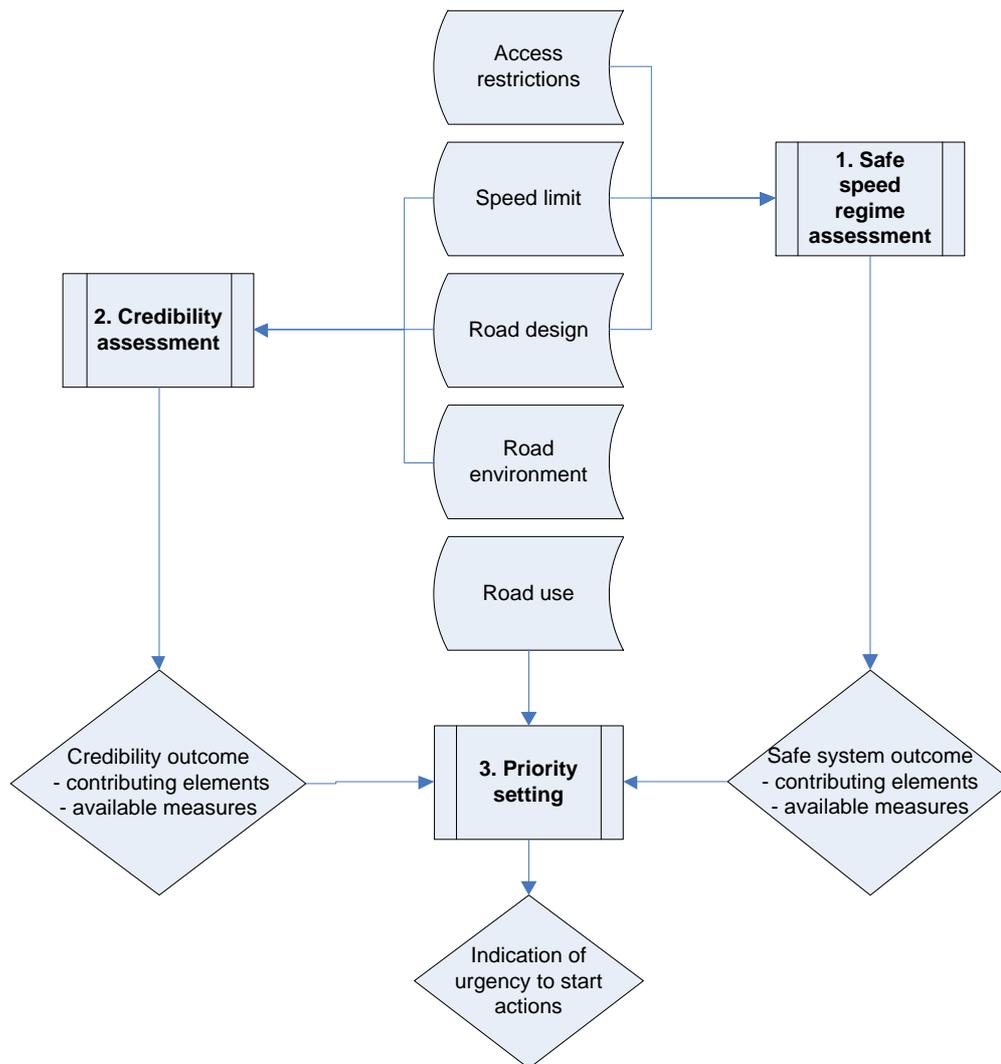


Figure 9: Overview of assessments and use of data types within the current ERASER tool.

### 4.2.1 Safety assessment

In the ERASER tool, safety is assessed by using the safe system requirements that were articulated in Chapter 2 and 3. This means that no real crash records are used for assessing the safety situation. If road authorities feel the need to use crash records additionally, they are stimulated to do so. Crash records can for instance be used as an additional priority setting tool after or prior to the use of the ERASER tool.

The safety assessment within the ERASER tool is performed by testing safety requirements (see Chapter 2). Safety requirements are the fit between the speed limit, access restrictions and road design. Speed limit is chosen in this case as surrogate for real driving speed. Road authorities are stimulated to also look at driving speeds available, such as the V90 or V85 to know the speed at which the majority of road users drives at that road. Because speed measurements are not always available, the tool does not use real driving speed as input.

Safety requirement testing means that the weakest link determines the 'safe' speed that is proposed. When for instance the road is well designed, with physical safety barriers, very good clear zones and hardened shoulders but has no access restrictions for vulnerable road users, the 'safe' speed drops to 40 km/h (25 mph). The following paragraphs give an

overview of the safety requirements that are tested in the current version of the ERASER tool. More background about these safety requirements can be found in Chapter 2 and 3.

**Step 1: Access restrictions for vulnerable road users**

First of all, the ERASER tool checks whether the assessed road has an access restriction for vulnerable road users such as pedestrians, cyclists and mopeds. See Table 2 for an overview of the requirements of access restrictions that are currently used in the tool. As this is one of the strictest safety requirements, roads without restrictions but with no vulnerable road users can be handled as if there are access restrictions.

**Table 2 Overview of requirements related to access restrictions**

Access restrictions applies to:	Maximum 'safe' speed or speed limit:
No restrictions for pedestrians AND cyclists AND mopeds	40 km/h; 25 mph
Only for pedestrians AND cyclists	50 km/h; 30 mph
Pedestrians AND cyclists AND mopeds	> 50 km/h; 30 mph; See further steps

**Step 2a: Clear zone or safety barrier**

When speeds and speed limits are higher than 50 km/h (30 mph) and access restrictions are set, the next element that is important is the shielding of obstacles or the distance to obstacles within the clear zone. See With a safety barrier, a high quality guardrail is meant that meets the NEN standards for safety requirements.

Table 3 for an overview of the requirements that are related to the clear zone and safety barriers along the road side. With a safety barrier, a high quality guardrail is meant that meets the NEN standards for safety requirements.

**Table 3 Overview of requirements related to clear zones and safety barriers**

Clear zone distance	Maximum 'safe' speed or speed limit:
Clear zone ≤ 2.5m	50 km/h; 30 mph; (+ step1)
Clear zone > 2.5m and ≤ 4.5m	60 km/h; 40 mph; (+ steps 1, 2b, 2c)
Clear zone > 4.5m and ≤ 6.0m	70 km/h; 45 mph; (+ step 1, 2b, 2c)
Clear zone > 6.0m and ≤ 8.0m	80 km/h; 50 mph; (+ step 1, 2b, 2c, 3)
Clear zone > 8.0m and ≤ 10.0m	90 km/h; 55 mph; (+ step 1, 2b, 2c, 3)
Clear zone > 10.0m and ≤ 11.5m	100 km/h; 60 mph; (+ step 1, 2b, 2c, 3)
Clear zone > 11.5m and ≤ 13.0m	110 km/h; 70 mph; (+ step 1, 2b, 2c, 3)
Clear zone > 13.0m or safety barrier	>110 km/h; >70 mph; (+ step 1, 2b, 2c, 3)

**Step 2b: Shoulder type and width**

Although the shoulder is part of the clear zone, the pavement of the shoulder and shoulder width are tested separately. Especially hardened shoulders are more important to have with higher speeds. See Table 4 for an overview of shoulder requirements.

**Table 4 Overview of requirements related to shoulder pavement and width**

Shoulder pavement and width	Maximum 'safe' speed or speed limit:
Soft or no shoulder (or other types)	50 km/h; 30 mph; (+ step1)
Unpaved shoulder (or paved shoulder)	50 km/h; 30 mph; (+ step1)
Unpaved shoulder, width $\geq 1\text{m}$ ; or paved shoulder	60 km/h; 40 mph; (+ steps 1, 2a, 2c)
Unpaved shoulder, width $\geq 2\text{m}$ ; or paved shoulder, width $\geq 1\text{m}$	70 km/h; 45 mph; (+ steps 1, 2a, 2c)
Paved shoulder, width $\geq 2\text{m}$	>70 km/h; 45 mph; (+ step 1, 2a, 2c)

### Step 2c: Lateral conflicts

The ERASER tool considers lateral conflicts by taking into account the type and frequency of intersections. A distinction is made between public and private intersections (accesses), which are related to a safe functionality of roads (e.g. Wegman and Aarts 2006).

**Table 5 Overview of requirements related to lateral conflicts**

Type and frequency of intersections	Maximum 'safe' speed or speed limit:
All types of intersections	50 km/h; 30 mph; (+ step1)
At most intersections at grade with speed reducing measures (incl. no and at grade intersections and roundabouts)	60 km/h; 40 mph; (+ steps 1, 2a, 2b, 2c)
At most intersections at grade with speed reducing measures, only some private accesses	70 km/h; 45 mph; (+ steps 1, 2a, 2b, 2c)
At most intersections at grade with speed reducing measures, low intersection frequency, no private accesses	90 km/h; 55 mph; (+ step 1, 2a, 2b, 2c)
At most intersections grade separated (incl. none), low junction frequency, no private accesses	>110 km/h; >70 mph; (+ step 1, 2a, 2b, 2c)

### Step 3: Physical separation of driving directions

In the current ERASER tool, only the availability and physicality of the separation of driving directions is taken into account as a relevant measure for safety (see Table 6).

**Table 6 Overview of requirements related to separation of driving directions**

Type of separation of driving directions	Maximum 'safe' speed or speed limit:
No separation	60 km/h; 40 mph; (+ steps 1, 2a, 2b, 2c)
Marked separation	70 km/h; 45 mph; (+ step 1, 2a, 2b, 2c)
Physical separation	>70 km/h; 45 mph; (+ step 1, 2a, 2b, 2c)

### 4.2.2 Credibility assessment

In the ERASER tool, the concept and knowledge about credible speed limits is taken as an equivalent to get self-explaining roads. This means that the ERASER tool leads to a road design that fits better to the intuitive speeds most drivers would prefer on a road. It does not take into account more explicit ways of communicating road characteristics like speed limits and possible presence of other road user types. The use of explicit cues can be taught to drivers, unless cues are not too obscure (e.g. Aarts and Davidse 2008).

The credibility assessment in the ERASER tool is performed by a summing up of characteristics that are known to act as a decelerator or an accelerator depending on the speed limit that is at hand. By adding accelerators as +1 and decelerators as -1, a final score is got from which the credibility situation of the speed limit can be derived:

- A score of 0 means that the road has a more or less credible speed limit
- A score lower than 0 means that the speed limit is too high (undercredible); drivers might tend to drive slow
- A score larger than 0 means that the speed limit is too low (uncredible); drivers might tend to speed

In this first draft of the tool, accelerators and decelerators are summed with an equal weight. This might be fine-tuned when more knowledge becomes available. Results of the Road User Pilot (WP2) may be used as a first direction for weights. These results might also be used for making the assessment more country-dependent, there appeared to be differences in the influence of credibility factors depending on the country where people come from (Houtenbos, Weller et al. 2011).

The next sections discuss the variables and cut-off scores that are used for the credibility assessment in the ERASER tool.

#### Road width, lane width and number of lanes

One of the important factors that should not be too difficult to gather data about is the width of the road or the lanes. The credibility effect is calculated on the uninterrupted road space that the driver can see on his driving part. This means that for roads with a physical separation, only the lane width is taken into account, multiplied by the number of lanes on the side of the driver. On undivided roads, the road width is taken into account. See Table 7 for an overview of road width, lane width and number of lanes and what cut-off scores are used to know whether they act as an accelerator or decelerator per speed limit.

**Table 7 Overview of accelerators and decelerators per speed limit, related to width of the road and lanes and number of lanes**

Speed limit	Decelerator	Accelerator
60 km/h; 40 mph	Road width < 4.5m Lane width < 2.5m -	Road width > 5.5m Lane width > 2.6m Lanes
70 km/h; 45 mph	Road width < 5m Lane width < 2.5m No lanes	Road width > 6m Lane width > 2.8m Lanes per driving direction > 1
80 km/h; 50 mph	Road width < 7m Lane width < 2.5m No lanes	Road width > 8m Lane width > 3.0m Lanes per driving direction > 1
90 km/h; 55 mph	Road width < 12m Lane width < 2.7m No lanes	Road width > 15m Lane width > 3.3m Lanes per driving direction > 1
100 km/h; 60 mph	Road width < 18m Lane width < 2.9m Lanes per driving direction < 2	Road width > 22m Lane width > 3.6m Lanes per driving direction > 2
110 km/h; 70 mph	Road width < 20m Lane width < 3.1m Lanes per driving direction < 2	Road width > 24m Lane width > 3.7m Lanes per driving direction > 2

### Separation of driving directions

The availability and type of separation of driving directions can give the road the look and feel of a higher or lower order road. See Table 8 for the details how separation of driving direction is defined as accelerators and decelerators in the ERASER tool. Furthermore, the separation of driving directions is relevant for the influence of width of the road or lanes (see previous paragraph).

**Table 8 Overview of accelerators and decelerators per speed limit, related to separation of driving directions**

Speed limit	Decelerator	Accelerator
60 km/h; 40 mph	-	Separation of driving directions
70 km/h; 45 mph	No separation of driving directions	Physical separation of driving directions
80 km/h; 50 mph	No separation of driving directions	-
90 km/h; 55 mph	No separation of driving directions	-
100 km/h; 60 mph	No separation of driving directions	-
110 km/h; 70 mph	No separation of driving directions	-

**Horizontal alignment: length of tangents**

In the current version of the ERASER tool only the length of tangents is taken into account as an alignment measure that has an effect on speed limit credibility. Table 9 shows how the length of tangents is operationalized in the ERASER tool as accelerators and decelerators per speed limit.

**Table 9 Overview of accelerators and decelerators per speed limit, related to length of tangents**

Speed limit	Decelerator	Accelerator
60 km/h; 40 mph	Tangent <65m	Tangent >180m
70 km/h; 45 mph	Tangent <80m	Tangent >240m
80 km/h; 50 mph	Tangent <105m	Tangent >300m
90 km/h; 55 mph	Tangent <135m	Tangent >380m
100 km/h; 60 mph	Tangent <170m	Tangent >460m
110 km/h; 70 mph	Tangent <210m	Tangent >550m

**Access restrictions for vulnerable road users**

Availability of access restrictions is related to higher order roads and can have an effect on speed choice. See Table 10 for the way in which access restrictions are taken into account as credibility factor in the ERASER tool.

**Table 10 Overview of accelerators and decelerators per speed limit, related to access restrictions for vulnerable road users**

Speed limit	Decelerator	Accelerator
60 km/h; 40 mph	-	Access restrictions
70 km/h; 45 mph	No access restrictions	-
80 km/h; 50 mph	No access restrictions	-
90 km/h; 55 mph	No access restrictions	-
100 km/h; 60 mph	No access restrictions	-
110 km/h; 70 mph	No access restrictions	-

### Lateral conflicts

The type and frequency of intersections can have an effect on speed choice and is for this reason taken into account in the ERASER tool (see Table 11).

**Table 11 Overview of accelerators and decelerators per speed limit, related to access restrictions for vulnerable road users**

Speed limit	Decelerator	Accelerator
60 km/h; 40 mph	-	No at grade intersections; no speed reducing measures at intersections
70 km/h; 45 mph	Speed reducing measures at intersections	No at grade intersections
80 km/h; 50 mph	Speed reducing measures at intersections	No at grade intersections
90 km/h; 55 mph	At grade intersections; speed reducing measures at intersections	-
100 km/h; 60 mph	At grade intersections; speed reducing measures at intersections	-
110 km/h; 70 mph	At grade intersections; speed reducing measures at intersections	-

### Road environment

Although most road authorities might have no data on the direct environment of their roads, too many studies have shown that the environment has an effect on speed choice for this characteristic to be ignored. Table 12 shows how the road environment characteristics are used as a speed limit credibility factor in the ERASER tool.

**Table 12 Overview of accelerators and decelerators per speed limit, related to road environment**

Speed limit	Decelerator	Accelerator
60 km/h; 40 mph	-	Open road environment
70 km/h; 45 mph	Dense road environment	Open road environment
80 km/h; 50 mph	Dense road environment	Open road environment
90 km/h; 55 mph	Dense road environment	Open road environment
100 km/h; 60 mph	Dense or semi-open road environment	-
110 km/h; 70 mph	Dense or semi-open road environment	-

### 4.3 Output of the tool

The ERASER tool gives a final output that consists of three parts (see Figure 9):

- Outcome related to system safety of the assessed road
- Outcome related to credibility features of the road
- Indication of urgency to start actions

All this output is meant to give the road authority an impression of what steps could be taken to improve the situation and how urgent these steps are. When jurisdictions really decide to take action, it is wise to use the outcome of the tool as an indication and take next steps to assess the local situation more detailed. Eventually, the help of specialists can be required as well.

The next paragraphs provide more details about what to expect from the ERASER tool outcome.

#### 'Safe' speed outcome

The outcome related to system safety consists of the 'safe' speed limit that is the result of the safe system requirement assessment. This speed limit is the highest speed limit that is considered to be 'safe' based on the weakest safe system element of the road. If the 'safe' speed limit is lower than the actual speed limit, the ERASER tool provides a list of possible measures that can be taken to improve the situation. In general, there are two possible directions to improve the situation:

- Lower the posted speed limit in order to make the speed limit better fit to the requirements of a safe system approach
- Take measures in the road design to get a better fit between the current speed limit and the safe system requirements of the road design

These measures are indicated in general terms, and also include an indication of the effectiveness of the measure as well as an indication of the costs (see the paragraph 4.3.1 for more details). From this list of possible measures to take, the road authority can deduce the characteristics that do not fit to the speed limit according to safe system requirements.

## Credible speed limit outcome

The ERASER tool gives an indication whether the current speed limit is 1) credible, 2) too high or 3) too low to be credible. Furthermore, details are provided of the accelerators, decelerators and credible features that were found in relation to the speed limit. As the credibility of speed limits is a delicate balance between elements related to the road design and road environment, it is hard to give ready-made indications of measures that can improve the situation. Furthermore, adaptations that might be taken to improve the safety situation can also have their impact on credibility. When the road authority is willing to reconsider and improve the credibility of the situation, the advice is to make a balanced evaluation of all the elements that can play a role. One of the deliverables of SPACE (Charman, Grayson et al. 2010), is given as an example to look at for getting ideas about what can be done to improve the situation.

Finally, the road authority is explicitly advised to also look at actual speed measurements. He is pointed to the fact that speed behaviour is influenced by a lot of factors other than design, like for instance, police enforcement.

### 4.3.1 Dealing with effectiveness and costs of measures

As noted above, the ERASER tool gives an indication of the effectiveness and the costs of the measures that can be implemented to get a better fit between the current speed limit and the safe system requirements of the road design. The effectiveness of measures is expressed in percentage reduction of injury accidents, rounded off by 5%. Since the measures in the ERASER tool are indicated in general terms, more specific measures have been identified. For each of these specific measures the effectiveness has been estimated on the basis of literature, resulting in ranges of effectiveness of the general measures. The main sources are The Handbook of Road Safety Measures (Elvik, Høye et al. 2009), and additionally an overview study of effectiveness and costs of road safety measures (Wijnen, Mesken et al. 2010, in Dutch, summary in English). Appendix 2 gives an overview of the effectiveness of each general measure and the underlying specific measures that has been used to get an indication of effectiveness. Also the specific sources that have been used to estimate the effectiveness are given there.

In addition, the ERASER tool gives an indication of the investments costs of measures. Since the costs of measures are dependent on country-specific characteristics - like general price level and prices of specific inputs - cost categories are used instead of costs expressed in euros. The indication of the costs is based on cost estimates of road safety measures in Norway (Elvik, Høye et al. 2009) and the Netherlands (Wijnen, Mesken et al. 2010). On the basis of the investment costs of each specific measure, the costs of the general measures have been classified into three classes: low (< 200.000 euro), medium (200.000-750.000 euro) and high (> 750.000 euro). The divergence of the costs of the measures was taken into account when setting the boundaries of these classes, although they are still somewhat arbitrary. Note that the costs that occur during the lifetime of a measure, like maintenance costs, are not directly taken into account. However, normally these costs are expected to be a more or less fixed percentage of the investments costs, and they are much lower than the investments costs. Including these costs would therefore have no effect on the cost category. Appendix 3 gives an overview of the costs of each general measure and their specific measures, as well as the sources that have been used.

### 4.3.2 Priority setting

As was pointed out before, the 'safe' speed limit assessment might be perceived as 'going too far' and strict because it might indicate a large difference between the safe system

requirements and the actual situation. The most prominent example is the access restrictions for vulnerable road users as one of the requirements for a 'safe' high speed road. As a matter of fact, a lot of countries may not have these access restrictions because they have no or nearly no vulnerable road users of a particular type on their roads (e.g. cyclists). One way to work around this restriction is to select such a road as if it had an access restriction.

However, the point is more general than that. This is also related to the cost-effectiveness of measures and the urgency to take further steps. On roads with very low traffic volumes (in general of traffic of a certain type), it is less obvious to take strict requirements into account than when these roads have high traffic volumes (general or of a certain type). Because of this, priority setting is included in the ERASER tool and uses indications of traffic volumes of the following traffic modes:

- General traffic
- Pedestrian use
- Cyclist use
- Moped use

Volumes are only taken into account in very crude classes of high, moderate, and very low use of the road. No absolute figures (e.g. AADT) are used here, because what is high and what is moderate is very country-specific. The tool leaves this indication to the road authority.

The indication of urgency is generally calculated as indicated in Table 13.

**Table 13 General calculation rules for urgency of taking action.**

	Speed limit <= 'safe' speed limit	Speed limit > 'safe' speed limit
<b>Speed limit is too high</b>	low	low
<b>Speed limit is credible</b>	no action required	moderate
<b>Speed limit is too low</b>	moderate	high

Furthermore, in special situations of traffic use, the urgency is adapted in the following way:

- If the general use of the road is low, the urgency is set one step lower
- If there is an access restriction required, AND this is the only safety requirement that is missing, AND the use of vulnerable road users is very low, the urgency is set one step lower (e.g. from moderate to low).

## 5 Usability and functionality check of the ERASER tool

The aim of the usability and functionality check was to ensure that the final version of the ERASER tool was as useful, and useable, as possible for Road Authorities. The usability and functionality check included an exploration of:

- Acceptance of the rules that underpin the tool (including the notions of safe and credible speed limits)
- How the Road Authorities would envisage using the tool
- The functionality that would be desirable to include or exclude from the tool
- The ease at which Road Authorities can collect the data that the tool requires
- The utility of the results of the tool and how these are presented

### 5.1 Methodology

#### 5.1.1 Meeting in Bonn

The Conference of European Directors of Roads (CEDR) road safety group meeting in Bonn held on 6th October 2011 provided an exceptional opportunity to present the ERASER tool to Road Authorities and gain feedback in a workshop style session. The special session held immediately before the CEDR road safety group meeting, was attended by 18 participants from 16 countries.

The ERASER team were particularly grateful for this opportunity to gain feedback from a wide range of Road Authorities within the context of a single meeting.

#### 5.1.2 Materials and demonstration

The session began with an introduction to the ERASER project and the programme for the morning (see Appendix 4). Following this, an overview of the ERASER tool was provided that outlined the importance of speed in road safety, and the concept of 'credible' speed limits (see Appendix 5). The participants were presented with the 'safe system'-rules that underlie the tool and the credibility assessment model was explained.

The introduction to the ERASER tool was followed by a 'walk-through' of the tool, which took the participants through the current functionality and planned functionality for the tool (see Appendix 6). The walk through also provided an opportunity to explore the ways in which the Road Authorities would plan to use the tool, the principles and rules underlying the tool, the ease at which road authorities could collect the data required by the tool and the utility of the presentation of results.

Finally, several 'real-life' examples were provided which demonstrated how the tool could be used and the results that were provided (see Appendix 7).

#### 5.1.3 Questionnaire

A questionnaire was developed in order to gain feedback from the participants. The participants were able to answer questions as the presentations were given, or at their leisure following the meeting. The questionnaire is provided in Appendix 8.

## 5.2 Feedback from road authorities

As well as informal feedback provided during the CEDR session, eight questionnaires were received, the countries represented being Germany, Italy, the Netherlands, Spain, Hungary, Slovenia, Ireland, and Switzerland (50% of those present).

In addition, a colleague from Sweden later responded by explaining that:

“It is almost impossible to answer and contribute to this questionnaire without being involved in and familiar with the present ERASER-version. But, the objectives of the project are challenging and we’re very interested in the result.”

Each of the questions asked is presented, followed by the numbers of responses to each question and / or the comments received in response in Appendix 9. A summary of the responses is described in the following paragraphs.

### 5.2.1 Purpose of the tool

All responding authorities surveyed indicated that they have the authority and responsibility to improve the passive safety and the majority indicated that they can take measures to improve the credibility of speed limits, and have the authority to change speed limits. However, few have the responsibility to install and operate speed cameras and the comments suggested that getting the police to enforce speed limits can be challenging.

All but one of the respondents indicated that there is a need for a tool for assessing the degree to which roads are self-explaining, with the dissenter indicating that more evidence is required to support the concept of self-explaining roads. The majority also indicated that there is a need for a tool for speed management, with one person responding that the tool would benefit from taking a network-wide approach. In a later question, the majority indicated that they would like a tool that can be applied across the whole network.

Most respondents considered that a speed management tool should recommend changes to the speed limit where required, and five of the eight would like a tool that recommends engineering treatments to improve both passive safety and credibility. Half of the respondents also liked the idea of a tool that recommends locations for increased enforcement and cameras, but few desire a tool that recommends educational interventions. These findings appear to reflect the responsibilities that authorities have. Additional comments regarding the capability of a speed management tool indicated that some respondents have the opinion that speed enforcement should be located based on the location of collisions that involved excessive speed, rather than on the basis of the current tool.

The majority of respondents already have some tools to help with similar functions, including the analysis of collision data and speed comparison software. However, the comments appear to reveal a gap in terms of tools for assessing the effect of the road environment on driver behaviour.

Half of the respondents indicated that they would like a tool that provides guidance, but which leaves the details to the road authority concerned. The same proportion also indicated that proactive treatment of locations that may be problematic in the future would be desirable. There were mixed responses when the road authorities were asked if they would like a complex tool or a simple tool, and about their willingness to pay for these to be developed. Additional comments pointed out that the tool had not yet been trialled, could be no more than a secondary source in any case, and that some of the mitigation measures suggested by the tool are unlikely to be sufficient where larger scale re-engineering work is required.

Several commented that the tool may be most appropriate for use in order to demonstrate to

politicians and other stakeholders why it is important to either maintain or reduce a speed limit.

### 5.2.2 The fundamentals

Whilst half of respondents indicated that they agree with the safe speed rules, a quarter did not, indicating that the concept was too theoretical, and a further quarter indicated that the application of a 'safe' speed approach may be challenging given their existing road infrastructure. Nonetheless, the comments indicated the tool could help to push political will.

The majority of respondents liked the idea of the credibility of a speed limit, with others indicating that they would accept the idea and might try out the tool. Again, one responder indicated that more research is required to support the idea of credible speed limits. The comments indicated that the tool needs to be developed further and emphasised that the idea of credibility is complex.

### 5.2.3 Data input

Most responders would like to have both data input and the credibility assessment to be country specific, so that the options available and the accelerators and decelerators are tailored appropriately.

The majority would like both actual speed and functional speed to figure in the tool, with most using 85th percentile speeds as their meaningful speed metric. Others indicated that average speeds would be useful, whether instead of or in addition to the 85th percentile speed. Most respondents indicated that the actual speed should be used to determine if there is a problem with speed limit credibility, and that credibility recommendations would not be needed if the actual speeds were already appropriate. Half also indicated that the actual speed would provide a sense check for the credibility assessment.

The number of lanes would be a desirable input for most respondents; most indicated that the carriageway and lane width ranges were already satisfactory, with a few comments suggesting that more precise values (smaller ranges) would be desirable. Similarly, most of the people responding to the questionnaire thought that the straight road length information was satisfactory, though the comments suggested that more effort might be required to make this a meaningful measure for road authorities.

As regards roadside shoulder information, some respondents suggested a simple paved / unpaved split would be useful, perhaps together with an indication of whether a paved roadside was an emergency lane, for example, while others wanted more precision in the widths. The type of roadside barrier was also regarded as a desirable input, along with a measure of the distance of obstacles from the road. However, other comments suggested that there should not be too many categories in order to facilitate data collection.

Most respondents regarded the intersection types as satisfactory as they are, though some wanted additional information such as traffic volumes to be included. On the other hand, more specific information on the intersection and access frequency was considered to be desirable by half of the respondents.

There was not a substantial demand for median markings to be used for the credibility assessment or for moped facilities or use to be included, but most respondents wanted pedestrian and bicycle facilities and use to be included. Most of those who responded wanted more precise traffic volume information to be included, and comments indicated that the proportion of traffic formed by heavy goods vehicles would be a useful input. Most respondents appeared to agree with the inclusion of the existing and proposed future variables in the tool, with some demand for additional geometric variables, such as horizontal

and vertical alignment.

#### **5.2.4 Results**

The most desired speed comparison was between posted and actual speeds, while there was little demand for functional speed information. As well as recommendations on road infrastructure, recommendations on speed camera locations and on changes to posted speed limits were also seen as desirable.

In the summary information, most respondents wanted the calculated safe speed presented, together with the posted speed limit and an assessment of the credible speed. The actual speed was also wanted by half of the respondents.

In the safe speed assessment, as well as the assessment itself, treatment suggestions were also seen as desirable. The respondents indicated that, as well as treatment options, an indication of the issues and a broad indication of the benefit-cost ratio might be desirable.

In the credibility assessment, as well as the assessment itself, there was a desire for the identification of accelerators, decelerators and credible road features. Half of those responding indicated that they wanted ERASER fact sheets.

Half of those responding also indicated that they would like guidance and advice on treatments, rather than detail. There was some support for a network-wide tool, for mapping and other colour coding.

### **5.3 *Proposed changes to the tool***

Although not all road authorities that visited the CEDR-meeting responded to the questionnaire, the majority of those who responded seemed to be quite content with the main ideas underlying the current ERASER tool. Where suggestions were made for changes, these were with respect to the fine tuning of the tool. In some respects, road authorities did not always provide compatible viewpoints – some preferring greater data entry requirements and better precision, others wanting the tool to remain simple and to have low data entry requirements. This suggests that in the future, two versions of the tool might be developed, one that allows greater precision through intensive data input, another that remains simple and has relatively straightforward data needs.

Based on the comments of the road authorities, the ERASER tool has been improved by providing a more precise explanation of the required data and improving the indication of categories within the data-input where needed. Other suggestions that were made – for instance the wish to include more speed comparisons and a network-wide approach - might be taken into account if a more extended version of the tool can be developed in the future.

## Appendix 1

SER dataset for an extended tool that may run on a GIS-based system. Note that for all these data, the choice can be made whether to look at the typical characteristics of a road or look more detailed and use dynamic segmentation.

Variable	Description of content to use in a tool
Name of the Region, name of the road section	Optional. This can be relevant if several different regions are investigated and keep the possibility to compare or benchmark results from different regions.
Start	Number of the hectometre stake at which the road segments (only if relevant) starts or earth-coordinates of the starting point of the road section
End	Number of the hectometre stake at which the road segments ends (only if relevant) or earth-coordinates of the starting point of the road section
Length	Length of the road section (in meter or other entity)
Rural or urban area	Optional, especially if there is interest in a distinction and this cannot be seen from the speed limits.
Separation of driving direction	Classes: physical separation (e.g. median, kerb, safety barrier, vehicle deflection etc.), single centre marking, double centre marking, double centre marking with coloured centre, no separation. Markings: intermittent, continuous, typically combined, continuously combined
Road width	Road width of the road section (in meter)
Lane width	Lane width of the road section (in meter)
Type of shoulder	Classes: None, semi hard shoulder, Hard shoulder, not relevant, unknown
Shoulder width	Classes: Small, moderate, wide. Alternative: absolute width (e.g. in meter)
Shoulder drop-off	Classes: drop off, no drop off Alternative: absolute drop off (e.g. in meter)
Emergency/break-down facility	Classes: on the shoulder, may-bye's, emergency lane, none, other
On-road parking facilities	Classes: parallel parking zones, angled parking zones, no parking facilities
Road side protection	Classes: safety barrier, other barrier, no barrier
Clear zone	Distance of clear zone (.e.g. in meter) if road side protection is other than safety barrier

Road tangents	Classes: long tangents- straight , moderate tangents, short tangents - bendy
Vertical alignment	Classes: descent, flat, ascent; Form: convex, concave Alternative: slope gradient,
Sight distance (e.g. stopping sight distance)	Classes: large, moderate, small Alternative: absolute sight distance (e.g. in meter)
Road surface	Classes: cobblestones, bricks, silent asphalt, concrete, normal asphalt, dust, other, unknown
Road surface quality	Classes: high quality, moderate, poor Alternative: absolute friction coefficient of the road surface (typical or per dynamic section)
Traffic calming measures	Classes: no traffic calming, calming at intersections only, calming at road sections only, calming at both road sections and intersections Types: chicanes, roundabouts, speed humps, plateaus, not relevant, other, unknown
Pedestrian facilities	Classes: pavement/footway, two-path (pedestrians, cyclists) none, other, unknown
Moped and/or cycling facilities	Classes: cycling street, cycling path (separate facility), cycling lane (on the road), combined cycle-moped path, other, unknown, no facilities Additional: compulsory, non-compulsory; Additional: one side of the road with one direction, two sides of the road with one direction, one side of the road with two directions
Service road or service facility	Classes: no service road, service road on one side, service road on two sides,
Intersection type	Classes: none, grade separated and/or cross-sections and/or T-junctions and/or public accesses and/or private accesses Giving way features: signalised, priority, turning pockets, none, not relevant
Intersection density	Classes: low density, moderate, high Absolute: density in junctions per kilometre
Road environment	Classes: sparse/open road environment, dense/obscure road environment, neutral environment, unknown Additional: driving side, other side, both sides, unknown
Speed limit	Speed limit (in km/h or mph)
Access restriction	Classes: access restrictions for pedestrians (and/or) cyclists (and/or) mopeds (and/or) other slow traffic (and/or) heavy traffic, no access restrictions

Overtaking restrictions	Yes/no Cross-check with separation of driving directions
Parking restrictions	Classes: no parking restrictions, parking on the road, parking allowed in on-road facilities
Speed enforcement	Absent, present
Speed enforcement method	Classes: not relevant, average speed cameras, spot speed cameras, radar controls, police surveillance, other methods, unknown
Speed enforcement effort	Amount of time (hours per day, days per month, days per year) police enforcement is present

## Appendix 2

Effectiveness of safety measures as used in the ERASER tool, and their underpinning.

Safety advice ERASER tool	Measure	Effectiveness (reduction injury accidents)	Specific measure	Effectiveness (reduction injury accidents)	Sources
Access restriction recommended for vulnerable road users.	Restrict access or construct separate infrastructure	0-25%	signs	N.a.	Elvik et al. (2009, p. 157) Wijnen et al. (2009)
			bicycle/moped track service road	no significant effect 25%	
Shoulder should be > Xm or forgiving road side.	Obstacles	20-75%	Increase obstacle-free zone	22-70% <sup>1</sup>	Elvik et al. (2009, p. 232), Wijnen et al. (2009)
			screen obstacles (safety barrier)	44%, 47%	
Shoulder	Shoulder	15-30%	(semi-)hard shoulder + removing obstacles	51-75%	Wijnen et al. (2009)
			raised junction construct roundabout	30% 69%	
Level junctions should have speed reducing measures (e.g. plateaus).	Junction measures	30-70%	service road combined with removing exits	25%	Wijnen et al. (2009)
			grade separate junction	57% (X-junction), 24% (T-junction), 28% (signalised junction)	
Exits are not recommended.	Construct separate infrastructure	25%	median	15%	Elvik et al. (2009, p. 225)
			median separation	n.a.	
Lateral conflicts should be eliminated (grade separate junctions).	Junction measures	25-55%	safety barrier	43%, 30%	Elvik et al. (2009, p. 255) Elvik et al. (2009, p. 255)
			cable-barrier	29%	
Physical separation of driving directions (e.g. kerb, median or safety barrier) is required.	Physical lane separator	15-30%	adaptation of speed limit sign	5-8% <sup>2</sup>	Aarts & Van Nes (2007, p. 81)

<sup>1</sup> Depending on the width of the zone  
<sup>2</sup> Based on 20 km/h reduction on roads with initial limit of 100, 80 and 60 km/h

## Appendix 3

Costs of safety measures as used in the ERASER tool, and their underpinning.

Safety advice ERASER tool	Measure	Investment costs (per km or per unit (junction, sign), 1000 euro, price level 2009)	Specific measures	Investment costs (per km or per unit (junction, sign), 1000 euro, price level 2009)	Sources
Access restriction recommended for vulnerable road users.	Restrict access or construct separate infrastructure	2-6 per sign (restrict access) 400-1000 per km (separate infrastructure)	signs	200-600 per sign	Elvik et al. (2009, p. 451), Wijnen et al. (2009)
			bicycle/moped track service road	1 mln 400,000	Elvik et al. (2009) Wijnen et al. (2009)
Shoulder should be > 2.5m or forgiving road side.	Obstacles	60-300	Increase obstacle-free zone	300,000	Wijnen et al. (2009)
			screen obstacles (safety barrier)	60,000-90,000	Elvik et al. (2009, p.153, p.256), Wijnen et al. (2009)
Shoulder	Shoulder	30	(semi-)hard shoulder + removing obstacles	30,000 <sup>1</sup>	Wijnen et al. (2009)
Level junctions should have speed reducing measures (e.g. plateaus).	Junction measures	20 (raised junction), 200-1000 (roundabout)	raised junction	17,000	Wijnen et al. (2009)
			construct roundabout	0,2-1 mln <sup>2</sup>	Elvik et al. (2009, p. 189), Wijnen et al. (2009)
Exits are not recommended. Lateral conflicts should be eliminated (grade separate junctions).	Construct separate infrastructure Junction measures	400 5,000-15,000	service road combined with removing exits	400,000	Wijnen et al. (2009)
			grade separate junction	5-15 mln	Wijnen et al. (2009), Elvik et al. (2009)
Physical separation of driving directions (e.g. kerb, median or safety barrier) is required.	Physical lane separator	30-50	median	n.a.	
			median separation	n.a.	
			safety barrier	30,000-50,000 <sup>3</sup>	Elvik et al. (2009, p.153), Wijnen et al. (2009), Elvik et al. (2009, p.256)
Decrease speed limit	speed limit adaptation	2-6 per sign	cable-barrier	37,500	Elvik et al. (2009, p.255)
			adaptation of speed limit sign	200-600 per sign	Elvik et al. (2009, p. 451), Wijnen et al. (2009)

<sup>1</sup> Dependent on shoulder width and terrain conditions

<sup>2</sup> Depending on the size of the roundabout

<sup>3</sup> Steel construction

## Appendix 4



**ERASER Project**

Presented by Dr Suzy Charman  
6th October 2011







### ERA Net Road

- Safety at the heart of road design funded 5 projects:
  - SPACE
  - ERASER
  - RISMET
  - EuRSI
  - IRDES
- 2 projects on Self Explaining Roads – SPACE and ERASER



Page • 2

### The ERASER project

TU Dresden produced the state of the art review available on ERA-NET website. Reviewed concept and theory behind Self Explaining Roads

SWOV and KFV have developed a tool to help guide road authorities as they make decisions on speed management – aim to make posted speeds 'safer' and more 'credible'

Information about ERASER will be disseminated on the project website, through fact sheets, reports, publications etc.



2 main strands of work:

1. Naturalistic driving studies with high tech analysis of movements of vehicles (University of Lund)
2. Internet based questionnaire study to investigate the effects of different combinations of road features on speed choice (SWOV)

This is the aim of today's workshop – to show you the tool and to get your views on whether it is useful, whether it meets a need you have already identified, and whether it seems to provide the right information



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**ERASER website**  
[www.kfv.at/eraser](http://www.kfv.at/eraser)

The screenshot shows a webpage with a navigation menu on the left containing 'Home', 'Project description', 'Work package 4', 'Work package 5', and 'Work package 6'. The main content area features a header image with the text 'ERASER' and 'ERASER: A multi-national European research project focusing on self-explaining pavement roads. The project aims to design the new pavement type incorporating knowledge of self-explaining roads and engineering practices.' Below the header, there is a 'Project description' section with a sub-heading 'ERASER' and a paragraph of text. The TRL logo is visible in the bottom right corner of the screenshot.

Page • 4

**Aims and objectives of this session**

- A key objective is to assess the feasibility of the outputs of earlier work and to refine these prior to dissemination (WP 5)
- Work Package 4 will ensure that:
  - The tools are as useful as possible to all the authorities in the PEB (and across Europe)
  - The product is effective in a broad range of scenarios
  - Solutions are as user friendly as possible for authorities
  - Uptake is good by involving road authorities in the development and refinement of the materials

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**Agenda**

Time	Topic	Facilitator
09.40	An introduction to the theoretical basis of the tool	Letty Aarts
10.00	Tool functionality	Suzy Charman
10.40	Break	-
11.00	Demonstration of the current version of the tool	Brian Lawton
11.40	Discussion	ERASER team
12.00	Close	-

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## Appendix 5



### Towards self-explaining and safe roads

Dr. Letty Aarts

road ERA net SWOV

Letty Aarts ERASER tool 1



### ERASER tool

road ERA net

- Aims
  - Support European road authorities
  - Topic: self-explaining roads (SER)
  - Allow for cost-effectiveness
- Inspired by ideas of
  - Self-explaining for speed: credible speed limits
  - Proactive, safe system approach: safe speed

SWOV

Letty Aarts ERASER tool 2

### Speed, safety and SER

road ERA net

- Important basis for safety:
  1. Decrease of crashes (black spots) and casualties
  2. ...important SPI for severe crashes and injury
  3. ... central theme in a generic safe system approach
- Speed and SER:
  - Credible speed limit: helps to get safe speed
  - SER not equal to full 'safe road design'



SWOV

Letty Aarts ERASER tool 3

## Both 50 km/h. Both safe? Both credible?

road ERAnet



SWOV

Letty Aarts

ERASER tool

4

## 100km/h or 120km/h? Which one?

road ERAnet



SWOV

Letty Aarts

ERASER tool

5

## Safe and credible

road ERAnet



1. Safe speeds and safe speed limits
2. Credible speed limits
  - Adapt road image
  - Adapt speed limit to safe speed limits
  - Additional enforcement
3. Informing drivers
4. Dynamic speed limits
5. ISA

SWOV

Letty Aarts

ERASER tool

6



## Main parts of the ERASER tool

- Safe speed assessment
  - Safety requirement testing
  - Specific features per speed limit (crash tests!)
  - If one or more features fail → speed limit drops
  
- Credibility assessment
  - Summing up decelerators (-1) and accelerators (+1)
  - Relative to speed limit: credible = 0



## What is a 'safe' speed?

(adopted from Sweden)

Types of infrastructure and traffic	Maximum safe travel speed (km/h)
Locations with possible conflicts between cars and pedestrians	30 (20 mph)
Intersections with possible side collisions between cars	50 (30 mph)
Roads with possible frontal collisions between cars	70 (40 mph)
Roads with no possibility of side or frontal collisions (only collision with structures)	>100 (> 60 mph)



## Credibility features

- Accelerators:
  - Open road environment
  - Wide road
  - Straight road stretches
  - High quality road surface



- Decelerators:
  - Dense road environment
  - Narrow roads
  - Short road stretches
  - Physical speed reducers
  - Low quality road surface





road ERA net

## Summary of ERASER tool

Assessment:

```

    graph TD
      SL[Speed limit] --> CSL[Credible speed limit]
      SL --> SS[Safe speed]
      SS --> P[Priority]
      CSL --> P
  
```

Options:

- Adapt speed limit
- Adapt road design & environment (list of features)
- Effects and costs/km

Additional general comment:

- Look at driving speeds, enforcement and communication

List of:

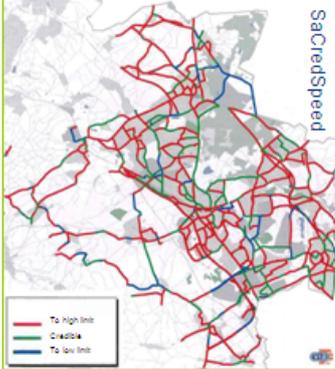
- Accelerators
- Neutral elements
- Decelerators
- Reference to ERA-NET SPACE-project

**SWOV**  
SWOV INSTITUUT VOOR WEGVEILIGHEIDSONDERZOEK

Letty Aarts ERASER tool 10

road ERA net

## Advanced versions of tool...

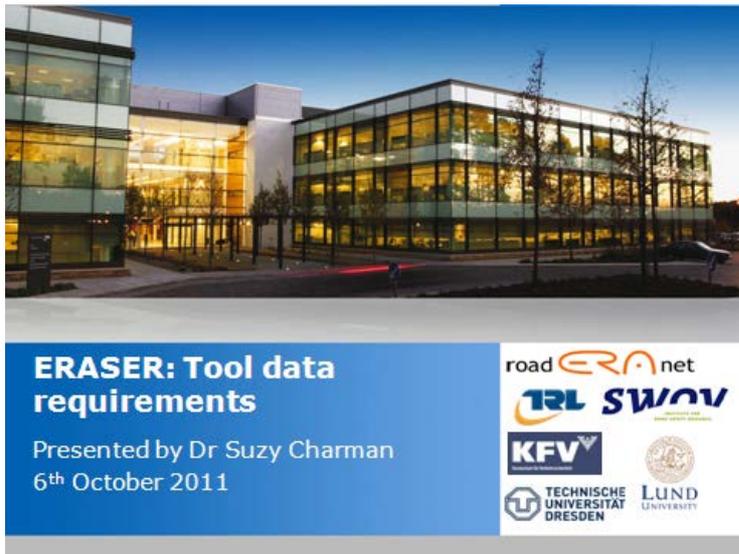


- Example of tool in NL:
  - GIS-based tool
  - Database of road network
  - Attractive user-interface

**SWOV**  
SWOV INSTITUUT VOOR WEGVEILIGHEIDSONDERZOEK

Letty Aarts ERASER tool 11

## Appendix 6



### As I'm talking ...

- Please think about, and write down on the questionnaire:
  - How you would use the tool
  - Any improvements you think we should include in the tool now or in the future
  - Anything you do not agree with
  - Comment on whether you (or your colleagues) would find the tool useful and for what purpose
- Not all the functionality that I will describe here is totally ready for the demonstration that will follow, however most of it will be in place soon
- I've flagged future developments in green
- If you would like to receive updates on what is included please let us know by providing your contact details on the questionnaire

Page • 2



### Use of the tool

- Currently:
  - Tool is currently to be used to review speed management on a single uniform stretch of road
  - Treatments that are suggested are infrastructure changes to make current speed limits:
    - 'Safer' in terms of crash severity outcomes
    - 'More credible' so that there is greater compliance with the posted speed limit
- In the future:
  - Could make the tool more advanced:
    - Allow a network wide review rather than just 1 section (see later in presentation)
    - Not only recommend infrastructure updates, but also other speed management interventions such as:
      - Speed limit changes
      - Prioritise areas for increased enforcement
      - Prioritise areas for educational campaigns

Page • 3



### The fundamentals ...

- Safe systems approach, other approaches relevant?
- Safe speed rules:

Types of infrastructure and traffic	Maximum safe travel speed (kph)
Locations with possible conflicts between cars and pedestrians	30 (20 mph)
Intersections with possible side collisions between cars	50 (30 mph)
Roads with possible frontal collisions between cars	70 (40 mph)
Roads with no possibility of side or frontal collisions (only collision with structures)	> 100 (> 60 mph)

- Credibility assessments

Page 4



### Country

- Austria
  - Germany
  - Ireland
  - The Netherlands
  - Sweden
  - United Kingdom
  - Other
- At present the tool is all static - ideally the tool would allow dynamic options to appear based on previous selections (e.g. if country = UK, speeds would be presented in mph etc.)
  - Can move to include more country options if there is demand
  - Translation?
  - Use of country specific credibility findings

Page 5



### Speed (now)

- **Posted speed limit**
  - 60 km/h (40 mph)
  - 70 km/h
  - 80 km/h (50 mph)
  - 90 km/h
  - 100 km/h (60 mph)
  - 110 km/h (70 mph)
  - 120 km/h (80 mph) and higher
- **Posted speed limits are used for comparison purposes**

Page 6



### Speed (future?)

- Actual speed
  - 85<sup>th</sup> percentile or V90
- Actual speed is not included now, but could be used to 'sense check' credible speed assessments
- Some challenges with actual speeds and how to use them since actual speed is influenced by enforcement etc.
- Functional speed
- Do we need to include functional speed – the speed that the road needs to achieve to fulfil it's function?

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### Cross section (future)

- **Number of lanes (direction A):**
  - 1
  - 2
  - 3
  - 4
- **Number of lanes (direction B):**
  - 1
  - 2
  - 3
  - 4
- Data could be used to assess credibility of posted speed limit
- Greater number of lanes in forward direction = accelerator

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### Cross section

- |                                     |                              |
|-------------------------------------|------------------------------|
| ▪ <b>Typical carriageway width:</b> | ▪ <b>Typical lane width:</b> |
| - <4.5m                             | - < 2.5m                     |
| - 4.5m and < 5.0m                   | - 2.5m and < 2.6m            |
| - 5.0m and < 5.5m                   | - 2.6m and < 2.7m            |
| - 5.5m and < 6.0m                   | - 2.7m and < 2.8m            |
| - 6m and < 7m                       | - 2.8m and < 2.9m            |
| - 7m and < 8m                       | - 2.9m and < 3.0m            |
| - 8m and < 12m                      | - 3.0m and < 3.1m            |
| - 12m and < 15m                     | - 3.1m and < 3.2m            |
| - 15m and < 18m                     | - 3.2m and < 3.3m            |
| - 18m and < 20m                     | - 3.3m and < 3.6m            |
| - 20m and < 22m                     | - 3.6m and < 3.7m            |
| - 22m and < 24m                     | - 3.7m and < 3.9m            |
| - 24m and < 26m                     | - => 3.9m                    |
| - => 26m                            |                              |

- Data used to assess credibility of posted speed limit
- Wide lanes = accelerator

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**Cross section**

- **Typical road environment – presence of vegetation and buildings:**
  - Open road environment: no vegetation or buildings on roadside
  - Semi-open road environment: some vegetation and/or buildings on roadside
  - Dense road environment: lots of vegetation and/or buildings on roadside
- Data used to assess credibility of posted speed limit
- Open road environment = accelerator

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**Cross section**

- **Maximum length of straight road:**
  - < 130m
  - => 130m and > 180m
  - => 180m and > 240m
  - => 240m and > 300m
  - => 300m and > 380m
  - => 380m and > 460m
  - => 460m and > 550m
  - => 550m
- Data used to assess credibility of posted speed limit
- Long length of straight road = accelerator

Page • 11

**Roadside**

- **Shoulder:**
  - Paved shoulder
  - Intermittent paved shoulder
  - Unpaved shoulder
  - Intermittent unpaved shoulder
  - Soft or no shoulder
- **Narrowest shoulder width:**
  - <1m
  - 1m-2m
  - >2m
- Data used to calculate safe speed – run-off crashes

Necessary to determine worst case for stretch of road for safe speed calculations

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### Roadside

- **Safety barrier:**
  - Good quality safety barrier in place along section length
  - Intermittent safety barrier
  - No safety barrier
- **Distance to nearest unprotected obstacle from shoulder edge:**
  - N/A (safety barrier throughout)
  - $\leq 2.5\text{m}$
  - $> 2.5\text{m}$  and  $\leq 4.5\text{m}$
  - $> 4.5\text{m}$  and  $\leq 6\text{m}$
  - $> 6\text{m}$  and  $\leq 8\text{m}$
  - $> 8\text{m}$  and  $\leq 10\text{m}$
  - $> 10\text{m}$  and  $\leq 11.5\text{m}$
  - $> 11.5\text{m}$  and  $\leq 13\text{m}$
  - $> 13\text{m}$
- Data used to calculate safe speed – run-off crashes
- Defaults to worst case e.g. if opt for intermittent safety barrier then the tool will use no safety barrier

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### Intersections (now)

- **Intersections:**
  - No intersections
  - Only grade separated intersections
  - Only roundabouts
  - Only junctions at grade with speed reducing measures (e.g. plateaus)
  - Only junctions at grade without speed reducing measures
  - Combination of junction types
- Data used to calculate safe speed – intersection crashes
- If side impacts are possible then safe speed cannot be greater than 50 Km/h based on the presence of speed reducing measures such as plateaus

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### Intersections (now)

- **Intersection frequency:**
  - No intersections
  - Very low intersection density
  - Moderate intersection density
  - High intersection density
- **Access frequency (private roads/driveways):**
  - No accesses to private properties along the road
  - Some accesses
  - Many accesses
- Data used to calculate safe speed – intersection crashes
- High frequency of intersections or accesses means safe speeds are lower
  - At very high speeds, no at grade junctions are allowed
  - At moderate speed, a moderate number of junctions are allowed
  - At low speeds (60 or 70), junctions with speed reducing measures are allowed.

Page \* 15



### Intersections (future?)

▪ **Grade separation (use slip roads for merges):**

- All are grade separated
- Some are grade separated
- None are grade separated

▪ **Roundabouts:**

- All junctions are roundabouts
- Some junctions are roundabouts
- No junctions are roundabouts

▪ **At grade junctions (T-junctions, Y-junctions or crossroads):**

- All junctions are 'at grade'
- Some junctions are 'at grade'
- No junctions are 'at grade'

▪ **Speed reducing measures:**

- Present
- Not present

▪ **Turning pockets:**

- All have turning pockets
- Some have turning pockets
- None have turning pockets

▪ **Signalisation:**

- All are signalised
- Some are signalised
- None are signalised

▪ **Data used to calculate safe speed**  
- intersection crashes

▪ **If side impacts are possible then safe speed cannot be greater than 50 Km/h**

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### Median (now) – Separation of driving directions

▪ **Separation of driving directions**

- No separation between driving directions
- Single intermittent middle marking
- Single continuous middle marking
- Double intermittent middle marking
- Double continuous middle marking
- Double continuous and intermitted middle marking
- Cross hatching middle marking
- Combination of separation types or no separation
- Physical separation (safety barrier, median, other physical separations)

▪ **Data used to calculate safe speed – head-on crashes**

▪ **If no physical separation safe speed can only be < 80 Km/h**

▪ **(Not possible to assess 'worst case' for a section of road at the moment)**

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### Median (future?)

▪ **Median safety barrier:**

- Median safety barrier throughout section
- Intermittent median safety barrier
- No median safety barrier

▪ **Other physical separation (grass/kerb):**

- Physical separation throughout section
- Intermittent physical separation
- No physical separation

▪ **Data used to calculate safe speed – head-on crashes**

▪ **If no physical separation safe speed can only be <80 Km/h**

▪ **Median line markings:**

- N/A – physical separation throughout
- Typically no median line markings
- Typically single 'dashed' centre line
- Typically solid double centre line (overtaking restriction)
- Typically cross hatching

▪ **Data used to assess credibility of posted speed limit**

▪ **Some markings are accelerators**

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**Vulnerable road users**

- **Access restrictions:**
  - No access restrictions for any road user group
  - Access restrictions for pedestrians
  - Access restrictions for pedestrians and bicyclists
  - Access restrictions for pedestrians, bicyclists and mopeds
- **Data used to calculate safe speed – VRU crashes**
- **If access restrictions then safe speed can be greater than 40Km/h**

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**Vulnerable road users (future?)**

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>▪ <b>Pedestrian footpaths:</b> <ul style="list-style-type: none"> <li>- Footpath along length of section</li> <li>- Intermittent footpath along length of section</li> <li>- No footpath</li> </ul> </li> <li>▪ <b>Type of pedestrian footpath:</b> <ul style="list-style-type: none"> <li>- Segregated</li> <li>- Non-segregated</li> <li>- N/A – no footpath</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>▪ <b>Pedestrian crossing facilities:</b> <ul style="list-style-type: none"> <li>- All grade separated (bridge or underpass)</li> <li>- Mixture of grade separated and surface level</li> <li>- All surface level</li> </ul> </li> </ul> |
|--|--|
- **Data used to calculate safe speed – VRU crashes**
  - **If fully segregated facilities (e.g. footpath away from road and separated with a good standard barrier, and crossings are bridges or underpasses) then higher safe speed is possible**

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**Vulnerable road users (future?)**

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>▪ <b>Bicycle facilities:</b> <ul style="list-style-type: none"> <li>- Bicycle lane along length of section</li> <li>- Intermittent bicycle lane</li> <li>- No bicycle lane</li> </ul> </li> <li>▪ <b>Type of bicycle lane:</b> <ul style="list-style-type: none"> <li>- Segregated</li> <li>- Non-segregated</li> <li>- N/A – no bicycle lane</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>▪ <b>Moped facilities:</b> <ul style="list-style-type: none"> <li>- Moped lane along length of section</li> <li>- Intermittent moped lane</li> <li>- No moped lane</li> </ul> </li> <li>▪ <b>Type of moped lane:</b> <ul style="list-style-type: none"> <li>- Segregated</li> <li>- Non-segregated</li> <li>- N/A – no moped lane</li> </ul> </li> </ul> |
|---|---|
- **Data used to calculate safe speed – VRU crashes**
  - **If fully segregated facilities then higher safe speed possible**

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### Use of road

- **General motorised traffic use:**
    - Very low use of the road
    - Moderate use of the road
    - High use of the road
  - **Pedestrian use:**
    - No use of the road
    - Very low use of the road
    - Moderate use of the road
    - High use of the road
  - **Bicyclists/moped use:**
    - No use of the road
    - Very low use of the road
    - Moderate use of the road
    - High use of the road
- Data used in order to give high priority to busy routes
  - Priority set to low if access restrictions are not sufficient for posted speed limit (must be 40km/h or less)
  - Could make this more precise by making this AADT for countries that have such data

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### Overview of data

	Safe	Credible
Now	<ul style="list-style-type: none"> <li>▪ Access restrictions for VRUs</li> <li>▪ Shoulder</li> <li>▪ Barrier/distance to obstacle</li> <li>▪ Intersection type</li> <li>▪ Intersection/access frequency</li> <li>▪ Median physical separation</li> </ul>	<ul style="list-style-type: none"> <li>▪ Carriageway/lane width</li> <li>▪ Road environment</li> <li>▪ Maximum length of straight road</li> </ul>
Later	<ul style="list-style-type: none"> <li>▪ Intersection turning pockets</li> <li>▪ Signalisation of intersections</li> <li>▪ Type and segregation of pedestrian, bicyclist and moped facilities</li> </ul>	<ul style="list-style-type: none"> <li>▪ Number of lanes</li> <li>▪ Median markings</li> </ul>

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### Results – Now

- Currently only 2 comparisons:
  - Safe speed compared to posted speed limit
  - Credible speed assessed against posted speed limit to produce 'accelerators' and 'decelerators'
- What about other comparisons
  - Actual speed (85<sup>th</sup> percentile or V90)
  - Functional speed
- What happens when they are all different?!
- Also only recommending engineering treatments, what about:
  - Changing the posted speed limit
  - Enforcement/speed camera locations

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**Results – Now**

- Overview of results:
  - Current speed limit
  - Calculated safe speed limit based on rules
  - Assessment of credibility
- Safe speed evaluation
  - What the evaluation is
  - Suggestion of interventions that might work
    - Estimate of effectiveness
    - Cost indication
- Credibility
  - Information presented:
    - Decelerators
    - Credible road features
    - Accelerators
  - Interventions – refer to SPACE report

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**Results – Now**

- Urgency evaluation based on:
  - Disparity between posted speed limit and safe speed limit
  - Disparity between posted speed limit and credible assessment
  - In combination with 'use of road' (high, moderate and low)
- Re-presentation of parameters

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**Results – Some improvements**

- Improve the layout of information

**Summary:**  
 The posted speed limit of your road is ..... 50 mph  
 The calculated safe speed is ..... 50 mph  
 The credible speed is higher than the posted speed limit  
 Actual speed (85<sup>th</sup> percentile) is ..... 55 mph

**Safe speed assessment**  
 The posted speed limit is higher than the safe speed for the road because:  
 •Risk of severe pedestrian crash: Pedestrian demand is high, there is no access restriction for pedestrians, there are no segregated pedestrian facilities and the speed limit is above the safe speed for pedestrian and motorised vehicles  
 •Risk of severe run-off road crash: Unprotected roadside obstacles within 2m of the roadside

Issue	Treatment options	Cost	Effectiveness
Reduce pedestrian crash severity	Segregated footpaths	\$\$	****
	Pedestrian bridge or underpass	\$\$\$\$\$	***
	Access restriction	\$	+
Reduce run-off crash severity	Increase clear zone	\$\$	****
	Roadside barriers	\$\$\$	***

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### Results – Some improvements

**Credible speed assessment:**  
Actual speed is greater than posted speed limit and safe speed

Accelerators	Credible road features	Decelerators
Open road environment	Number of lanes	Narrow lane width
Median markings		

**Treatment options**  
I would like to treat:

- A link
- A curve
- A transition (change in speed limit or transition to village)
- An intersection

Link to relevant part of SPACE report



### Results – Long term

**Speed information about selected road**

Posted Speed Limit? 60  
Actual Driver Speed? 62  
Functional Speed Limit? 60  
Safe Speed Limit 40

**Alerts**  
Safe speed is lower than Posted, Actual and Functional speeds. Increased risk of high severity injuries from collisions with roadside obstacles close to the roadside.

Treatment Options	Description	Treatments to Consider	Cost/E to £/EE/EE£	Effectiveness (% to %%%)	Typical C/I/H/Low, medium, High
Option1	Engineering to raise safe speed of road	Provide crash barriers Provide paved shoulder	EE£	%%	Medium
Option2	Lower speed limit and increase enforcement	Increase Police presence Vehicle Activated signs Lower Posted Speed Limit	EE	%%	High

- Interactive mapping – zoom in/out
- Colour coded according to priority or potential
- Alerts
- Interventions
  - Engineering
  - Enforcement
  - Speed limit changes
- Interventions cost, effectiveness, BCR?
- Functional and actual speeds included



## Thank you

Presented by Suzy Charman  
Road Safety Group  
6<sup>th</sup> October 2011

Email: [scharman@trl.co.uk](mailto:scharman@trl.co.uk)  
[blawton@trl.co.uk](mailto:blawton@trl.co.uk)



## Appendix 7



**ERASER: Tool use examples**

Presented by Brian Lawton  
6<sup>th</sup> October 2011

road ERA net  
TRL SWOV  
KFV  
TECHNISCHE UNIVERSITÄT DRESDEN  
LUND UNIVERSITY

### The ERASER Tool

<http://www.swov.nl/enquete/Eraser/Tool.php>



road ERA net

**ERASER**  
Evaluations to Realise a common Approach  
to Self-Explaining European Roads  
road research in europe

ERA-NET ROAD  
Project description  
Working Plan  
Partners  
Tool  
Download  
Legal notice

**Select your country**

- Other
- Austria
- Germany
- The Netherlands
- United Kingdom
- Ireland
- Sweden

 ERA-NET ROAD II is funded by the European Commission. 

### Example 1: A595 in Cumbria



Page • 3



### Select speed limit



- ERA-NET ROAD
- Project description
- Working Plan
- Partners
- Tool
- Download
- Legal notice

#### Speed limit of the road

- 60 km/h (40 mph)
- 70 km/h
- 80 km/h (50 mph)
- 90 km/h
- 100 km/h (60 mph)
- 110 km/h (70 mph)
- 120 km/h (80 mph) and higher



ERA-NET ROAD II is funded by the European Commission.



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## Cross section



**ERA-NET ROAD**

- Project description
- Working Plan
- Partners
- Test
- Download
- Legal notice

**Road characteristics (1 of 4)**  
Please fill in all boxes for the road that you would like to assess.

**Cross section**

**Separation of driving directions**  
Type of separation throughout whole the road section:

**Number of lanes**  
Lanes presence and number in direction A:  
  
 Lanes presence and number in direction B:

**Road widths**  
Typical width of carriageway:  
  
 Typical lane width:



ERA-NET ROAD is funded by the European Commission



## Road side and road environment

**Road characteristics (2 of 4)**

**Road side and road environment**

**Road shoulder**  
Type of road shoulder:  
  
 narrowest shoulder width:

**Roadside**  
Barrier along road side:  
  
 Distance to nearest obstacle from shoulder edge:

**Road environment**  
Typical density of the road environment:





open
semi open
dense

## Alignment



- ERA-NET ROAD
- Project description
- Working Plan
- Partners
- Tool
- Download
- Legal notice

### Road characteristics (3 of 4)

#### Alignment

##### Horizontal alignment

Length of straight, uninterrupted road:

< 130m

Next



ERA-NET ROAD II is funded by the European Commission.



## Road user interaction and use

### Road characteristics (4 of 4)

#### Road user interaction and use

##### Dealing with lateral conflicts in design

Junction presence and type:

only junctions at grade without speed reducing measures

Junction frequency:

moderate junction density

Frequency of accesses to private properties:

some accesses to private properties along the road

##### Vulnerable road users

Mixture with vulnerable road users:

no access restrictions for any road user group

Pedestrian facilities:

No footpath

Bicyclist facilities:

no bicycle track

##### Use of the road

General use of the road (motorised traffic):

very low use of the road

Pedestrian use of the road:

very low use of the road

Cyclist use of the road:

very low use of the road

Next

## Results (1)

### Results

The speed limit of your road= 60 km/h (40 mph)  
 The calculated safe speed limit=40 km/h (25 mph)  
 The speed limit is credible

### Evaluation details

The speed limit is higher than the current safe system standards allow for.  
 You might decrease the speed limit to 40 km/h (25 mph).  
 Effectiveness: 5-10%  
 Cost indication: low

Alternatively, you might adapt the falling design elements of the road, which are:

- Access restriction recommended for vulnerable road users.  
 Effectiveness: 0-25%  
 Cost indication: medium-high
- Obstacle free zone should be > 2.5m or safety barrier.  
 Effectiveness: 20-75%  
 Cost indication/km: low-medium
- Shoulders should be present and well paved, or be unpaved for more than 1m.  
 Effectiveness:  
 Cost indication/km:
- Level junctions should have speed reducing measures (e.g. plateaus).  
 Effectiveness: 30-70%  
 Cost indication/km: low-high

## Results (2)

### Credibility

#### Decelerators

- The road is smaller than 4.5m

#### Credible road features

- No access restrictions
- No separation of driving directions
- Dense or semi-open road environment
- Straight stretch of road is shorter than 180m

#### Accelerators

- No physical speed reducers at (all) junctions

When available, speed data can be a useful additional source of information. Be aware that speed is influenced by more factors than road design alone.  
 More information about measures that can be taken, can be found in this document of the [SPACE-project](#).

### Urgency

The urgency of taking action on your road is medium

## Example 2: A36 near Southampton



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## Data input

- Speed limit: 50mph
- Single intermittent middle markings
- 1 lane in each direction
- Typical width of carriageway:  $\geq 7\text{m}$  and  $< 8\text{m}$
- Typical lane width:  $\geq 3.3\text{m}$  and  $< 3.6\text{m}$
- Road shoulder: soft or no hard shoulder
- Narrowest shoulder width:  $< 1\text{m}$
- No safety barrier along road shoulder
- Distance to nearest obstacle:  $< 2.5\text{m}$
- Dense road environment: lots of vegetation and buildings
- Length of straight, uninterrupted road:  $< 130\text{m}$
- Combination of junction types
- Very low junction density
- No accesses to private property along road
- Access restrictions for pedestrians and bicyclists
- No footpath
- No bicycle track
- Motorised traffic: Moderate use of the road
- Pedestrians: Very low use
- Cyclists: Very low use

Page \* 12



## Results (1)

### Results

The speed limit of your road= 80 km/h (50 mph)  
 The calculated safe speed limit=50 km/h (30 mph)  
 The speed limit is too low to be credible

### Evaluation details

The speed limit is higher than the current safe system standards allow for.  
 You might decrease the speed limit to 50 km/h (30 mph):  
 Effectiveness: 5-10%  
 Cost indication: low

Alternatively, you might adapt the following design elements of the road, which are:

- Access restriction required for vulnerable road users and mopeds.  
 Effectiveness: 0-25%  
 Cost indication: medium-high
- Obstacle free zone should be > 6m or forgiving road side.  
 Effectiveness: 20-75%  
 Cost indication/km: low-medium
- Shoulders should be present, and well paved for more than 2m.  
 Effectiveness:  
 Cost indication/km:
- Level junctions should have speed reducing measures (e.g. plateaus).  
 Effectiveness: 30-70%  
 Cost indication/km: low-high
- Physical separation of driving directions (e.g. kerb, median or safety barrier) is required.  
 Effectiveness: 15-30%  
 Cost indication/km: low

Page • 13

## Results (2)

### Credibility

#### Decelerators

- No access restrictions for vulnerable road users and mopeds
- Physical speed reducers at lateral conflicts
- Dense road environment

#### Credible road features

- Separation of driving directions
- Straight stretch of road is shorter than 300m
- Road width between 7m and 8m

#### Accelerators

- None

When available, speed data can be a useful additional source of information. Be aware that speed is influenced by more factors than road design alone. More information about measures that can be taken, can be found in this document of the [SPACE-project](#).

#### Urgency

The urgency of taking action on your road is **Low**

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### Example 3: A33 near Reading



### Data input

- Speed limit: 70mph
- Physical separation
- 2 lanes in each direction
- Typical width of carriageway:  $\geq 7\text{m}$  and  $< 8\text{m}$
- Typical lane width:  $\geq 3.3\text{m}$  and  $< 3.6\text{m}$
- Road shoulder: soft or no hard shoulder
- Narrowest shoulder width:  $< 1\text{m}$
- No safety barrier along road shoulder
- Distance to nearest obstacle:  $\geq 2.5\text{ m}$  and  $< 4\text{m}$
- Semi-open road environment: some vegetation and buildings
- Length of straight, uninterrupted road:  $\geq 460\text{m}$  and  $< 550\text{m}$
- Only grade separated junctions
- Very low junction density
- No accesses to private property along road
- Access restrictions for pedestrians and bicyclists
- No footpath
- No bicycle track
- Motorised traffic: High use of the road
- Pedestrians: Very low use
- Cyclists: Very low use

Page \* 16



## Results (1)

### Results

The speed limit of your road= 110 km/h (70 mph)  
 The calculated safe speed limit=50 km/h (30 mph)  
 The speed limit is too low to be credible

### Evaluation details

The speed limit is higher than the current safe system standards allow for.  
 You might decrease the speed limit to 50 km/h (30 mph).  
 Effectiveness: 5-10%  
 Cost indication: low

Alternatively, you might adapt the failing design elements of the road, which are:

- Access restriction required for vulnerable road users and mopeds.  
 Effectiveness: 0-25%  
 Cost indication: medium-high
- Obstacle free zone should be > 11.5m or forgiving road side.  
 Effectiveness: 20-75%  
 Cost indication/km: low-medium
- Shoulders should be present, and well paved for more than 2m.  
 Effectiveness:  
 Cost indication/km:

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## Results (2)

### Credibility

#### Decelerators

- No access restrictions for vulnerable road users and mopeds
- Dense or semi-open road environment
- No access restrictions for vulnerable road users and mopeds
- Dense or semi-open road environment

#### Credible road features

- Physical separation of driving directions
- No lateral conflicts
- Straight stretch of road is shorter than 550m
- Lane width between 3.1m and 3.7m
- Physical separation of driving directions
- No lateral conflicts
- Lane width between 3.2m and 3.9m

#### Accelerators

- None

When available, speed data can be a useful additional source of information. Be aware that speed is influenced by more factors than road design alone.  
 More information about measures that can be taken, can be found in this document of the [SPACE project](#).

### Urgency

The urgency of taking action on your road is **Low**

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## Appendix 8

### ERASER Speed Tool Questionnaire

Name: .....

Country: .....

Organisation: .....

Email address: .....

- I would like to hear about future developments of this tool by email

#### Part 1: Introductory slides

##### Use of the tool

**As the road authority, we have the power to (please tick all that apply):**

- Change speed limits on some roads (please specify which roads below in comments section)
- Introduce measures to improve the passive safety of the infrastructure
- Introduce innovative measures to improve the credibility of speed limits
- Install speed cameras
- Operate speed cameras
- Ask for increased speed enforcement from the police

Comments:

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**Is there a need for a tool for assessing the degree to which roads are self explaining?**

- Yes
- No

If you answered 'no', then why not?

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**Is there a need for a tool for speed management?**

- Yes
- No

If you answered 'no', then why not?

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**What do you think a speed management tool should be able to do (please tick all that apply)?**

- Recommend changes to the posted speed limit where they are required
- Recommend engineering treatments to improve passive safety
- Recommend engineering treatments to improve speed limit credibility
- Recommend locations where increased enforcement efforts are required
- Recommend locations for speed enforcement cameras
- Recommend educational interventions
- Other (please specify)

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**Do you already have any tools that help with the above functions?**

- Yes
- No

If yes, please describe the tools and their functions

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**Please tick any statements that apply (the tool = speed management tool):**

- I would like a simple tool that I do not have to pay for
- I would like a more complex tool, even if I have to pay for it
- I would like a more complex tool, but it would need to be free
  
- I would like a tool that can be applied across my whole road network
- I would like a tool to be used at single locations
- I would like a tool to be used along a section of road
  
- I would like a tool that tells me exactly what sort of treatments I need to consider and where
- I would like a tool that provides guidance and advice, but leaves the detail to me and my colleagues
  
- I would like a tool that helps me prioritise where I spend my safety budget
- It is up to me and my engineers to determine priorities, not a tool
  
- I would like a tool that would help me to treat known hotspots (black spots)
- I would like a tool that would help me proactively treat locations that could become a problem in the future

Other comments

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**The fundamentals**

**Safe speeds (please tick all that apply):**

- I agree with the safe speed rules presented and think they are useful for the proactive management of speed
- I think the basic premise is right, but the application might be challenging in my country since we are a long way from a 'safe system'
- I do not believe in the safe speed rules (if you tick this box please use the comments section to explain why)

Other comments

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**Credible speeds (please tick all that apply):**

- I like the idea of 'credibility' of a speed limit and think the idea has potential
- I am happy to accept this innovative approach and may try out the tool
- More research has to be done before I'm willing to use the tool
- I do not like the idea of 'credibility' of a speed limit and think that it has no place in speed management (if you tick this box please use the comments section to explain why)

Other comments

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**Part 2: Data input**

**[Please note that not all desired functionality can be included in this version of the tool being developed for the ERASER project]**

**Country**

**Tick all options that you would like to see included (now or in the future):**

- Dynamic data input so that all items are relevant (e.g. country choice impacts on what speed limits are provided as options)
- Translation into my language
- Use of country specific accelerators and decelerators for credible speed assessment
- Other (please specify)

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**Speed**

**Tick all options that you would like to see included (now or in the future):**

- Actual speed
- Functional speed

Please explain why (preferably scientific basis) you would like these additional options to be included:

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**In my country, for actual speed, we use:**

- 85th percentile
- 90th percentile
- Other (please specify)

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**Actual speed (please tick all that apply):**

- Should be used
- Should not be used as it is difficult to collect these data
- Should be optional
- Should be used to provide a 'sense check' in the results to check credibility assessment is correct
- Should be used to determine if there really is a problem with speed limit credibility, and to remove credibility recommendations if actual speeds are OK
- Should replace credible speed assessment (only possible where enforcement is minimal or absent)
- Should be included in the model along with data on amount of enforcement activity

**Other comments**

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**Cross section**

**Please tick if you would like to see the following included (now or in the future):**

- Number of lanes

**Other comments (please comment on why the option(s) you ticked should be included)**

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**Options for carriageway width and lane width are:**

- Fine as they are – it should be easy to estimate this
- Fine as they are – but it will be difficult to estimate this
- The categories are too narrow for sensible estimates

Other comments

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**Options for road environment – please provide comments:**

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**Options for maximum length of straight road are:**

- Fine as they are – it should be easy to estimate this
- Fine as they are – but it will be difficult to estimate this
- The categories are too narrow for sensible estimates

Other comments

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**Roadside**

**Options for roadside shoulder – please provide comments:**

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**Options for roadside safety barrier – please provide comments:**

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**Options for roadside distance to nearest obstacle – please provide comments:**

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**Intersections**

**Intersection type (tick all that apply):**

- Is fine as it is – best to keep it simple
- Should include turning pockets
- Should include signalisation

**Other comments**

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**Intersection frequency/access frequency:**

- Is fine as it is – best to keep it simple
- Should be more specific – e.g. x intersections per x metres

**Other comments**

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**Median**

**Options for median treatment – please provide comments:**

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**Please tick if this statement applies:**

- It would be good to include median markings in the credible speed assessment

**Other comments (please comment on why the option(s) should be included)**

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**Vulnerable road users**

**Options for access restrictions – please provide comments:**

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**Tick all options that you would like to see included (now or in the future):**

- Pedestrian footpath facilities
- Segregation of footpath facilities
- Pedestrian crossing facilities
- Bicycle facilities
- Segregation of bicycle lane
- Moped facilities
- Segregation of moped lane

**Other comments (please comment on why the option(s) you ticked should be included)**

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**Use of road**

**General motorised traffic use categories:**

- Are fine as they are – broad categories are acceptable
- Should stay imprecise as accurate data are not always available
- Should be more precise (e.g. AADT)

Other comments

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**Tick all options that you would like to see included (now or in the future):**

- Pedestrian use (categories only)
- Bicycle use (categories only)
- Moped use (categories only)

Other comments (please comment on why the option(s) you ticked should be included)

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**Overview of data**

In the table below, please:

- Put a line through any variables that you think are unnecessary e.g. access restrictions
- Add any additional variables that you think we should consider including

	Safe	Credible
Now	Access restrictions for VRUs Shoulder Barrier/distance to obstacle Intersection type Intersection/access frequency Median physical separation	Carriageway/lane width Road environment Maximum length of straight road
Planned	Intersection turning pockets Signalisation of intersections Type and segregation of pedestrian, bicyclist and moped facilities	Number of lanes Median markings
Additional variables		

**Part 3: Results**

**Results: Now**

**At present, only 2 comparisons are made (safe speed vs. posted speed limit; credibility of posted speed limit). Do you think more comparisons should be included (tick all that apply)?**

- Posted speed limit vs. safe speed
- Posted speed limit vs. credible speed
- Posted speed limit vs. actual speeds
- Posted speed limit vs. desired functional speed
- Actual speed vs. safe speed
- Actual speed vs. credible speed
- Actual speed vs. desired functional speed
- Safe speed vs. desired functional speed
- Safe speed vs. credible speed
- Desired functional vs. credible speed

Posted speed limit	The current speed limit on the road
Actual speed	85th percentile or V90 travelled speed
Safe speed	Calculated safe speed based on 'rules'
Credible speed	The speed that drivers should intuitively adopt without posted speed limits or enforcement

Other comments (please comment on why the option(s) you ticked should be included)

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**At present, the tool only recommends changes to the road infrastructure. Would you like to see alternative recommendations made (tick all that apply)?**

- Enforcement locations
- Speed camera locations
- Changes to posted speed limits

Other comments (please comment on why the option(s) you ticked should be included)

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**Please provide any additional comments on the current results:**

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**Results – Some improvements**

**What information should be in the summary (please tick all that apply):**

- Posted speed limit
- Calculated safe speed
- Assessment of credible speed
- Actual speed

Other comments/ideas

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**What information should be in the safe speed assessment (please tick all that apply):**

- The assessment
- Explanation of the reason
- Treatment suggestions

Other comments/ideas

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**What information should be in the treatment information for safe speed assessment (please tick all that apply):**

- Issue
- Treatment options
- Indicative cost (as presented)
- More precise cost information
- Indicative effectiveness (as presented)
- More precise effectiveness information
- Benefit-Cost Ratio

Other comments/ideas

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**What information should be in the credible speed assessment (please tick all that apply):**

- The assessment
- Calculated credible speed (not currently proposed)
- Accelerators, credible road features, decelerators
- Treatment options

Other comments/ideas

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**What information should be in the treatment information for credible speed assessment:**

- I'm happy to be re-directed to another ERA Net road report
- I would prefer ERASER fact sheets
- I would like individual treatment options and more information as for the safe speed treatments

Other comments/ideas

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**Results – Long term**

**Please tick all the statements that apply:**

- I am interested in a network wide tool
- The tool results should be a GIS based system with mapping
- Interactive mapping (dragging, moving, zoom) would be appealing
- I would like roads to be colour coded according to priority
- I would like roads to be colour coded according to potential for casualty savings
- I would like there to be an alert system that would tell me which roads I need to be concerned about and why
- I would like detailed information about treatments – cost, effectiveness etc.
- I would like guidance and advice on treatments, rather than detail
- I would like prioritisation information to be included in the results
- I would like economic appraisal to be included in the results

Other comments/ideas

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## Appendix 9

### ERASER Speed Tool Questionnaire

Name: Eight questionnaires  
 Country: A variety  
 Organisation: Various  
 Email address: N/A

I would like to hear about future developments of this tool by email

#### Part 1: Introductory slides

##### Use of the tool

**As the road authority, we have the power to (please tick all that apply):**

- 8 Introduce measures to improve the passive safety of the infrastructure
- 7 Introduce innovative measures to improve the credibility of speed limits
- 6 Change speed limits on some roads (which roads below in comments section)
- 6 Ask for increased speed enforcement from the police
- 3 Install speed cameras
- 1 Operate speed cameras

Comments:

We can ask for increased speed enforcement but difficult to get police to buy in. Setting of SL's a function of the local authorities	To check the validity of current speed limit	Motorway, 1x1, 1x2, 2 lane road	Asking for increased speed enforcement does not mean that the request is always granted	only on motorways
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**Is there a need for a tool for assessing the degree to which roads are self explaining?**

- 7 Yes
- 1 No

If you answered 'no', then why not?

first the concept of self explaining should be proved to work

**Is there a need for a tool for speed management?**

- 6 Yes
- 2 No

If you answered 'no', then why not?

the key to this tool is a network wide approach [comment of somebody answering 'yes']

**What do you think a speed management tool should be able to do (please tick all that apply)?**

- 6 Recommend changes to the posted speed limit where they are required
- 5 Recommend engineering treatments to improve passive safety
- 5 Recommend engineering treatments to improve speed limit credibility
- 4 Recommend locations where increased enforcement efforts are required
- 4 Recommend locations for speed enforcement cameras
- 2 Recommend educational interventions

Other:

Enforcement zones have to be related to speed collisions	Identify locations where expected/actual speeds exceeds the posted speed limit. Identify locations where expected/actual speed of one stretch is significantly higher than the critical speed of the following stretch	Posted speed limits should be as uniform as possible along roads of the same functional category	Every engineering treatment is a choice/responsibility of the designer and must descend from specific knowledge and experience and not by software
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**Do you already have any tools that help with the above functions?**

- 6 Yes
- 2 No

If yes, please describe the tools and their functions

Analysis of collision database	Comparison of V85 and speed limit	Basically, models are included in the design guidelines and design tools. These, however do not include effects of the road environment on driving behaviour	EuroRap	Detailed road safety studies, speed limit warrants set in the road signing design standards	In general we use database of accidents and then ? safer measures. We have methodology for black spots management	there are 3D simulators that help you according to different speeds to evaluate and recognise failing elements of road design
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**Please tick any statements that apply (the tool = speed management tool):**

- 5 I would like a tool that can be applied across my whole road network
- 4 I would like a tool that provides guidance and advice, but leaves the detail to me and my colleagues
- 4 I would like a tool that would help me proactively treat locations that could become a problem in the future
- 3 I would like a simple tool that I do not have to pay for
- 3 I would like a more complex tool, even if I have to pay for it
- 3 I would like a more complex tool, but it would need to be free

- 3 I would like a tool to be used along a section of road
- 3 I would like a tool that helps me prioritise where I spend my safety budget
- 2 I would like a tool to be used at single locations
- 2 I would like a tool that tells me exactly what sort of treatments I need to consider and where
- 2 It is up to me and my engineers to determine priorities, not a tool
- 1 I would like a tool that would help me to treat known hotspots (black spots)

Other comments

<p>obviously would need to trial the tool first</p>	<p>there is a need to focus on another idea: an important part of the self-explaining road theory is to find locations in the existing network that are not self-explaining or even misleading. Setting up speed limits, or even to use uniform road markings, does not help fixing the problem. If the infrastructure leads to wrong expectations, this has to be fixed by other treatments than speed limits</p>	<p>I think that the tool would be used only as a secondary source of reference. Detailed studies are required in any case for this complex matter</p>
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**The fundamentals**

**Safe speeds (please tick all that apply):**

- 4 I agree with the safe speed rules presented and think they are useful for the proactive management of speed
- 2 I think the basic premise is right, but the application might be challenging in my country since we are a long way from a 'safe system'
- 2 I do not believe in the safe speed rules (if you tick this box please use the comments section to explain why)

Other comments

<p>Ireland is a long way from "safe system" but tool could be useful to push 'political will'</p>	<p>It is the actual speed that counts. If a speed limit is not credible it won't be accepted, even when it is safe. In addition to this, even the safe speeds may be too high for vulnerable road users. To use Rune Elvik's words: "the only safe speed is zero"</p>	<p>too simplistic and theoretical. Looks good on paper but would not be applicable in reality. Need to take into account that risk is not always present - too low speed limits are not credible in most instances</p>
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**Credible speeds (please tick all that apply):**

- 5 I like the idea of ‘credibility’ of a speed limit and think the idea has potential
- 3 I am happy to accept this innovative approach and may try out the tool
- 1 More research has to be done before I’m willing to use the tool
- 0 I do not like the idea of ‘credibility’ of a speed limit and think that it has no place in speed management (if you tick this box please use the comments section to explain why)

Other comments

<p>The system has to be further developed before I see a profit in using the tool</p>	<p>Credibility is a complex issue. Risk factors (ie pedestrians) are not always present. Drivers assess the road it terms of the conditions they encounter, not of the risk factors</p>
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**Part 2: Data input**

**[Please note that not all desired functionality can be included in this version of the tool being developed for the ERASER project]**

**Country**

**Tick all options that you would like to see included (now or in the future):**

- 6 Dynamic data input so that all items are relevant (e.g. country choice impacts on what speed limits are provided as options)
- 6 Use of country specific accelerators and decelerators for credible speed assessment
- 3 Translation into my language

Other:

<p>It seems that the original background of the tool was rather to find measures for increasing the level of safety of a road than to evaluate its effect on driving behaviour. Since I seem to have other expectations in such a tool, I fear answering the following couple of questions would not help you in further developing your tool. Generally to be accepted, a toll must be credible itself but also user-friendly. If it requires a lot of manual input, it should be included in road design tools or in GIS databases. elements which have certain and significant effects should be included</p>	<p>Elements of the road design and geometry, horizontal and vertical alignment and a more precise description of the cross sections avoiding the use of ranges</p>
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**Speed**

**Tick all options that you would like to see included (now or in the future):**

- 7 Actual speed
- 7 Functional speed

Please explain why (preferably scientific basis) you would like these additional options to be included:

<p>Functional speed is known for all road segments, if local analysis is necessary, the measurement of actual speed is relevant</p>	<p>To check for extreme differences</p>
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**In my country, for actual speed, we use:**

- 6 85th percentile
- 0 90th percentile

Other:

moving toward 'mean speeds'	plus average speed	85th percentile is not considered for safety assessments. It is the reference speed for comfort?
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**Actual speed (please tick all that apply):**

- 6 Should be used to determine if there really is a problem with speed limit credibility, and to remove credibility recommendations if actual speeds are OK
- 4 Should be used to provide a 'sense check' in the results to check credibility assessment is correct
- 3 Should be used
- 2 Should be optional
- 1 Should replace credible speed assessment (only possible where enforcement is minimal or absent)
- 0 Should not be used as it is difficult to collect these data
- 0 Should be included in the model along with data on amount of enforcement activity

**Cross section**

**Please tick if you would like to see the following included (now or in the future):**

- 5 Number of lanes

**Options for carriageway width and lane width are:**

- 5 Fine as they are – it should be easy to estimate this
- 1 The categories are too narrow for sensible estimates
- 0 Fine as they are – but it will be difficult to estimate this

Other comments

There are great differences between 70m and 800m width of carriageway. 70m width is not enough for overtaking a moped or a cycle without touching the opposite lane, but 80m is enough	The effects of design elements are not independent. Depending on the context	it would be good to introduce the possibility of setting more precise values= real dimensions
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**Options for road environment – please provide comments:**

**It would be good to introduce the possibility of setting more precise values=real dimensions or features**

**Options for maximum length of straight road are:**

- 5 Fine as they are – it should be easy to estimate this
- 0 Fine as they are – but it will be difficult to estimate this
- 0 The categories are too narrow for sensible estimates

Other comments

No problem in estimating. I do not think that speed limits should be based in such a detailed analysis. The more uniform they are along roads of the same functional level the better	country specific?	it would be good to introduce the possibility of setting more precise values= real dimensions or features
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**Roadside**

**Options for roadside shoulder – please provide comments:**

hard shoulder width, unpaved shoulder width, verge width & slope	paved or not paved - if paved - is it emergency lane?	Paved/unpaved	It would be good to introduce the possibility of setting more precise values= real dimensions or features
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**Options for roadside safety barrier – please provide comments:**

distance from the road	what is the material of the safety barrier. What is the connection to EN 1317	too many categories	sort of barrier
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**Options for roadside distance to nearest obstacle – please provide comments:**

width of clear zone, objects in the clear zone and how far away	single obstacle or line obstacles	too many categories
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**Intersections**

**Intersection type (tick all that apply):**

- 5 Is fine as it is – best to keep it simple
- 2 Should include turning pockets
- 2 Should include signalisation

Other comments

is there a connection between signalized intersections (green line)?	traffic volumes are key to intersection safety
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**Intersection frequency/access frequency:**

- 4 Should be more specific – e.g. x intersections per x metres
- 1 Is fine as it is – best to keep it simple

**Median**

**Please tick if this statement applies:**

- 2 It would be good to include median markings in the credible speed assessment

**Vulnerable road users**

**Tick all options that you would like to see included (now or in the future):**

- 6 Pedestrian crossing facilities
- 6 Bicycle facilities
- 6 Segregation of bicycle lane
- 5 Pedestrian footpath facilities
- 3 Segregation of footpath facilities
- 2 Moped facilities
- 2 Segregation of moped lane

**Use of road**

**General motorised traffic use categories:**

- 6 Should be more precise (e.g. AADT)
- 0 Are fine as they are – broad categories are acceptable
- 0 Should stay imprecise as accurate data are not always available

Other comments

Percentage of heavy goods vehicles, vehicles from other countries	it would be good to introduce the possibility of setting precise values for traffic with the specific percentage of heavy traffic
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**Tick all options that you would like to see included (now or in the future):**

- 6 Bicycle use (categories only)
- 5 Pedestrian use (categories only)
- 3 Moped use (categories only)

**Overview of data**

In the table below, please:

- Put a line through any variables that you think are unnecessary e.g. access restrictions
- Add any additional variables that you think we should consider including

	Safe	Credible
Now	Access restrictions for VRUs (7/1) Shoulder (7/1) Barrier/distance to obstacle (7/1) Intersection type (7/1) Intersection/access frequency (7/1) Median physical separation (7/1)	Carriageway/lane width (8/0) Road environment (8/0) Maximum length of straight road (8/0)
Planned	Intersection turning pockets(7/1) Signalisation of intersections(7/1) Type and segregation of pedestrian, bicyclist and moped facilities (7/1)	Number of lanes (8/0) Median markings (7/1)
Additional variables	accident statistic	visibility (distance) hilliness (slope) curve radii curvature gradient

**Part 3: Results**

**Results: Now**

**At present, only 2 comparisons are made (safe speed vs. posted speed limit; credibility of posted speed limit). Do you think more comparisons should be included (tick all that apply)?**

- 4 Posted speed limit vs. actual speeds
- 3 Posted speed limit vs. safe speed
- 3 Posted speed limit vs. credible speed
- 3 Actual speed vs. credible speed
- 2 Actual speed vs. safe speed
- 1 Posted speed limit vs. desired functional speed
- 1 Actual speed vs. desired functional speed
- 1 Safe speed vs. desired functional speed
- 1 Safe speed vs. credible speed
- 1 Desired functional vs. credible speed

Posted speed limit	The current speed limit on the road
Actual speed	85th percentile or V90 travelled speed
Safe speed	Calculated safe speed based on 'rules'
Credible speed	The speed that drivers should intuitively adopt without posted speed limits or enforcement

Other comments (please comment on why the option(s) you ticked should be included)

It might make it over complicated to include these options	safe speed vs. road safety situation	safe speed rules should be fully justified and supported with data of their implications in terms of crash frequency and severity
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**At present, the tool only recommends changes to the road infrastructure. Would you like to see alternative recommendations made (tick all that apply)?**

- 4 Speed camera locations
- 4 Changes to posted speed limits
- 3 Enforcement locations

Other comments (please comment on why the option(s) you ticked should be included)

Difficult to achieve	in my country we have some speed cameras which are located only on accidents data
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**Please provide any additional comments on the current results:**

the main reason for this kind of tool use - the problem at location. The problem is the road safety situation of the site. Comparison of road safety situation and recommendations of total is necessary

**Results – Some improvements**

**What information should be in the summary (please tick all that apply):**

- 6 Calculated safe speed
- 5 Posted speed limit
- 5 Assessment of credible speed
- 4 Actual speed

Other comments/ideas

Relation with sight distance, as a function of the available sight distance

**What information should be in the safe speed assessment (please tick all that apply):**

- 6 The assessment
- 4 Treatment suggestions
- 3 Explanation of the reason

**What information should be in the treatment information for safe speed assessment (please tick all that apply):**

- 5 Treatment options
- 4 Issue
- 4 Benefit-Cost Ratio
- 3 Indicative cost (as presented)
- 3 More precise effectiveness information
- 2 More precise cost information
- 2 Indicative effectiveness (as presented)

Other comments/ideas

B-C ratio rough classes <1, 1-10, 11-20, 21-40 etc

**What information should be in the credible speed assessment (please tick all that apply):**

- 6 The assessment
- 5 Accelerators, credible road features, decelerators
- 3 Calculated credible speed (not currently proposed)
- 2 Treatment options

**What information should be in the treatment information for credible speed assessment:**

- 4 I would prefer ERASER fact sheets
- 2 I would like individual treatment options and more information as for the safe speed treatments
- 1 I'm happy to be re-directed to another ERA Net road report

**Results – Long term**

**Please tick all the statements that apply:**

- 4 I would like guidance and advice on treatments, rather than detail
- 3 I am interested in a network wide tool
- 3 The tool results should be a GIS based system with mapping
- 3 Interactive mapping (dragging, moving, zoom) would be appealing
- 3 I would like roads to be colour coded according to potential for casualty savings
- 2 I would like detailed information about treatments – cost, effectiveness etc.
- 2 I would like economic appraisal to be included in the results
- 1 I would like roads to be colour coded according to priority
- 1 I would like there to be an alert system that would tell me which roads I need to be concerned about and why
- 1 I would like prioritisation information to be included in the results

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