**DESIGN MANUAL FOR ROADS AND BRIDGES**

**SUMMARY OF CORRECTION – TA 85/01 Volume 6, Section 1, Part 3**
**GUIDANCE ON MINOR IMPROVEMENT TO EXISTING ROADS**

In May 2002, you received instructions to replace pages 5/1 – 5/14 inclusive, A1/1 – A1/2 and A1/9 – A1/10, as the images printed in black and white, should have been printed in colour. It has now come to light that only pages 5/1 – 5/14 inclusive should have been printed in colour.

We apologies for the inconvenience caused.

**VOLUME 6 ROAD GEOMETRY**
**SECTION 1 LINKS**

## PART 3

## TA 85/01

# GUIDANCE ON MINOR IMPROVEMENTS TO EXISTING ROADS


### SUMMARY

This document provides guidance and good design practice for layout improvements and other improvements to existing all-purpose roads.


### INSTRUCTIONS FOR USE

This is a new Advice Note to be incorporated in the Manual.

1. Remove existing contents page for Volume 6 and insert new contents page for Volume 6 dated November 2001.

1. Insert TA 85/01 in Volume 6, Section 1, Part 3.

2. Archive this sheet as appropriate.

Note: A quarterly index with a full set of Volume Contents Pages is available separately from The Stationery Office Ltd.

THE HIGHWAYS AGENCY

SCOTTISH EXECUTIVE DEVELOPMENT DEPARTMENT

THE NATIONAL ASSEMBLY FOR WALES
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THE DEPARTMENT FOR REGIONAL DEVELOPMENT
NORTHERN IRELAND

# Guidance on Minor Improvements to Existing Roads

Summary: This document provides guidance and good design practice for layout improvements and other improvements to existing all-purpose roads.

## REGISTRATION OF AMENDMENTS

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**VOLUME 6 ROAD GEOMETRY**
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## PART 3

## TA 85/01

# GUIDANCE ON MINOR IMPROVEMENTS TO EXISTING ROADS

**Contents**

# 1. INTRODUCTION

**General**

1.1 Current design standards, contained in the **Design Manual for Roads and Bridges (DMRB)** have been developed over a number of years. Some existing roads pre-date those standards and may include features such as tight bends or poor visibility.

1.2 All improvement schemes should be consistent with the wider national road safety and integrated transport objectives and take account of the need to encourage walking and cycling; protect the environment; reduce community severance and provide value for money. All improvement schemes should be subject to current procedures for project appraisal, as set out by the Overseeing Organisation.

1.3 When a major improvement is being considered (eg bypass of an urban area) it is clear that the proposed layout should meet current design standards. When a minor improvement to a section of the network is being considered (eg the vertical re-alignment of a severe crest curve) Designers may be faced with reduced options due to budget constraints, land availability and conflicting priorities.

1.4 Experience has shown that in some cases, low cost minor improvements aimed at improving safety and making better use of the existing road network can often be highly cost effective, for example:

- road markings to create a “ghost island” layout for right turning traffic;
- minor physical alterations to the layout can improve safety at junctions (eg kerb realignments, drainage, coloured surfacing etc);
- lower speed limits together with traffic calming measures can help to improve safety where a trunk road passes through a built up area.

1.5 The purpose of this Advice Note is to provide guidance for the identification and development of minor improvement schemes, and to:

- provide advice on principles to be considered when carrying out minor improvements to existing roads;
- assist identification of possible situations to consider for improvement;
- encourage recognition of flexibility already incorporated within current standards. This will include seeking approval for Departures from Standards from the Overseeing Organisation where it is not reasonably practicable to achieve standards;
- ensure that appropriate arrangements are made for all road users;
- ensure that environmental needs are considered.

1.6 All existing features retained within the design which do not meet the requirements of the **DMRB** should be identified. Approval for Departures from Standard should be sought from the Overseeing Organisation.

**Minor Improvement Measures**

1.7 The term **minor improvement measure** is used to indicate design elements which may be either introduced individually or combined to form a minor improvement scheme. Any works that are not maintenance and are less than the national threshold in cost are by definition minor improvements.

**Scope**

1.8 This Advice Note does not replace or supersede any current standards. All of the measures discussed should be assessed in accordance with the relevant standards contained in the **DMRB**.

1.9 This Advice Note does not provide guidance on Traffic Calming or Traffic Management schemes. The Department for Transport, Local Government and the Regions (DTLR) publication list identifies recent developments regarding policy on traffic control and management issues. Designers should refer to the appropriate **Local Transport Notes** contained in the DTLR publication list for current advice.

**Implementation**

1.10 This Advice Note should be used forthwith on all schemes for the management, improvement and maintenance of all-purpose roads (ie not motorways) currently being prepared providing that, in the opinion of the Overseeing Organisations, this will not result in significant additional expense or delay progress. Design Organisations should confirm its application to particular schemes with the Overseeing Organisation.

# 2. DESIGN PRINCIPLES

**Introduction**

2.1 When considering low cost minor improvements to existing roads, Designers may have difficulty in achieving **DMRB** design criteria, within the imposed physical, economic or environmental constraints. Even by incorporation of Relaxations within or Departures from Standards it may still be difficult to justify the improvement. This may result in the scheme being delayed or removed from the programme unless suitable alternatives are identified.

2.2 Designers may not have previously considered improvements that retain or use geometrical features below those recommended in **DMRB**. However, a minor improvement which retains or improves some sub-standard elements may still provide, under certain circumstances, a viable solution in terms of the overall benefits achieved. Requests for approval to the use of Departures from Standards should be made where it is not reasonably practicable to achieve standard layouts.

2.3 Designers may identify innovative solutions to some design problems, and this is to be encouraged. However it is essential to ensure that innovative designs do not present a safety risk and such designs should be considered as Departures from Standards and submitted to the Overseeing Organisation for approval. Such designs should be carefully considered prior to implementation and monitored following construction. In some situations (eg introducing deflector islands at roundabouts) the proposals may be tested by means of temporary works prior to full implementation.

**The Need for Improvements**

2.4 Improvement schemes have traditionally addressed deficiencies in one or more of three **basic criteria**:

- safety;
- capacity/operation;
- environmental aspects.

2.5 In future all improvement schemes should be considered as part of an integrated transport system which is intended to provide choice in meeting people's transport needs. This approach is based on the following criteria:

- **Integration** – ensuring that all decisions are taken in the context of the integrated transport policy;
- **Safety** – to improve safety for all road users;
- **Economy** – supporting sustainable economic activity in appropriate locations and getting good value for money;
- **Environmental Impact** – protecting and enhancing the built and natural environment;
- **Accessibility** – improving access to everyday facilities for those without a car and reducing community severance.

2.6 Designers should bear in mind the practical implications of an integrated transport system when considering minor improvements. The examples of siting bus build-outs or lay-bys convenient to junctions or pedestrian accesses demonstrate that even simple measures can assist this national policy by improving accessibility and safety.

2.7 The need for improvement schemes, particularly minor improvements, may be related to a number of more specific aspects, including other criteria such as:

- requirements of non-motorised road users especially those with mobility difficulties;
- speed reduction;
- driver behaviour (and perception);
- improving route consistency;
- whole route (or network) strategy;
- maintenance requirements;
- local issues.

2.8 Designers should assess the effect of all proposed minor improvements in terms of safety, capacity and the environment, to ensure that net benefits are taken into account and any unacceptable disbenefits in these aspects are avoided.

2.9 Improvement schemes covered by this guidance should not be considered as **Accident Remedial Schemes**, but are intended to assist Designers to identify measures that may for example help to reduce the risk of loss of control or eliminate conflict with non-motorised road users.

**Accident Remedial Schemes, Safety Improvement Schemes and Road Safety Audits**

2.10 **Accident Remedial Schemes** arise from the recommendations contained in formal **Accident Investigation and Prevention (AIP)** studies undertaken by experienced staff appointed by the Overseeing Organisation. AIP studies must include specific forecasts for the number of casualties that will be 'saved'.

2.11 **Safety Improvement Schemes** are those schemes which have not been the subject of an **AIP** study. When considering such schemes the possible causes of accidents should be taken into account by Designers. The measures taken should be relevant to safety issues and should reflect feedback from accident records.

2.12 All schemes will be subject to **Road Safety Audits** during design and at completion of construction, to identify potential safety hazards which may affect road users. Measures may be necessary to eliminate or mitigate identified problems. Road Safety Audits should be carried out in accordance with the appropriate DMRB Standard.

2.13 Designers should consider the need for advice from Accident Investigation and Road Safety Audit specialists during scheme identification and preparation. In this way the possible safety consequences of retaining existing elements and/or introducing new minor improvement measures can be assessed, albeit often by non-quantifiable judgements. The **ROSPA Road Safety Engineering Manual** may provide a useful source of information concerning accident investigation, prevention and evaluation.

**Accident Statistics - Overview**

2.14 Accidents in rural areas tend to be more geographically scattered than those in urban areas with the majority occurring away from junctions. In urban areas accidents tend to be more concentrated, with the majority occurring at, or near, junctions.

2.15 Although less than one third of all accidents occur on rural roads, accident statistics indicate that casualty severity on rural roads is higher than that on urban roads. More than half of all fatalities occur on rural roads.

2.16 Casualties on rural (non-motorway) roads can be attributed to 5 basic types of accidents as indicated in **Table 2/1**. The proportions of accident types indicated are approximate and provided as a guide only. Further statistical information regarding accidents and casualties may be obtained from R**oad Accidents Great Britain (The Casualty Report)** published annually, from which the figures in **Table 2/1** have been extracted.

| Rural Accident Type | Nature of Accident | Approximate % |
|---|---|---|
| Loss of Control (No Collision) | ⇨ | 30 |
| Collision with Vehicle Intersecting at Junction | ⇘★⇗ | 20 |
| Collision with Oncoming Vehicles | ⇨★⇦ | 20 |
| Collision with Rear of Vehicle Ahead | ⇨★⇨ | 15 |
| Collision with Non-Motorised Road User (eg pedestrians, cyclists and equestrians) | ⇨● | 15 |

**Table 2/1: Proportions of Rural Accident Types in Great Britain**

2.17 The information above is provided for background only and does not lead to definitive conclusions. Decisions on treatments must be made however and the following observations may assist the process:

- The avoidance (or reduction in scale) of the typically more severe accidents in rural areas can be particularly beneficial;
- The dispersion of accidents in rural areas may create difficulties when assessing and prioritising effective improvement measures. When appropriate Designers should consider route-action schemes (ie consistent application of measures along a route);

- In urban areas the relative concentration of accidents can simplify problem identification and assessment;

- The use of traffic management techniques as described in documents such as the **Traffic Signs Manual, Local Transport Notes** and **Traffic Advisory Leaflets** may assist the prevention of a proportion of accidents in urban areas.

2.18 The accident types indicated in **Table 2/1** are the effects which may result from a number of different causes. It is important to clearly identify the cause(s), and when assessing contributory factors it is important to identify any dominance that occurs under particular conditions (eg wet weather, night time, poor lighting etc). For example in the case of a collision with an oncoming vehicle, close investigation may show that what was initially attributed to driver error may have had other contributory causes (eg incorrect road markings, slippery surface etc).

**Potential Casualty Reduction**

2.19 When accident records contribute to scheme justification the process of estimating economic benefits can often be determined from historical data concerning the improvement location and the effect of similar local schemes. However, not all safety issues can be examined in this way (eg the absence of safety fence at a given location will not contribute to accident statistics unless loss of control, resulting in an accident, occurs). Such issues should be considered as possible casualty reduction measures.

2.20 Research is continuing to identify the types of minor improvement schemes that give the greatest accident reductions **(eg TRL Report 127)**. This report contains estimates of rates of return and accident savings relating to various types of local safety schemes. In the absence of specific estimates based on local historical data the estimates for accident savings contained in **TRL Report 127** can be used to assist in comparing options.

2.21 The reduction in the number of potential casulties due to a minor improvement may in some circumstances be estimated to assist in comparing alternatives. There is limited UK research linking the magnitude of casualty reductions with individual improvement measures, but Designers should consider the use of the improvement measures identified in **Table 2/2**.

2.22 Some minor improvement measures may be more beneficial than others in reducing the potential for accidents to occur. Some may have no significant effect, or may even have an adverse effect if applied under the wrong conditions (eg increasing main-line lane widths at T junctions may result in increased speed and enlarged conflict zones). Designers should carefully consider these factors when developing their scheme options.

| Nature of Accident | Typical Improvement Measure |
|---|---|
| ⇨ | • Vertical and horizontal realignment;<br>• Carriageway widening;<br>• Reflectors on bends and junctions;<br>• Raised rib/hatched road markings;<br>• Warning signs. |
| ⇘★⇗ | • Advance direction signs;<br>• Junction widening to improve visibility;<br>• Ghost island road markings for right turning lane;<br>• Coloured surfacing. |
| ⇨★⇦ | • Vertical and horizontal realignment;<br>• Carriageway widening;<br>• Raised rib/hatched road markings;<br>• Coloured surfacing;<br>• Reflectors on bends and junctions. |
| ⇨★⇨ | • Advance direction signs;<br>• Junction widening to provide right turning lane. |
| ⇨● | • Provision of crossing points;<br>• Provision of footways;<br>• Provision of cycle lanes. |

**Table 2/2: Typical Improvement Measures**

2.23 Before undertaking any improvement measures Designers should initially consider whether any maintenance works are required **(see paragraphs 2.44 to 2.50)**.

**Capacity/Operation**

2.24 The presence of large volumes of traffic on rural single carriageways may cause driver frustration, particularly where slow moving vehicles are encountered. This can lead to attempts to overtake at inappropriate locations, resulting in head-on collisions.

Continuous heavy volumes of traffic on roads passing through built up areas can give rise to safety problems for pedestrians and cyclists and to general environmental problems such as community severance and noise and air pollution.

2.25 Relief of congestion on existing roads and improvement in the flow of traffic may be achieved by making minor improvements to road layouts or better utilisation of existing road space. Dedicated lanes and other measures for buses and high occupancy vehicles may not relieve general congestion but will be of benefit to selected users.

2.26 Implementation of a minor improvement designed to increase capacity or improve operation may introduce aspects of design which result in increased vehicle speeds. This may adversely affect safety and it is important that such disbenefits are taken into account in the economic assessment. The situation should be avoided where subsequent action needs to be taken to counter adverse effects after the construction of an improvement. For example widening the carriageway through a junction may encourage higher main-line traffic speeds, which necessitate further measures to reduce speeds.

**Environmental Aspects**

2.27 Improvement schemes may bring benefits to the environment and local communities and in any event should be designed to minimise any adverse environmental impacts. Some minor improvements (or measures) may be introduced wholly or partly for environmental reasons:

- installation of a noise barrier alongside residential properties;
- improved surfacing to reduce road noise;
- landscaping and planting or relocating street furniture to mitigate visual intrusion;
- improved street lighting to reduce light pollution.

2.28 In some circumstances landscaping may be introduced to restrict excessive forward visibility on bends **(see Chapter 5 Example 10)**.

2.29 It is important to assess the effect environmental improvement measures have on safety (eg where planting is carried out near junctions visibility requirements must be achieved). In addition the environmental effect of improvements introduced for other reasons should be considered.

2.30 Relevant environmental organisations and other interest groups should be consulted, and local opinion sought during scheme development.

**Non-Motorised Road Users**

2.31 To assist in encouraging cycling and walking the requirements of non-motorised road users (eg pedestrians, cyclists and equestrians) should be given due consideration in both the identification of locations for treatment and in the design of all minor improvement measures. A minor improvement scheme may be identified to address a problem associated with a particular group(s) of non-motorised road users, eg the provision of:

- footways or cycle lanes;
- footpath, bridleway or cycle track crossings;
- pedestrian guardrail, tactile paving and dropped kerbs;
- pedestrian refuges;
- bus stops, bus bays and associated crossing points.

2.32 Designers should refer to particular advice contained within **Local Transport Notes** and **Traffic Advisory Leaflets** and other DTLR publications, relating to the various groups of non-motorised road users.

**Speed Reduction**

2.33 Speed reduction can provide positive benefits in terms of potential casualty reduction. Speed is a major contributory factor in accidents. Changes to the road layout can significantly influence the control of speed **(see Chapter 5 Examples 3 and 6)**, whether the problem is excessive speed (breaking speed limits) or inappropriate speed (driving too fast for local conditions).

2.34 Designers should utilise minor improvement measures to reduce speed where this is desirable, and should in all cases assess the effect of their designs on speed within the scheme and beyond. For example the improvement of a tight bend may eliminate accidents at that location but may cause accident migration by

enabling drivers to approach a second, adjacent bend too fast.

2.35 From research **(TRL Contractors Report 319)**, references to design features which may influence speed include:

- speeds of light vehicles are more influenced by flow and geometry effects than speeds of heavy vehicles, which are constrained more by performance;
- bendiness is the most important determinant of speed for both light and heavy vehicles;
- hilliness and net gradient are important speed determinants for heavy vehicles;
- carriageway width (wider lanes encourage higher speeds) has an impact on light vehicles but less so on heavy vehicles;
- the provision of continuous hard strips and edge lining encourage higher speeds of light vehicles;
- wider verges and excessive visibility encourage increased speeds;
- the number and spacing of junctions/accesses influence speed.

**Drivers' Behaviour**

2.36 Drivers' behaviour, which is the prime cause of many accidents, generally accords with their perception of the road layout and its environment. The modern design of vehicles enables easier handling and permits higher speeds, which can contribute to accidents. Engineering solutions may help to overcome these effects and influence drivers to reduce speeds in some circumstances.

2.37 If existing conditions give rise to accidents in which excessive speed appears to be a significant factor, and there is limited scope for physical improvement of the layout, measures such as speed cameras can encourage drivers to reduce speed, and should be considered.

2.38 If driver awareness can be maintained and reinforced, for example by signs and road markings, an appropriate speed is more likely to be adopted.

**Improving Route Consistency**

2.39 Improving route consistency can assist in making drivers aware of the overall nature of the route. By using similar minor improvement measures at particular hazard locations the message to the driver concerning the nature of those hazards can be reinforced (eg central hatched markings on all sub-standard bends). Route signing consistency is also important.

2.40 It may be impracticable to apply some minor improvement measures over the whole length of a route. However, identification of the most critical sections may be appropriate in such situations (eg curve widening may be introduced at tight bends and locations of accidents only).

**Route Management Strategies**

2.41 A Route Management Strategy is a co-ordinated approach to network management based on satisfying customer needs on a route basis. A route management strategy should consider the following factors:

- National and regional transport policy objectives;
- Route functions;
- Levels of service;
- Budgets;
- Improvement options;
- Timescale.

2.42 The outcome of such a strategy may lead to a programme for the implementation of a group of minor improvements to the route, such as closure of central reserve gaps **(see Chapter 5 Example 5)**. In these cases the Designer may not be involved in the justification process but must still consider all aspects of their impact in each particular instance.

2.43 If practicable highway maintenance, construction of improvement schemes and public utility works should be managed on a route basis to minimise disruption. Wherever possible work during times of peak traffic flows should be avoided.

**Maintenance**

2.44 Designers should take into account future maintenance requirements in their assessment of improvement schemes, to optimise whole-life costs.

2.45 The process of monitoring maintenance requirements for a road may provide opportunities to incorporate some minor improvement measures into maintenance schemes. This may enhance value for money by minimising the delay and disruption to traffic that would have occurred during separate maintenance and construction activities.

2.46 Some of the measures described in Chapter 4 will result from good management practice concerning maintenance of the highway network. Designers should liaise with the maintenance management team and should be aware of the **Routine Maintenance Management System (RMMS)** inspection regimes, which are intended to provide early warning of the need to intervene. For example the clearing of vegetation beginning to obscure sight lines is an effective safety measure, and may in itself be sufficient action at a particular location.

2.47 When considering improvement measures it is important to consider maintenance requirements at an early stage, to ensure that safety problems are not introduced. For example locating a new gully on a tight bend may cause a hazard during gully emptying operations, and may necessitate traffic control. Such a situation may be avoidable by minor adjustment of the carriageway/channel profile and relocation of the gully.

2.48 Consideration should also be given at design stage to the choice of materials, to ensure that any additional costs are justified. Designers should be aware that the use of special materials may incur higher capital and/or maintenance costs.

2.49 If an improvement scheme relies on regular future maintenance (eg clearance of vegetation) then alternative measures should be considered, particularly where failure to undertake the maintenance may increase the potential for accidents to occur. For example, warning signs should not be placed close to vegetation as the signs will become ineffective when plant growth obscures the sign.

2.50 The following maintenance measures could improve safety for all of the accident types identified in **Table 2/1**:

- Replacement of worn road surfacing;
- Replacement of worn road signs;
- Replacement of worn road markings;
- Use of localised high friction surfacing;
- Clearing and cutting back obstructions to visibility.

**Local Issues**

2.51 Local issues may provide the initial identification of the need for an improvement, arising from such sources as:

- parish council representations;
- local action/pressure groups;
- the effect of planning consents for adjacent land.

2.52 A physical indication of the potential for a serious accident to occur may be observed and Designers should look for warning features such as:

- skid marks;
- damage to road surfacing or street furniture;
- over-running of verges;
- migration of drainage filter media onto the carriageway.

# 3. DESIGN PROCEDURE

**Introduction**

3.1 The objective of the design procedure is to achieve optimal value for money (taking all factors into account) within budget constraints. Having identified a need for an improvement scheme **(see Chapter 2)**, the procedure for design should accord with good practice, following three basic phases as illustrated in **Figure 3/1**:

- **Phase 1** Data Gathering;
  Preliminary Assessment of Information.
- **Phase 2** Identification of Options;
  Preliminary Design of Viable Options;
  Identification of Departures from Standards;
  Traffic Management and Control Requirements;
  Testing of Options;
  Detailed Assessment of Preferred Option.
- **Phase 3** Detailed Design.

3.2 The scale of many improvements covered by this document will not require exhaustive assessment and the experience of the Designer will be called upon to implement an efficient and effective procedure based upon the above phases. The development of a simple framework to facilitate comparison between options will frequently be beneficial **(see Annex 1, Worked Example)**.

3.3 The procedure is iterative in order that scheme development takes account of opportunities for review and modification of options.

3.4 Road Safety Audits should be carried out for all improvement schemes in accordance with the requirements set out in **DMRB 5.2**.

3.5 An example of the design procedure for the Data Gathering, Preliminary Assessment of Information and Identification of Options is provided in Annex 1. This can be developed further to include other relevant information.

**Phase 1**

**Data Gathering**

3.6 The basic design issues and constraints should be established following the collation of information relevant to the existing situation and proposed improvement, including:

- existing and future traffic flows (all road users);
- design speed in each direction (validated by actual vehicle speed measurements);
- existing accident patterns (all road users);
- approved and potential development proposals within the design period;
- Local Plan policies relating to future land use;
- environmental constraints;
- programmed maintenance proposals;
- land availability;
- budget limitations.

**Preliminary Assessment of Information**

3.7 The objectives of the preliminary assessment are to:

- establish links between elements of information and data gathered, eg between geometrical data, accident records and traffic volumes;
- categorise all possible minor improvement measures which are considered to address the identified needs;
- consider the potential for casualty reduction;
- assess the effects of the measures upon safety, capacity and the environment, and determine the potential contribution toward an integrated transport system.

3.8 At the end of **Phase 1** the Designer should be aware of all the substandard features of the existing layout, a range of valid individual minor improvement measures and their effects, and should be in a position to develop viable scheme options. It may become apparent (eg from the extensive nature of the horizontal and vertical realignments necessary) that a major improvement is likely to achieve significant benefits and should be investigated further. In such cases the development of a minor improvement scheme to form the "do minimum" comparator may be appropriate. Alternatively the minor improvement(s) may be considered as a short term solution.

**Phase 2**

**Identification of Options**

3.9 The minor improvement measures should be combined as appropriate to establish minor improvement scheme options which address the identified needs. It is essential that the Designer keeps an open mind at this stage, and does not overlook simple solutions. Value workshops may be of benefit in this respect.

3.10 At this stage the Designer may be able to make an initial assessment/judgement based on experience in order to reduce the number of options to be tested.

**Preliminary Design of Viable Options**

3.11 Only sufficient design should be carried out at this stage to facilitate fair comparison between viable options. Budget estimates should be prepared, perhaps on a simplified unit rate basis for the various improvement measures. This will facilitate the review of viable options before selecting the preferred scheme for assessment.

**Identification of Departures from Standards**

3.12 Any Relaxations within and Departures from Standards should be fully identified during this phase in order to assist in the testing of all viable options.

**Traffic Management and Control Requirements**

3.13 Consideration should be given at this stage to the traffic management and control measures which will be required during construction and maintenance operations, to determine any adverse effects on safety.

**Testing of Options**

3.14 Testing will include assessment of safety, economics and environmental aspects. The purpose is to compare options to assist selection of a preferred option in terms of value for money. Testing may also enable priorities between competing schemes to be established by the Overseeing Organisation.

3.15 The process of testing will usually be iterative as ideas are developed and options refined. The process should commence as a coarse assessment of all viable options (including "do nothing"), leading to elimination of inappropriate options and refinement of valid options to establish the preferred choice. It will not always be possible to make direct comparisons between options and the application of judgement will frequently be required to enable decisions to be made.

3.16 In situations where the existing road is below current standards, although no accidents have been recorded, Designers should consider the potential safety benefits of improvement measures.

3.17 The degree of testing should reflect the nature of the measures envisaged but Designers should note that in some cases their judgement following discussions with the Overseeing Organisation, will provide an effective comparison between options.

**Detailed Assessment of Preferred Option**

3.18 The cost of an improvement scheme should be justified in terms of the following key assessment criteria:

- environmental impact;
- safety;
- economy;
- accessibility;
- integration.

3.19 When assessing options it will be relevant to consider all appraisal criteria, and Designers may find it useful to prepare an appraisal summary for each option. It should be noted however that a simple minor improvement scheme, perhaps based on a single measure, may not require rigorous assessment to enable a satisfactory conclusion to be drawn. Further information on this aspect is provided in **Volume 5 DMRB**, where advice concerning assessment and

selection of preferred options is given. If necessary consultations should be made with the Overseeing Organisation concerning the appropriate level of assessment for each criterion.

**Phase 3**

**Detailed Design**

3.20 Following refinement and review of options, any requirements for Relaxations and Departures should be assessed and approval sought where necessary, prior to carrying out detailed design and refinement of estimates.

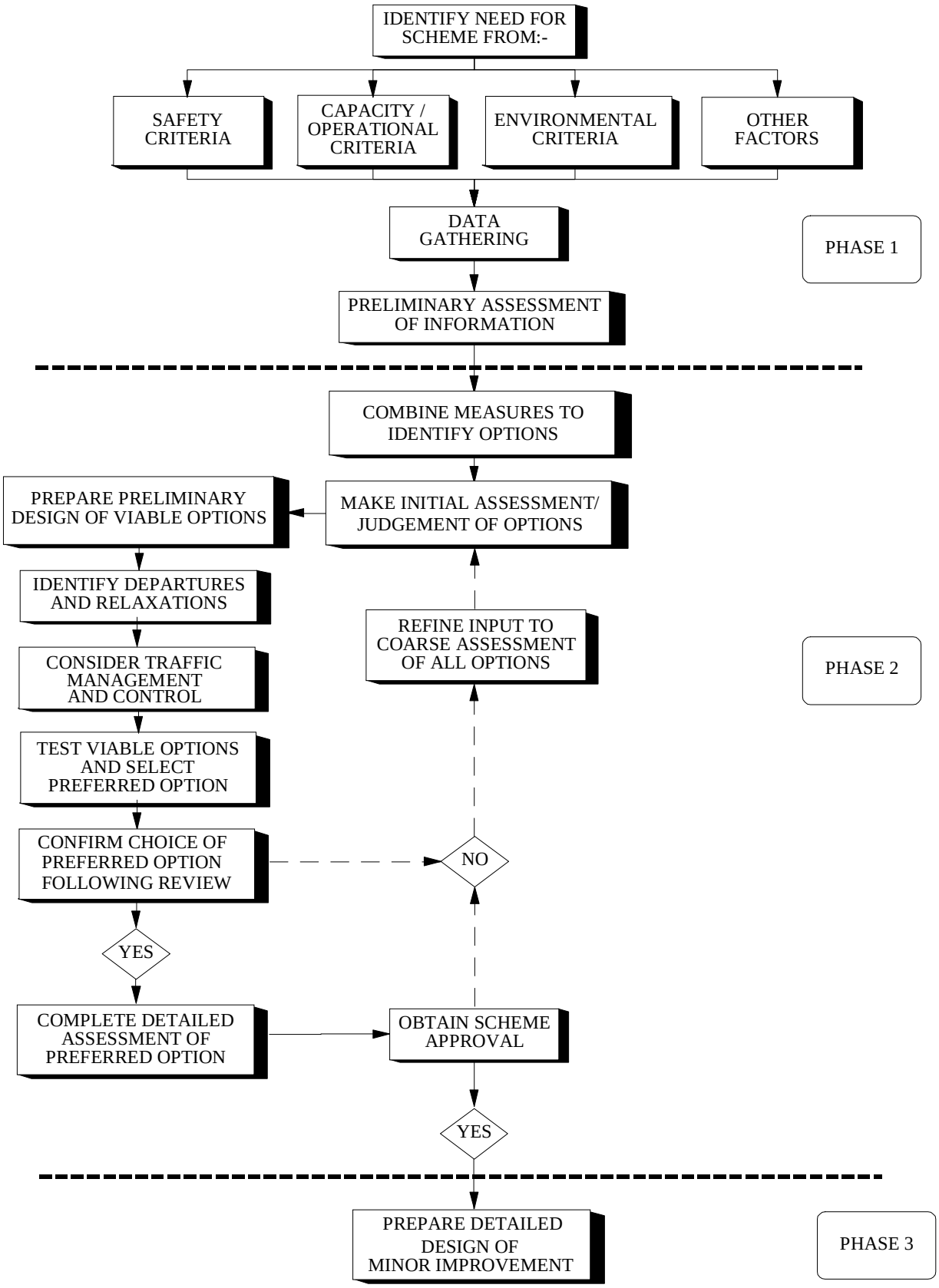



**Figure 3/1: Design Procedure**

# 4. MINOR IMPROVEMENT MEASURES

**Introduction**

4.1 Minor improvement schemes will comprise one or more minor improvement measures, which may be combined in different ways to meet specific requirements, as illustrated by examples in **Chapter 5**. However it is essential that the Designer does not simply combine measures without considering the scheme as a whole.

4.2 It should be noted that the examples in **Chapter 5** may also be combined to form an overall scheme. For example, channelisation of traffic **(Example 2)**, the use of road markings to improve discipline and alert drivers to the hazard ahead **(Example 3)**, curve widening **(Example 4)** and vertical re-profiling **(Example 8)** could form a scheme designed to overcome a sub-standard section of existing road. This could form an alternative to a full **DMRB** realignment which may open up the appearance of the road layout resulting in increased vehicle speeds inappropriate to contiguous sections.

4.3 Combinations of measures need to be assessed for their effect on each other, in order to avoid an adverse consequence. An example of an inappropriate combination, in certain circumstances, may be speed reduction by road markings **(Example 3)** together with visibility improvement in excess of that required, which may encourage increased vehicle speeds.

4.4 Minor improvement measures to an existing road may be applied locally, to a discrete section or to a whole route. It is essential that the Designer takes an overview of the improvement measure(s) within an appropriate route length in order to avoid the introduction of a new problem either at the location of the improvement or elsewhere. Designers should appreciate the net effect of all elements of the layout, including retained existing detail, on the perceptions and behaviour of drivers, pedestrians, cyclists and equestrians.

4.5 For the purpose of this Advice Note minor improvement measures have been divided into 3 categories, as shown in **Table 4/1**, based upon typical treatment costs. A minor improvement scheme may comprise a combination of these (or other) individual measures. Although all measures are described as minor the relative price per metre is likely to be highest for Category 1 and lowest for Category 3. Some of the measures (eg Lighting) could be relevant to more than one category depending on the scale of the improvement.

4.6 **Table 4/1** also indicates the **Principal Design Standards** to which Designers should refer when considering the various improvement measures. These standards will in all cases direct Designers to other related standards or advice which should also be considered.

4.7 The measures identified in **Table 4/1** are not exhaustive, and Designers may identify options which are more appropriate to specific situations.

**Category 1**

4.8 The **Principal Standards** pertaining to the Category 1 improvements are contained within **DMRB 6.1 and 6.2**.

4.9 **Horizontal** and **Vertical Realignments** are generally the most costly measures and have the greatest environmental disbenefits when compared with other measures, but will be justified in some cases. Good practice however requires the consideration of other, less costly, options such as those identified in Categories 2 and 3.

4.10 Severe bends may be addressed by some form of speed reduction treatment. Normally bend realignment cannot be physically improved at low cost. However, improved safety may be achieved at relatively low cost by Category 2 minor improvement measures such as providing adequate warning signs or artificially influencing the perception of the alignment.

4.11 High speed differentials occur at crests and sags, resulting in increased numbers of accidents particularly where visibility is restricted. Improved safety may be achieved by Category 2 minor improvement measures.

4.12 The provision of **Overtaking Sections**, **Climbing Lanes**, **Carriageway Widening** or **Major Junction Improvements** to improve capacity may be prohibitive in terms of cost and environmental disbenefits. In some circumstances a combination of appropriate Category 2 and 3 measures may provide suitable alternatives by improving junction capacity or segregating various road users (eg localised carriageway widening and coloured surfacing).

| Principal Standards | Category 1 | Category 2 | Category 3 |
|---|---|---|---|
| **TD 19 (DMRB 2.2) Safety Fences & Barriers** | | | Safety Fence |
| **DMRB 4.2 Drainage** | | Drainage | |
| **TD 9 (DMRB 6.1) Highway Link Design** | Horizontal Realignment Vertical Realignment Overtaking Sections Climbing Lanes | Alterations to Superelevation, Crossfall or Adverse Camber | Visibility Improvements by Removing/Cutting Back Vegetation |
| **TD 27 (DMRB 6.1) Cross-sections and Headroom** | Carriageway Widening | Localised Carriageway Widening | Edge Treatment |
| **DMRB 6.2 Junctions** | Major Junction Improvements | Junction or Road Closure and Junction Modification | |
| **TA 57 (DMRB 6.3) Roadside Features TA69 (DMRB 6.3) The Location and Layout of Lay-bys** | | Provision of Lay-bys and Rest Areas, Kerbing, Arrester Beds | Pedestrian Guardrail, Anti-dazzle Fencing, Cattle Grids, Access Provision and Control, Equestrian Facilities, Pedestrian Facilities at Level Crossings |
| **TA 81 (DMRB 6.3) Coloured Surfacing In Road Layout** | | Coloured Areas and Lanes | Coloured Bands and Strips |
| **DMRB 7 Pavement Design and Maintenance** | | | Surface Dressing, Patching, Skid Resistant Surfacing |
| **TD50 (DMRB 6.2) The Geometric Layout of Signal-Controlled Junctions and Signalised Roundabouts DMRB 8.1 Traffic Signals and Control Equipment** | | Provision of Traffic Signals at New and Existing Priority Junctions (including Roundabouts) | Upgrading an Existing Signal Controlled Junction, Providing Pedestrian Phases |
| **DMRB 8.2 Traffic Signs and Road Markings** | | | Road Markings and Delineators, Traffic Signs, Reflectors and Road Studs |
| **DMRB 8.3 Lighting** | | | Lighting |
| **DMRB 8.5 Pedestrian Crossings** | | | Provision of Pedestrian Crossings |
| **Traffic Signs Manual** | | | Traffic Signs and Road Markings |
| **Local Transport Notes, Traffic Advisory Leaflets and other DTLR Publications** | | | Cycle Lanes, Footways, Tactile Paving, Traffic Calming/Management |

**Table 4/1: Principal Design Standards Pertaining to Categories of Minor Improvements/Measures**

**Category 2**

4.13 The **Principal Standards** pertaining to the Category 2 improvements are contained within **DMRB 4** and **DMRB 6**. The installation of traffic signals **(DMRB 8)** at an existing priority junction should also be considered as Category 2.

4.14 Localised **Carriageway Widening**, used in conjunction with road markings designed to provide warning to drivers or to channelise traffic, can be an effective alternative to a more costly horizontal realignment **(see Chapter 5 Examples 1 and 4)**. Other improvement measures include:

- removing/cutting back vegetation, realigning fences;
- providing road markings such as central or edge hatching and delineators to channelise traffic;
- providing authorised advisory speed signs, speed roundels or bend warning markings on approaches to the hazard;
- introducing coloured surfacing to enhance road markings;
- providing warning signs such as chevrons at bends.

4.15 As a low-cost alternative to vertical realignments **(see paragraph 4.9)**, Designers could consider the following improvement measures:

- vertical re-profiling **(see Chapter 5 Example 8)**;
- segregation of slow moving vehicles by the provision of climbing lanes (or cycle lanes) where the existing road width permits;
- providing arrester beds on long downhill sections;
- providing safely located and adequately designed crossing points for non-motorised road users.

4.16 **Junction** or **Road Closures** and **Junction Modification** may be appropriate in some circumstances **(see Chapter 5 Examples 7 and 11)**. Particular turning movements can cause delays and accidents at busy junctions even where current design standards are met.

4.17 Although this Advice Note does not refer to the detailed design of junctions, Designers should note that minor improvement measures (eg the conversion to a ghost island layout) can improve operational and/or safety aspects for main line traffic as well as minor road traffic. The needs of non-motorised road users should also be addressed in the design of the improvement.

4.18 Control of land use and accesses is important in minimising accidents. Roads with frequent direct frontage access generally have higher accident rates than those with limited access.

4.19 Alterations to **Superelevation**, **Crossfall** or **Adverse Camber** may be necessary where there are indications that surface water run-off is ineffective or where drivers are losing control for any reason.

4.20 **TA 57 (DMRB 6.3)** provides guidance concerning the various types of **Kerbing** most appropriate for different applications. Kerbing may assist in:

- defining the edge of the carriageway;
- improving drainage by directing run-off to gullies;
- preventing vehicles over-running the edge of carriageway where hardstrips are not provided.

4.21 **Drainage** improvements should be considered wherever problems are observed such as standing water on the carriageway or verges or field run-off onto the road. Evidence of road foundation instability should be investigated and may result from sub-surface drainage deficiencies. Guidance on drainage is provided in **DMRB 4.2**.

4.22 Provision of **Lay-bys** and **Rest Areas** should be made in accordance with **TA 69 (DMRB 6.3)** which gives guidance on layout, spacing and location.

**Category 3**

4.23 **TA 57 (DMRB 6.3)** provides a useful initial reference for a number of Category 3 improvements including:

- pedestrian guardrails;
- anti-dazzle fences;
- facilities for cyclists;

- access provision and control;
- roadside facilities for ridden horses;
- pedestrian features at level crossings.

4.24 Designers should also consult appropriate **Local Transport Notes, Traffic Advisory Leaflets and Mobility Unit Circulars** to obtain current information relating to non-motorised road user groups, traffic calming and traffic management.

4.25 **Road Markings**, **Delineators** and **Coloured Surfacing** are particularly useful minor improvement measures, which can lead to a reduction in the number and severity of accidents **(see Chapter 5 Example 2)**. Guidance on road markings and delineators is contained in **DMRB 8.2**, the **Traffic Signs Manual and in Volume 1, Series 1200 Specification for Highway Works**. Traditional road markings, raised ribbed markings, delineators or coloured surfacing may be designed to:

- indicate priorities, prohibitions or manoeuvres;
- channelise vehicles into lanes;
- provide lateral guidance;
- influence speed and flow.

4.26 Various forms of edge line and centre line markings are beneficial in segregating traffic and indicating hazards. Thermoplastic road markings should normally be reflectorised to enhance visibility in poor weather. Other improvements include:

- coloured surfacing to enhance road markings;
- raised rib edge lines.

4.27 Guidance on Road Signs is contained in **DMRB 8.2**, and **Chapter 7 Traffic Signs Manual** sets out the requirements. Possible improvement measures to road sign installations, dependent on individual circumstances, may include:

- signs such as plastic chevrons which deform when struck by a vehicle;
- careful placement in a position clearly visible to drivers, not obscured by vegetation and not susceptible to spray from vehicles;
- retroreflective faces (Class I);
- lighting units to signs;
- variable message signs (eg speed warning);
- consistency of signs throughout route.

4.28 **Reflectors and Road Studs** are useful in delineating the road, side road junctions, accesses, lay-bys and hard shoulders.

4.29 The erection of **Safety Fences** along a section of the network may be part of a route strategy **(see Chapter 5 Example 9)**. New safety fences should be provided in accordance with **DMRB 2.2**.

4.30 **Highway Lighting** should be provided in accordance with **DMRB 8.3** and records indicate that provision of lighting can reduce accident rates at sites where there is a history of accidents during darkness. It is important that illumination levels should be uniform. The use of breakable columns, set back from the carriageway, may be considered as well as appropriate safety fence protection.

4.31 **Road Surface Characteristics** have a significant effect on road safety. Accidents in wet conditions are generally less frequent and less severe on surfaces with higher skid resistance. Good surface texture is particularly important for wet conditions, especially on higher speed roads and at junctions.

4.32 Driver vision at night can be improved by a suitable road surface texture which reduces glare from reflections. In certain circumstances it may be necessary to consider resurfacing or drainage improvements.

4.33 **Footpath**, **Cycle Track** and **Bridleway Crossings** can produce safety benefits. Designers should also be aware that community severance can be reduced by the provision of suitably located crossing points.

4.34 Opportunities should be taken to rationalise the frequency and layout of existing crossings or provide new crossings for pedestrians, cyclists and equestrians. The use of crossings at appropriate and convenient locations should reduce conflict between vehicles and non-motorised users.

4.35 Positioning of **Street Furniture** (and Statutory Undertakers' apparatus) should not create safety problems by obstructing visibility or increasing the severity of an impact. In rural areas immovable roadside features such as walls or trees may require safety fences to be installed to safeguard road users.

4.36 Where horizontal and vertical alignments combine to obscure the direction of the road ahead, careful positioning of street furniture and planting can help to delineate the route.

4.37 **Cyclist** and **pedestrian facilities** which physically segregate these road users from vehicular traffic can help to encourage these forms of transport as well as improving safety.

# 5. EXAMPLES OF MINOR IMPROVEMENTS

**Introduction**

5.1 It is important that Designers correctly identify problems, and their causes, before attempting to produce solutions. A number of notional examples follow which are intended to illustrate the scale and type of improvement measures/options:

Example 1 Edge to Edge Surfacing;

Example 2 Channelisation of Traffic;

Example 3 Encourage Discipline on Bends by Use of Road Markings;

Example 4 Curve Widening;

Example 5 Closure of Central Reserve Gaps;

Example 6 Speed Reduction on Bends by Introducing Roundabouts;

Example 7 Road Closure;

Example 8 Vertical Re-profiling;

Example 9 Route Enhancement;

Example 10 Restricting Excessive Forward Visibility on Bends;

Example 11 Re-locating Accesses;

Example 12 Re-locating Signs.

5.2 Layouts provided in this chapter are intended for guidance only and are not exhaustive. The inclusion or exclusion of minor improvement measures does not imply applicability in all circumstances. The examples are not drawn to scale and are intended to be diagrammatic in nature.

5.3 Other innovative solutions should always be considered and the needs of non-motorised road users should be taken into account. In the examples described in this chapter other arrangements could be considered, eg the use of traffic signal control in **Examples 5**, **6** and **7**; or to provide a third roundabout with **Example 5**. Designers should avoid becoming fixed on a single solution to the problem at an early stage in the design process. A flexible, open-minded approach should be adopted when developing options.

## Example 1 Edge to Edge Surfacing

5.4 **Figure 5/1** represents a situation where a rural road passes through hilly and bendy terrain. The edge limits may typically be defined by hedges, dry stone walls, rock cuttings or natural outcroppings. In the existing situation the road width may vary with narrow grass verges on both sides. Problems which may result, include:

- overgrown verges possibly reducing sight distances on bends;
- rutted verges causing potential drainage/subgrade problems;
- traffic disruption caused during maintenance operations (eg grass cutting);
- occasional pedestrian, cyclist and equestrian use of trafficked carriageway due to condition of verges.

5.5 The proposed improvement option illustrated in **Figure 5/2** has a number of advantages:

- avoids widening of highway corridor/land take;
- slight improvement in sight distances on bends;
- hardstrips improve opportunities for passing broken down vehicles;
- reduces the requirement for temporary traffic signal control or road closure during maintenance works;
- hardstrips provide safer environment for occasional pedestrians, cyclists and equestrians;
- reduces traffic disruption during routine maintenance works;
- minimises environmental impact.

5.6 The better delineation of the route may lead to increased speed and Designers should consider this implication and provide associated measures such as signs and road markings where appropriate.

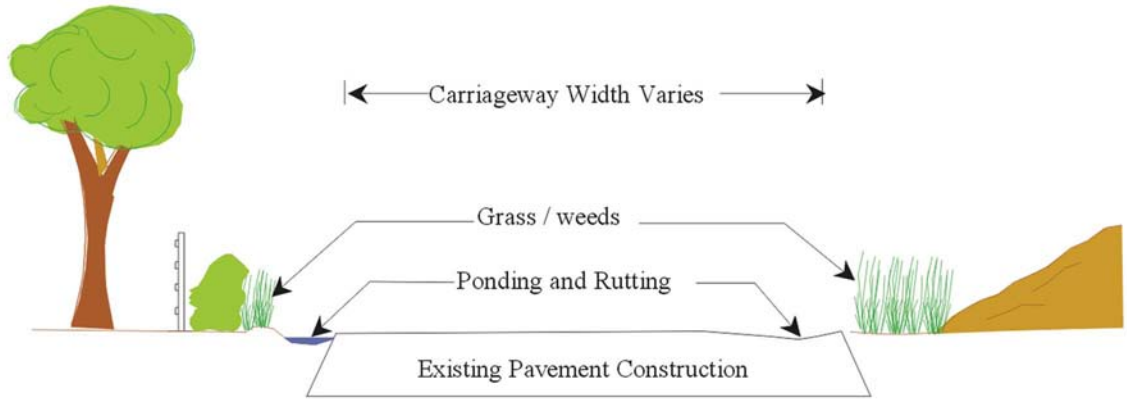



**Figure 5/1: Existing Cross Section**

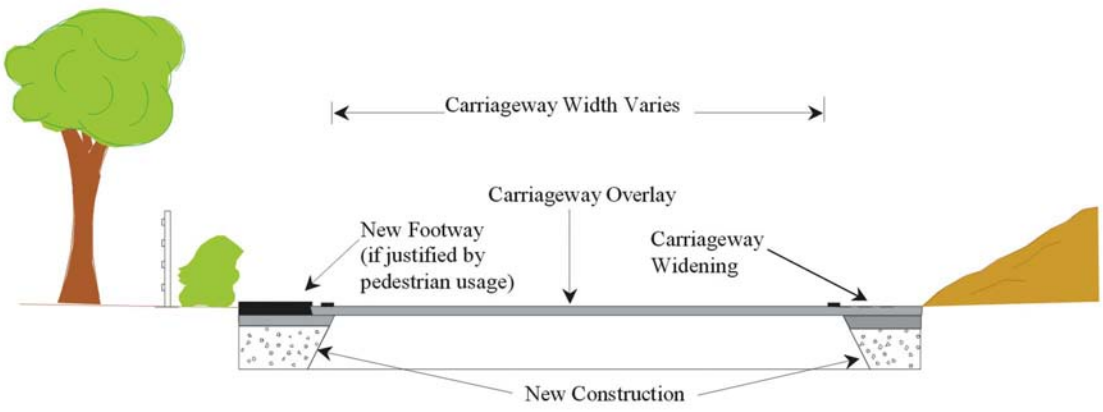



**Figure 5/2: Proposed Cross Section**

**Example 2 Channelisation of Traffic**

5.7 **Figure 5/3** represents an existing WS2 carriageway, approximate width 12m (including hardstrips), with high traffic flows between two relatively closely spaced roundabouts, in a situation where the horizontal radius may result in dubious overtaking conditions **(ie Band C, Figure 24, TD 9, DMRB 6.1)**. Problems which may result, include:

- conflict may occur at point C, as overtaking traffic commence their manoeuvres at points A and B;
- high speeds encouraged by wide lane widths and hardstrips
- conflict between non-motorised road users and vehicles at the existing crossing.

5.8 **Figure 5/4** illustrates two alternative minor improvements options, both of which have the following advantages:

- lane markings provide clear channelisation of traffic;
- lower speeds encouraged due to narrower lane widths and replacement of hardstrips with central or edge hatched areas;
- vehicle conflict reduced/overtaking sections clearly indicated;
- improved/safer crossing facilities;
- low cost.

5.9 Removal of the hardstrips may not be appropriate if there is a significant number of pedestrians, cyclists or equestrians, and it may therefore be necessary to consider the provision of footways, cycle lanes or bridleways in these circumstances. If the road is bisected by a footpath, cycle track or bridleway and there is no other convenient crossing. Designers may, with the agreement of the Overseeing Organisation, consider the provisions of a traffic island as a designated crossing facility, provided it is conspicuous to all road users at all times; lighting the area is recommended to enhance safety for all road users.

5.10 Where 3 lane roads are provided, clear signing and road marking is essential to advise drivers of changes in priority. The use of the coloured surfacing in both options illustrates how this message can be reinforced.

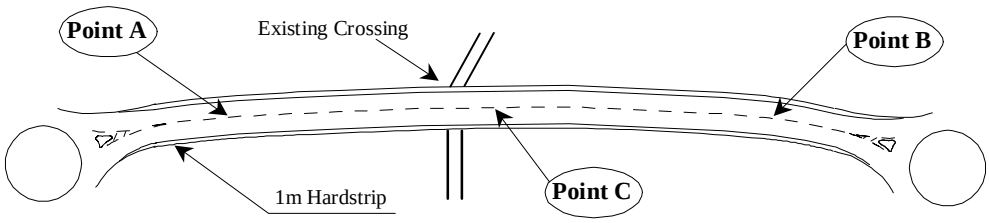
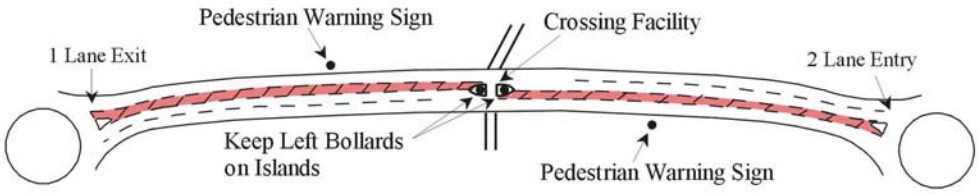
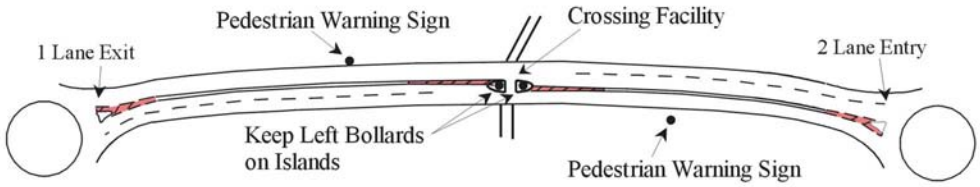



**Figure 5/3: Existing Two Lane Layout**




**Option A – Coloured Surfacing and Central Hatched Markings**




**Option B - Coloured Surfacing and "No Overtaking" Roadmarkings**

**Figure 5/4: Alternative Proposed Layout Options**

## Example 3 Encourage Discipline on Bends by Use of Road Markings

5.11 **Figure 5/5** represents a situation where an unimproved section of S2 carriageway lies between two sections with higher standards. Problems associated with this comprise high speeds on approaches and through the substandard section of road.

5.12 The existing road alignment may have resulted from a major constraint (eg a hill). An off-line improvement designed to **TD 9 (DMRB 6.1)** would have the following disadvantages:

- high scheme cost may result in a negative Net Present Value (NPV);
- major construction and earthworks;
- detrimental effect on the environment;
- land-take.

5.13 The proposed minor improvement layout option illustrated in **Figure 5/6** may provide a short term solution, where there is sufficient carriageway width. This has a number of advantages:

- rumble areas provide a physical warning of the approaching hazard;
- central hatched markings provide clear channelisation of traffic through the hazard;
- low cost;
- no land requirement.

5.14 These low cost measures should be carried out in conjunction with the appropriate advance warning signs. Reflecting or other types of road studs can also be used to delineate the curves.

5.15 Where the existing road is too narrow to accommodate the central hatched markings, the measures indicated in **Example 1** could also be incorporated. Where properties are close to the road the use of rumble areas may be inappropriate due to the noise created.

5.16 Where rumble areas constituting transverse road markings are used Designers should ensure that ponding will not be exacerbated as a result of obstruction of surface water drainage paths. In these cases flush reflectorised road markings can be used, although they are less effective during daylight.

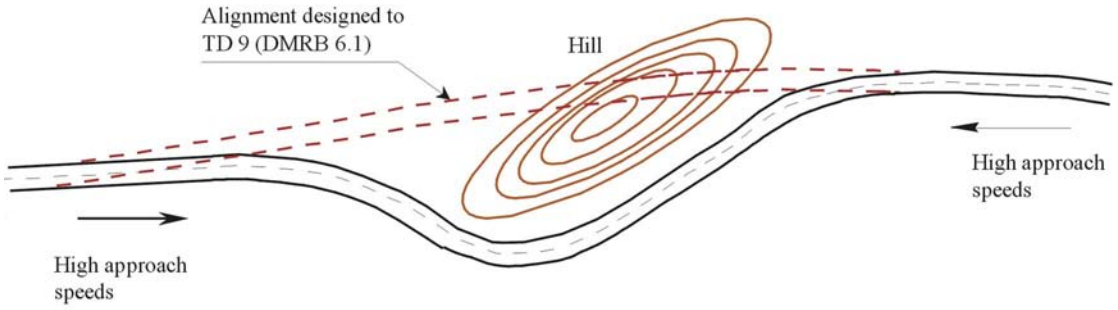



**Figure 5/5: Existing Layout**

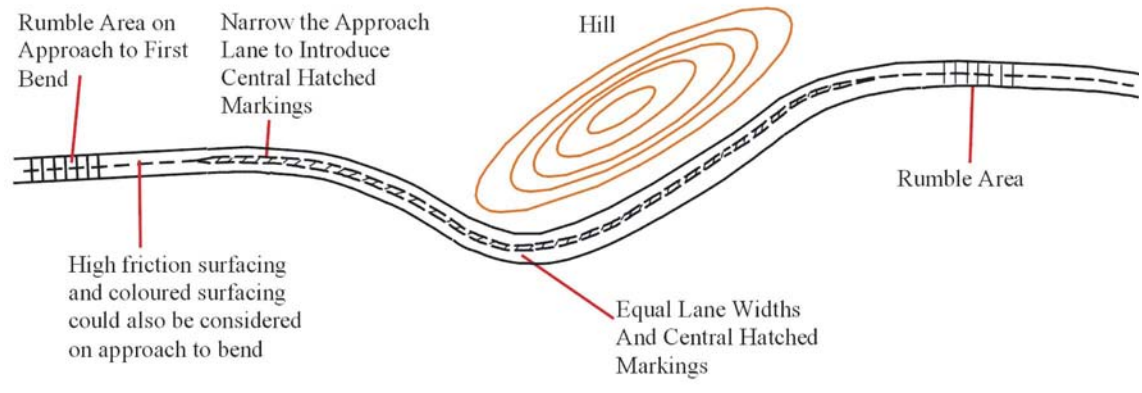



**Figure 5/6: Proposed Layout**

**Example 4 Curve Widening**

5.17 **Figure 5/7** represents a situation where an unimproved section of S2 carriageway lies between two sections with higher standards. Problems associated with this comprise high speeds on approaches and through the section of substandard road.

5.18 In this example the road is bounded by dry stone walls and passes over a culvert. An off-line improvement designed to **TD 9 (DMRB 6.1)** would have the following disadvantages:

- relatively high scheme cost may result in a negative NPV;
- major construction including a new culvert and long lengths of dry stone walling;
- detrimental effect on environment;
- land-take.

5.19 The proposed improvement illustrated in **Figure 5/8** has a number of advantages:

- physical construction minimised;
- provides clear channelisation of traffic through the hazard;
- hatched areas provide margins for error and manoeuvrability for large vehicles;
- no effect on watercourse;
- low cost improvement;
- land requirement minimised.

5.20 Where the existing road is too narrow to accommodate central hatched markings, the measures indicated in **Example 1** could also be incorporated. The use of reflecting road studs could also be used to delineate the bends as in Example 3.

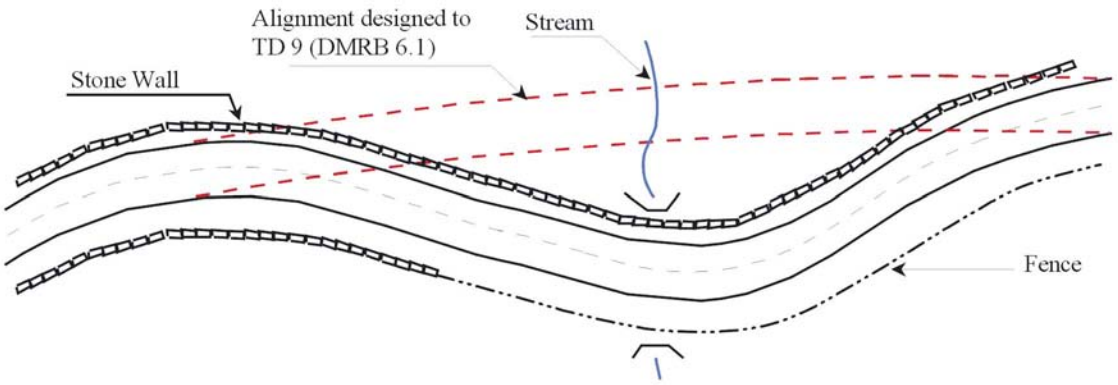



**Figure 5/7: Existing Layout**

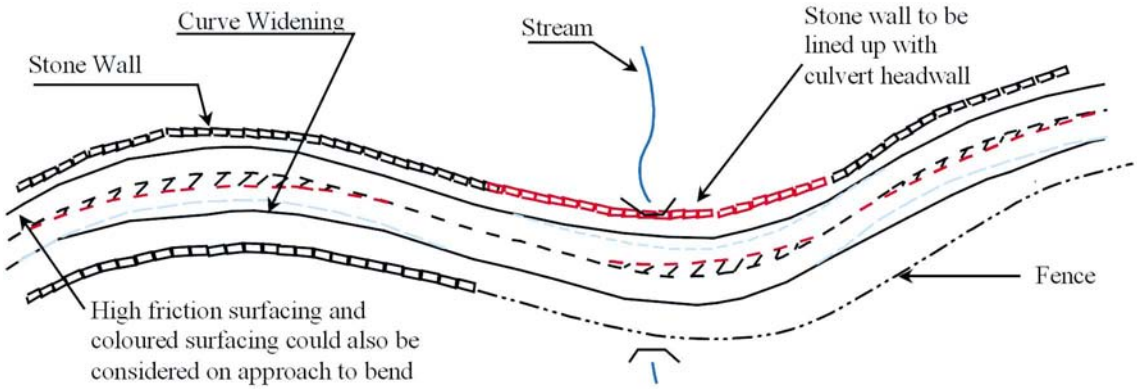



**Figure 5/8: Proposed Layout**

## Example 5 Closure of Central Reserve Gaps

5.21 **Figure 5/9** represents a section of D2AP carriageway which has a number of at-grade crossings with central reserve gaps along its length. Problems which may result, include:

- a poor accident record associated with right turning traffic movements at junctions;
- traffic flows disrupted by weaving at intermediate junctions.

5.22 The proposed improvement option illustrated in **Figure 5/10** has a number of advantages:

- removes all right turns (except at roundabouts) by closure of all central reserve crossings;
- land requirements minimised;
- improves traffic flows between roundabouts.

5.23 Designers should consider the need for an additional entry lane at roundabouts to cater for increase in right turning traffic (ie 'u-turns').

5.24 A disadvantage of this solution however is that journey lengths may increase as it requires some traffic to either redistribute to other links in the network or perform "u-turns" at the roundabouts. Where junctions are being closed and traffic diverted, it is important to identify the special needs of those affected. Consultations with local authorities, emergency services, other relevant organisations and individuals may be necessary.

5.25 An additional advantage may be achieved in eliminating cross-over accidents by the provision of central reserve safety fence. Where an existing footpath, cycle track or bridleway crosses the road or at intermediate accesses where pedestrian and cyclist usage demands, provision will be required to overlap the central reserve safety fence to allow crossing unless alternative arrangements are available. In addition consideration should be given to requirements for channelising pedestrians and cyclists at the roundabouts where usage demands.

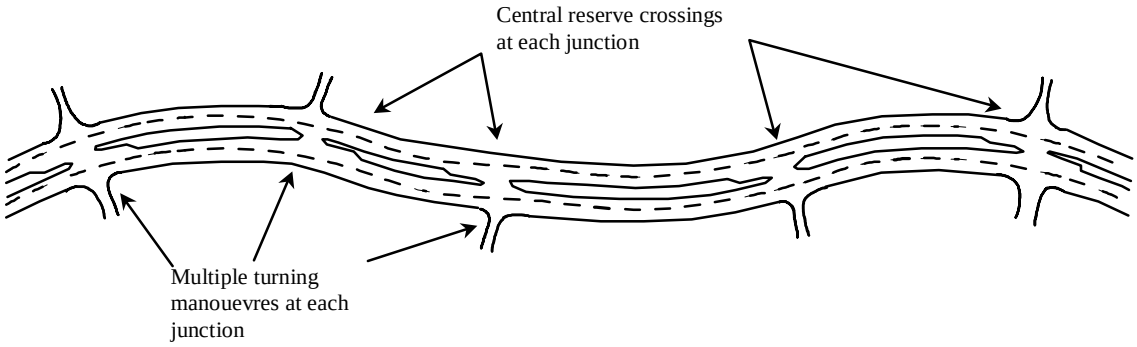



**Figure 5/9: Existing Layout**

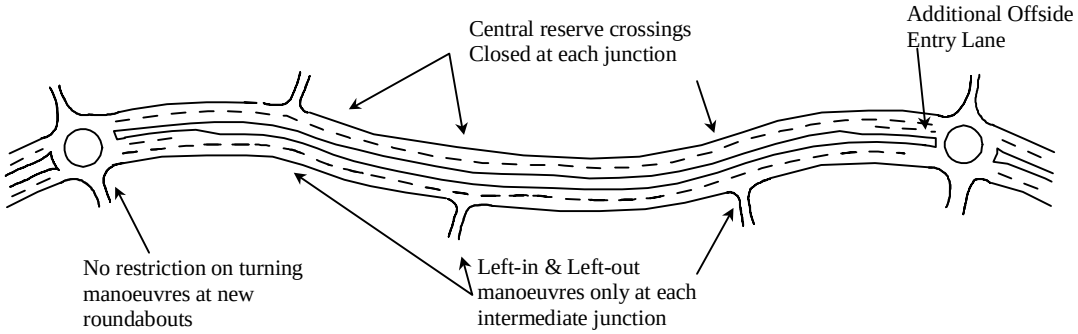



**Figure 5/10: Proposed Layout**

## Example 6 Speed Reduction on Bends by Introducing Roundabouts

5.26 **Figure 5/11** represents a situation where an unimproved section of S2 carriageway lies between two sections with higher standards. Problems associated with this comprise high speeds on approaches and through the sub-standard section of road.

5.27 The existing road alignment may have resulted from constraints (eg a woodland and a hill). An off-line improvement designed to **TD 9 (DMRB 6.1)** would have the following disadvantages:

- high scheme costs may result in a negative NPV;
- major construction including a deep rock cutting into the hillside;
- detriment to the environment (SSSI);
- large areas of land required.

5.28 The proposed improvement option illustrated in **Figure 5/12** has a number of advantages:

- roundabouts physically reduce approach speeds on the central section;
- relatively little new construction;
- avoids environmental impact on SSSI and hill;
- reduced land take compared to an off-line improvement;
- increases driver awareness of changed carriageway standards.

5.29 The introduction of roundabouts will have the disadvantage of incurring economic disbenefits, due to traffic delay costs. The number of slight accidents at the junctions may be increased, but there are likely to be accident savings overall. In situations where economic justification is difficult to achieve, a road closure option which retains only one junction may be more beneficial.

5.30 There may also be environmental disadvantage with respect to lighting at both roundabouts. However lighting may be justified when compared to the adverse effects of the off-line solution. In certain circumstances a single central column with four high pressure sodium lanterns at each roundabout, may be an acceptable solution.

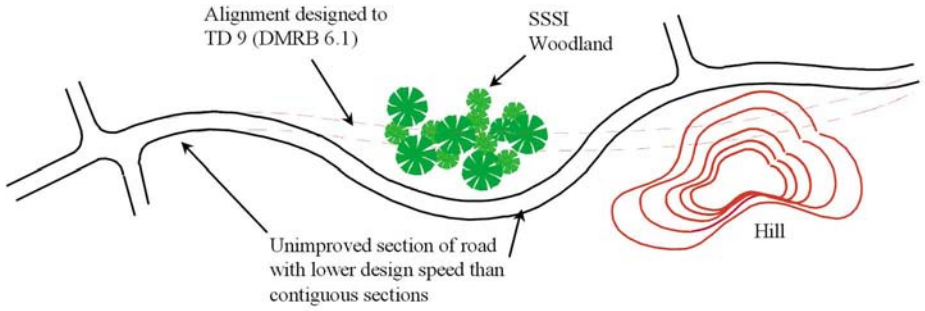



**Figure 5/11: Existing Layout**

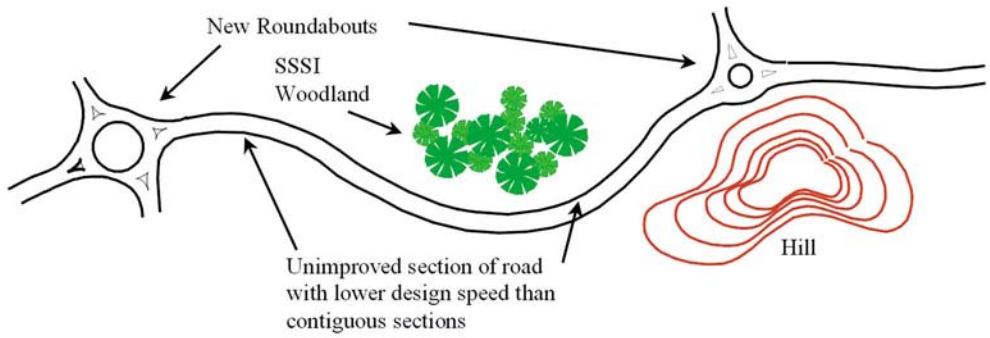



**Figure 5/12: Proposed Layout**

**Example 7 Road Closure**

5.31 **Figure 5/13** represents a situation where a section of a major road has two cross road junctions in close proximity, one of which is also indicated as a skew junction. Problems associated with the layout may include:

- high approach speeds on the major road;
- difficulty in providing clear directional signing;
- multiple turning movements at all junctions causing conflicts;
- poor visibility at the junctions.

5.32 The proposed improvement option illustrated in **Figure 5/14** has a number of advantages:

- roundabout physically reduces approach speeds on the major road;
- removal of redundant link;
- improved junction visibility;
- improved turning movements;
- improved signing;
- less vehicular conflict and driver confusion.

5.33 The introduction of roundabouts will have the disadvantage of incurring economic disbenefits as described in **paragraph 5.29**.

5.34 In urban locations the existing layout could be modified to form a gyratory system, or other options such as mini-roundabouts or traffic signals may be considered.

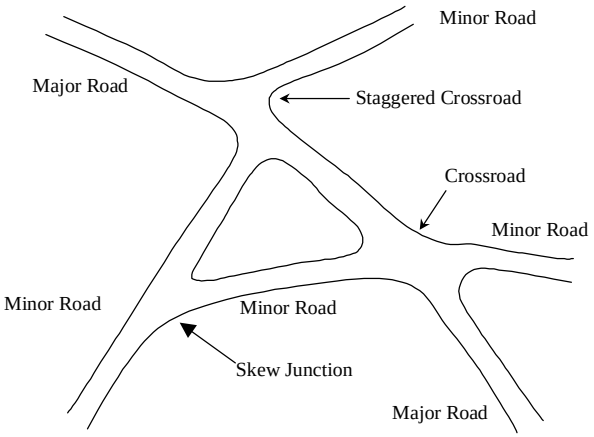



**Figure 5/13: Existing Layout**

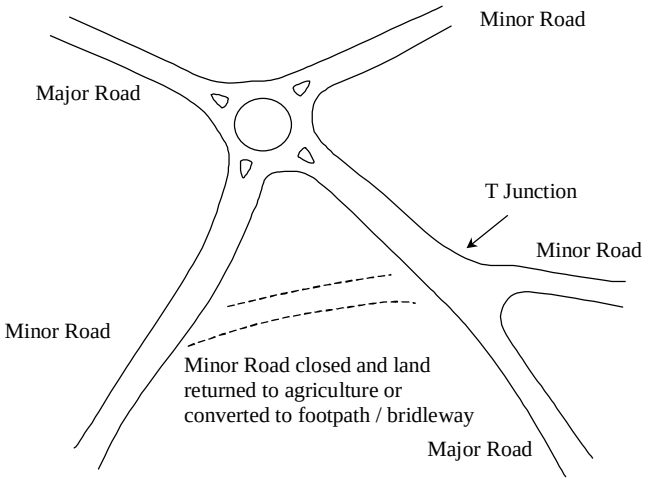



**Figure 5/14: Proposed Layout**

**Example 8 Vertical Re-profiling**

5.35 **Figure 5/15** represents the substandard vertical alignment of a section of single carriageway, which causes on-coming vehicles to "disappear" within the dip.

5.36 The disadvantages of a full vertical realignment to **TD 9 (DMRB 6.1)** may include:

- high scheme costs may result in a negative NPV;
- major construction including a new underpass;
- diversion of Statutory Undertakers' apparatus;
- additional land required.

5.37 The proposed improvement option illustrated in **Figure 5/16** has a number of advantages:

- improvement may be carried out within existing land;
- minimal construction;
- low cost;
- although sight distance standards of **TD 9 (DMRB 6.1)** may not be fully achieved, on-coming vehicles are more visible to vehicles from point A.

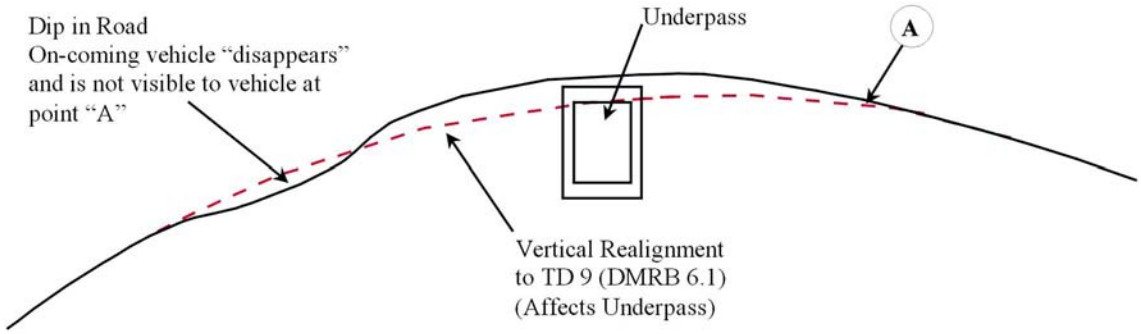



**Figure 5/15: Existing Alignment**

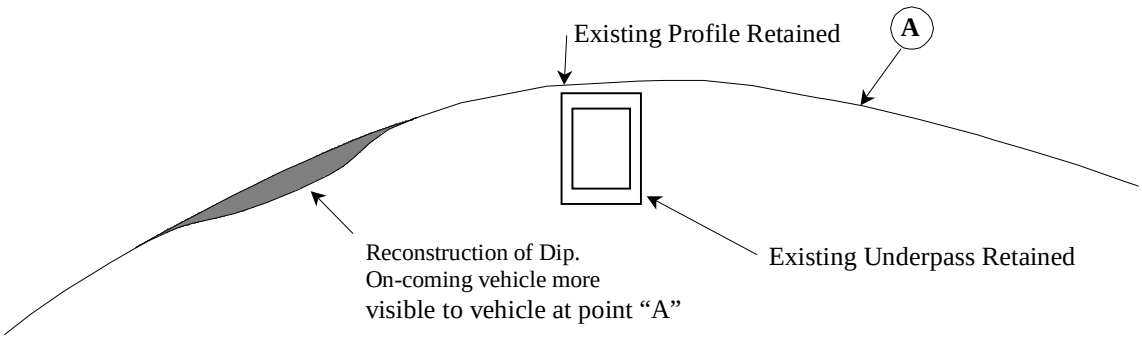



**Figure 5/16: Proposed Alignment**

**Example 9 Route Enhancement**

5.38 **Figure 5/17** represents a short section of route where a number of accidents may have occurred, at different locations, due to various causes. Minor improvements, such as those identified in other examples may be applicable at some locations. However as part of an overall strategy it may be appropriate, for example, to carry out improvements and additions to the safety fence throughout the route.

5.39 **Figure 5/17**, illustrates a section of the route where:

- safety fence is not provided at hazards such as culverts, high embankments, tight bends or large diameter sign posts;
- substandard safety fence is provided at certain hazards;
- a large redundant obstruction is within close proximity of the carriageway.

5.40 The proposed option in **Figure 5/18** illustrates the provision of the required lengths of safety fence and demolition of the redundant obstruction. Account must be taken of stopping sight distance requirements when locating the safety fence.

5.41 Other examples of route enhancement may target other features such as drainage, lighting, road markings, edge treatment, road signs etc.

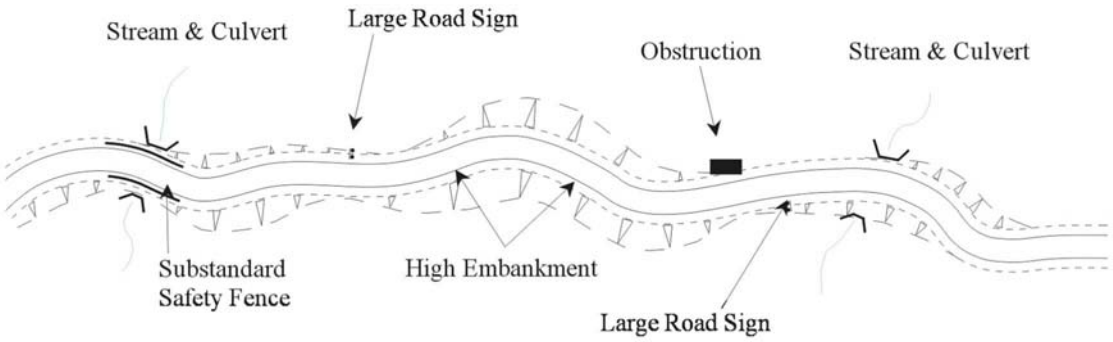



**Figure 5/17: Existing Layout**

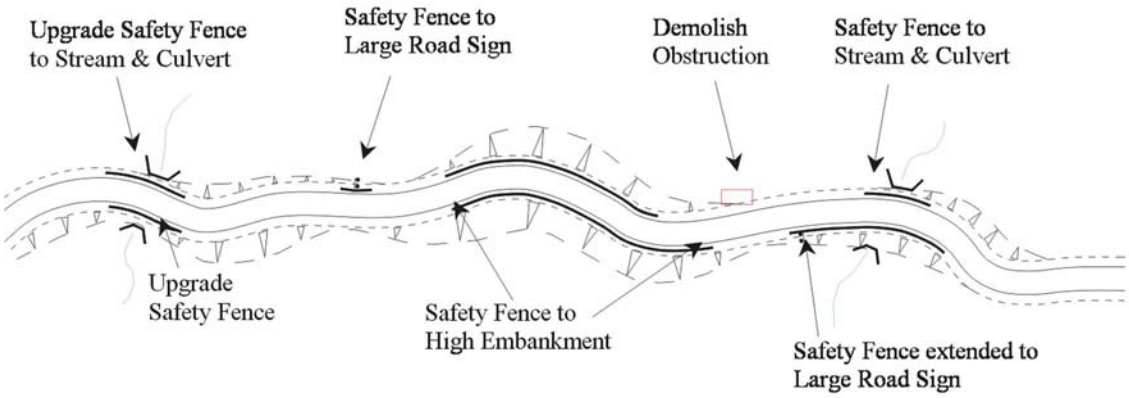



**Figure 5/18: Proposed Layout**

## Example 10 Restricting Excessive Forward Visibility on Bends

5.42 **Figure 5/19** represents a section of S2 carriageway which goes through a generally open landscape and results in excessive forward visibility being available on the inside of the bend. Drivers approaching the bend on the inside of the curve may decide that the road ahead is clear and commence overtaking. Meanwhile a vehicle could enter from the side road resulting in an accident.

5.43 The proposed option indicated in **Figure 5/20**, shows how intermittent planting has been provided to reduce forward visibility (to that required in **TD 9 (DMRB 6.1)**) on the approach to the bend to deter drivers from overtaking. As planting takes time to become established additional signing may be required or alternatively false cuttings may be provided. These measures are intended to improve the driver's awareness of the need to reduce speed rather than improve the alignment to permit higher speeds.

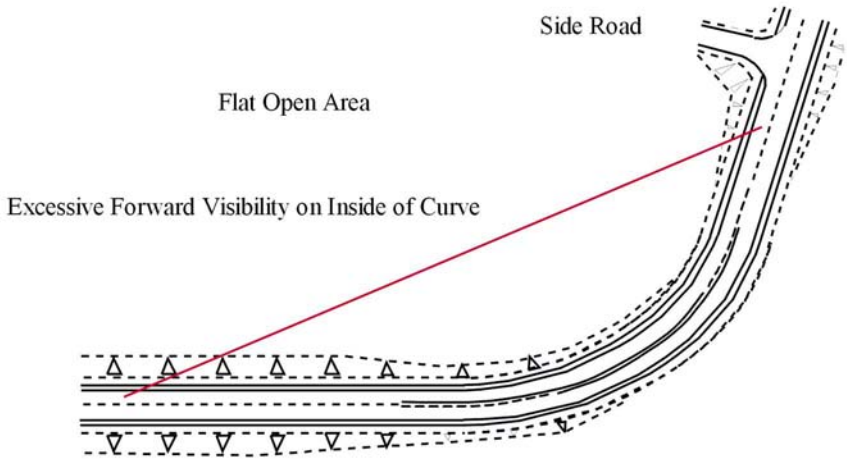



**Figure 5/19: Existing Layout**

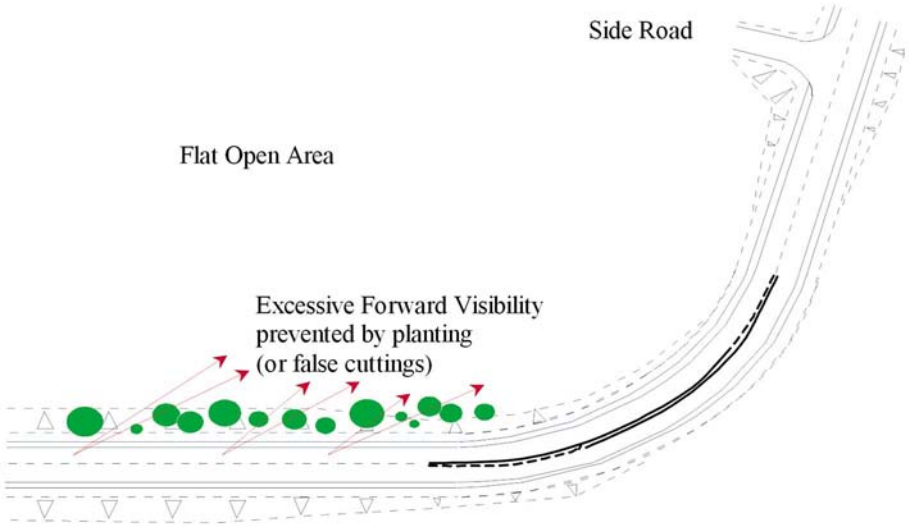



**Figure 5/20: Proposed Layout**

### Example 11 Re-locating Accesses

5.44 **Figure 5/21** illustrates an example where a field access located close to a junction may contribute to a poor accident record. Re-locating the access onto the minor road can eliminate the conflict between traffic on the major road and the vehicles using the access.

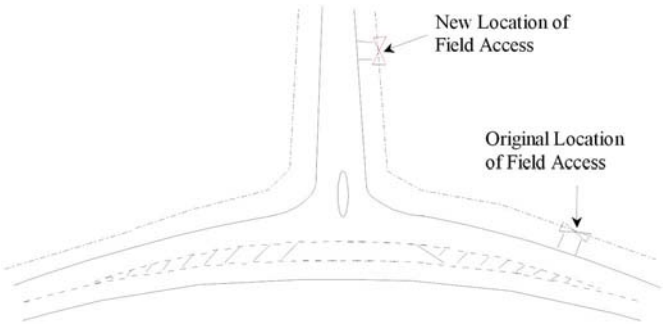



**Figure 5/21: Existing and Proposed Layouts**

5.45 **Figure 5/22** illustrates a section of road with a large number of individual field accesses along its length, which with the owner's co-operation, could be improved by reducing the number of access points and providing gates between fields as illustrated in the proposed option illustrated in **Figure 5/23**.

5.46 Such rationalisation may not be feasible. Other options to consider to reduce the effect of frequent access points include:

- provision of a parallel service road with replacement connections;
- access closure where an alternative is available.

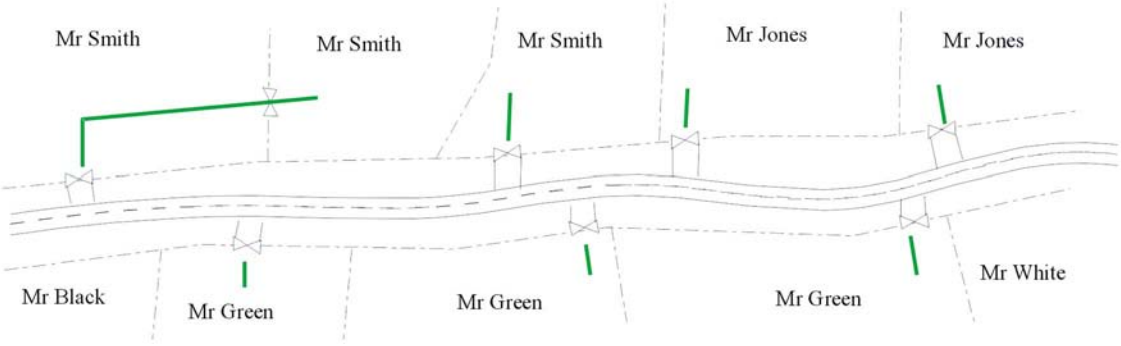



**Figure 5/22: Existing Layout**

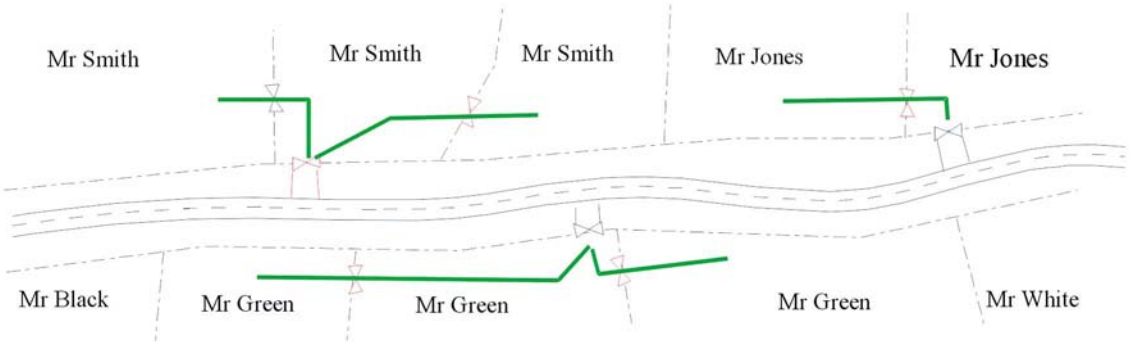



**Figure 5/23: Proposed Layout**

## Example 12 Re-locating Signs

5.47 **Figure 5/24** represents a situation where trees close to direction signs have grown and eventually obscure part or all of the signs from the driver, and encroach within the visibility splay from the junction. As an alternative to removing all trees, Designers should consider whether there are suitable alternative positions for the sign within the requirements described in the **Traffic Signs Manual**. **Figure 5/25** indicates notional examples of tree removal and re-location of signs to improve visibility.

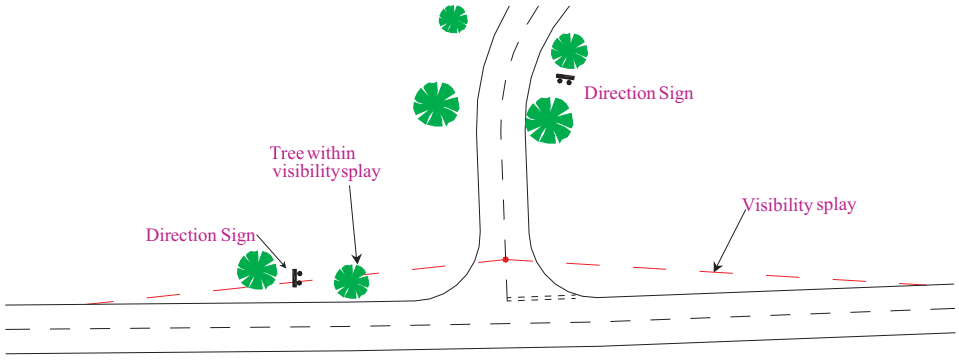



**Figure 5/24: Existing Layout**

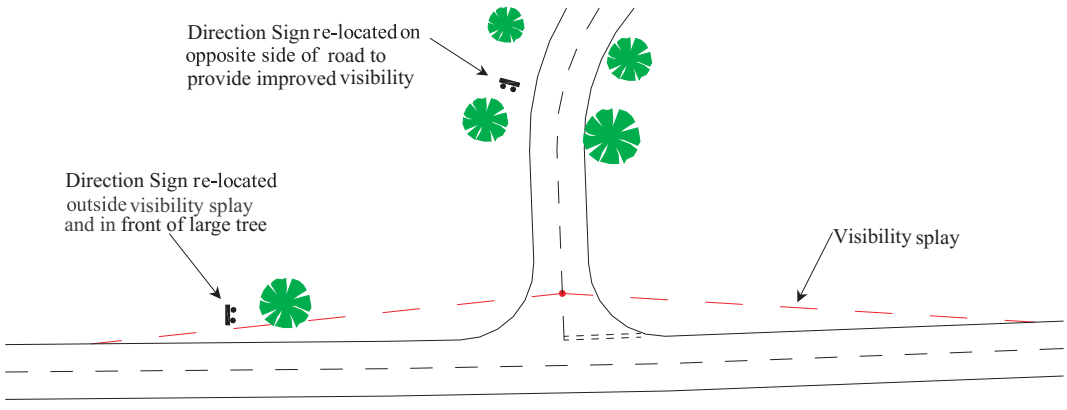



**Figure 5/25: Proposed Layout**

# 6. REFERENCES

**1. Design Manual for Roads and Bridges (DMRB): The Stationery Office**

a. **Volume 2** - Highway Structures.

b. **Volume 4** - Geotechnics and Drainage.

c. **Volume 5** - Assessment and Preparation of Road Schemes.

d. **Volume 6** - Road Geometry.

e. **Volume 7** - Pavement Design and Maintenance.

f. **Volume 8** - Traffic Signs and Lighting.

g. **Volume 10** - The Good Roads Guide.

h. **Volume 11** - Environmental Assessment.

i. **Volume 12** - Traffic Appraisal of Road Schemes.

j. **Volume 12a** - Traffic Appraisal of Road Schemes.

**2. Traffic Sign Regulations**

a. SI 1994 No 1519 - The Traffic Signs Regulations and General Directions 1994: The Stationery Office.

b. Traffic Signs Manual: The Stationery Office.

c. Traffic Signs Regulations (Northern Ireland) 1997: The Stationery Office.

d. The National Cycle Network: Guidelines and Practical Details Issue 2 1997: Sustrans.

**3. Department for Transport, Local Government and the Regions**

a. A New Deal for Trunk Roads in England: Guidance on the New Approach to Appraisal.

b. A New Deal for Trunk Roads in England: Understanding the New Approach to Appraisal.

c. Project Appraisal Report Guidance Notes (available on the DTLR (C) Highways Economics and Traffic Appraisal division web site www.roads.dtlr.gov.uk/roadnetwork/heta/hetapubs.htm).

d. Traffic Management and Tolls, and Charging and Local Transport Divisions Publications List - these two Divisions are responsible for the development of policy on traffic control and management issues, including:

- Cycling;
- Traffic Calming;
- Pedestrianisation;
- Traffic Signs;
- Bus Priority Systems;
- Parking.

**4. Transport Research Laboratory**

a. TRL Report 127, Transport supplementary grant for safety schemes - Local authorities' schemes from 1992/93 allocations (1995); TRL.

b. TRL Contractors Report 319 - Speed/Flow/Geometry Relationships for Rural Single Carriageway Roads.

**5. Miscellaneous**

a. Department of Transport (1994): Safer by Design - A guide to road safety engineering.

b. Road Accidents in Great Britain (The Casualty Report) - Published annually: The Stationery Office.

c. Road Safety Engineering Manual: ROSPA.

# 7. ENQUIRIES

All technical enquiries or comments on this Advice Note should be sent in writing as appropriate to:

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# ANNEX 1 WORKED EXAMPLE

## Introduction

A1.1 This Annex provides an example of the design procedure leading to the identification of options for a low cost minor improvement to an existing road. It refers to a situation where there are difficulties in achieving all of the relevant **DMRB** design criteria, within the imposed physical, economic and environmental constraints.

A1.2 The scheme indicated in **Figure A1/1** covers a section of single carriageway with two simple at-grade junctions (**A** and **B**) serving a village which is to the north of the road.

## Phase 1

### Identify Need for Scheme

A1.3 There have been a large number of personal injury accidents in the vicinity of the junctions. It is intended that improvement options should be identified to improve safety.

### Data Gathering

#### *Traffic*

A1.4 The main line has a 2 way 24 hr AADT of 13,750 vehicles with 25% commercial vehicles. The turning traffic flows at the two village junctions are indicated in **Table A1/1**.

A1.5 The design and measured speed for the trunk road was determined as 100kph in both directions.

| Location | Junction A | | Junction B | |
|---|---|---|---|---|
| | To Village | From Village | To Village | From Village |
| West | 126 | 126 | 313 | 313 |
| East | 42 | 42 | 104 | 104 |
| Two-way Total | 336 | | 834 | |

**Table A1/1: Turning Traffic at Village Junctions (24hr AADT)**

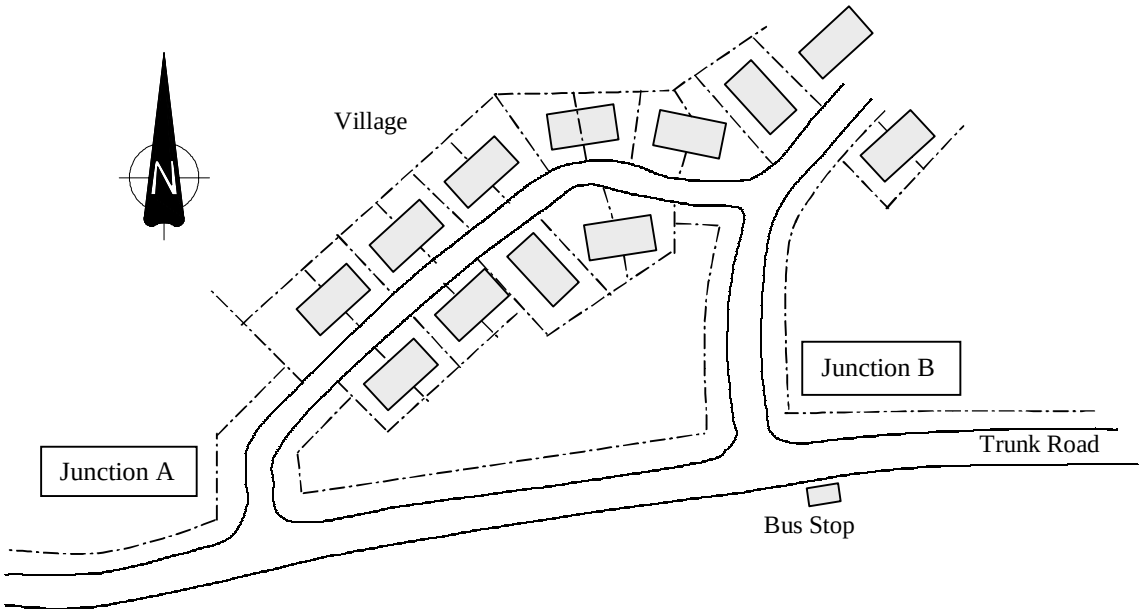


**Figure A1/1: Village Access Arrangement**

***Accidents***

A1.6 Accident data within the immediate approaches to the junctions was inspected and categorised into the accident types identified in **Chapter 2 Table 2/1**. To assist in the development of options the accident data was separated between Junctions A and B as indicated in **Tables A1/2** and **A1/3**.

| Conditions | | Severity and Number of Casualties | Number of Vehicles and Accident Type | Conflict |
|---|---|---|---|---|
| Light | Dry | Slight – 1 | 2 | No description |
| Light | Dry | Serious – 2 | 3<br>←★← | V1 (car) westbound collided with V2 (car) and V3 (cycle) while overtaking |
| Dusk | Dry | Slight – 1 | 2<br>→• | V1 (PSV) eastbound collided with V2 (cycle) while overtaking |
| Light | Dry | Serious – 1 | 2<br>→★↓ | V2 (car) turning right from Village fails to stop and collides with V1 (HGV) eastbound |
| Dark | Wet | Slight – 2 | 2<br>→★← | V1 (car) westbound crosses centreline & collides with V2 (car) eastbound turning into junction |
| Dark | Wet | Slight – 1 | 1<br>→ | No description (vehicle leaves carriageway) |
| Dark | Wet | Slight – 1 | 1<br>→ | V1 (car) eastbound leaves carriageway |
| Dark | Wet | Slight – 1 | 1<br>→• | V1 (car) stopped at previous RTA and struck Police officer as V1 pulls away |
| Dark | Wet | Serious – 1 | 1<br>→• | V1 (HGV) westbound hits pedestrian on verge |

**Table A1/2: Accident Data at Junction A**

| Conditions | | Severity and Number of Casualties | Number of Vehicles and Accident Type | Conflict |
|---|---|---|---|---|
| Light | Wet | Serious – 3 | 3<br>→★←★← | V1 (HGV) westbound collides and shunts stationary V2 (PSV) into V3 (car) eastbound |
| Light | Dry | Slight – 2 | 3<br>←★← | V3 (car) westbound shunts stationary V2 (car) into V1 (car) westbound turning right |
| Light | Wet | Slight – 1 | 4<br>←★←★←★← | V4 (car) westbound turning right, V3 (car) stationary shunted by V2 (car) and V1 (car) |
| Dark | Dry | Slight – 1 | 3<br>←★←★← | V3 (car) westbound turning right, V2 (car) waiting behind struck by V1 (car) westbound |
| Light | Wet | Slight – 2 | 4<br>←★←★←★← | V4 (car) westbound turning right, V1 & V2 (cars) shunted into V4 by V3 (car) |

**Table A1/3: Accident Data at Junction B**

***Main Line Alignment***

A1.7 The horizontal alignment was assessed using Ordnance Survey plans **(Table A1/4)** and a level survey along one channel was undertaken to obtain vertical alignment details **(Table A1/5)**.

| Chainage | | Radius (m) | Hand | Comments |
|---|---|---|---|---|
| From | To | | | |
| 100 | 117 | Straight | | |
| 117 | 330 | Straight | | |
| **330** | **400** | **510** | **Left** | **1 Step below Desirable Minimum 720m radius** |
| **440** | **510** | **400** | **Right** | **Between 1 and 2 Steps below Desirable Minimum 720m radius** |
| 510 | 750 | 10,000 | Left | Above Minimum 2,040m radius |
| 710 | 991 | 4,000 | Right | Above Minimum 2,040m radius |
| 991 | 1,000 | 4,000 | Right | Above Minimum 2,040m radius |

**Table A1/4: Horizontal Alignment**

| Chainage | | Radius (m) | Type | Comments |
|---|---|---|---|---|
| From | To | | | |
| 117 | 240 | | | No information available |
| 240 | 280 | +2.9% | Gradient | Above Minimum of 0.5% and below Desirable Maximum of 6% |
| **280** | **410** | **2,600** | **Crest** | **Absolute Minimum 2,600m radius** |
| 410 | 550 | 60,000 | Crest | Exceeds Desirable Minimum Crest 10,000m radius (Note 10,000m not recommended for single carriageways) |
| 550 | 620 | 6,000 | Sag | Above Absolute Minimum of 2,600m |
| **620** | **690** | **10,000** | **Crest** | **Desirable Minimum Crest 10,000m not recommended for single carriageways** |
| 690 | 740 | 7,000 | Sag | Above Absolute Minimum of 2,600m |
| **740** | **870** | **10,000** | **Crest** | **Desirable Minimum Crest 10,000m not recommended for single carriageways** |
| **870** | **991** | **4,000** | **Level** | **Below Minimum Gradient of 0.5%** |
| **991** | **1,000** | **4,000** | **Level** | **Below Minimum Gradient of 0.5%** |

**Table A1/5: Vertical Alignment**

A1.8 The sections in bold text in **Tables A1/4** and **A1/5** indicate where required standards for 100kph design speed are not achieved.

***Junction Visibility***

A1.9 To assess the junction visibility a series of observations were made from the relevant X and Y distances at each junction for the appropriate design speed.

| "X" (m) | "Y" (m) To East | "Y" (m) To West | Y = 215m | Comments (References to **TD 42 DMRB 6.2**) |
|---|---|---|---|---|
| 2.4 | >215 | | Yes | In accordance with "exceptional conditions" standard (para 7.8) |
| | | **90.5** | **No** | **Visibility constrained by vertical alignment** |
| 4.5 | **46.7** | | **No** | **Visibility obstructed by Hedge and Earthworks** |
| | | **22.5** | **No** | **Visibility obstructed by Hedge and Earthworks** |
| 9.0 | **TP** | | **No** | **Visibility obstructed by Hedge and Earthworks** |
| | | **0** | **No** | **Visibility obstructed by wall** |
| 15.0 | TP | | Yes | In accordance with full standard (para 7.6b) |
| | | **0** | **No** | **Visibility obstructed by wall** |

**Table A1/6: Visibility at Junction A**

| "X" (m) | "Y" (m) To East | "Y" (m) To West | Y = 215m | Comments (References to **TD 42 DMRB 6.2**) |
|---|---|---|---|---|
| 2.4 | >215 | | Yes | In accordance with "exceptional conditions" standard (para 7.8) |
| | | **114** | **No** | **Visibility obstructed by Hedge and Earthworks** |
| 4.5 | 215 | | Yes | In accordance with "difficult conditions" standard (para 7.8) |
| | | **100** | **No** | **Visibility obstructed by Hedge and Earthworks** |
| 9.0 | **70** | | **No** | **Visibility obstructed by Hedge and Earthworks** |
| | | **77** | **No** | **Visibility obstructed by Hedge and Earthworks** |
| 15.0 | TP | | Yes | In accordance with full standard (para 7.6b) |
| | | TP | Yes | In accordance with full standard (para 7.6b) |

**Table A1/7: Visibility at Junction B**

A1.10 The sections in bold text in **Tables A1/6 and A1/7** indicate where visibility standards are not achieved for 100 kph design speed.

***Stopping Sight Distances***

A1.11 Stopping Sight Distances within the Immediate Approaches to the Junction (on the major and minor roads) were assessed from the OS plans and longitudinal profile as indicated in **Table A1/8**.

| Junc. | Limits Start | Limits End | Cause of Reduction in SSD |
|---|---|---|---|
| A | 290 | 430 | Vertical Alignment |
| A | 280 | 410 | Vertical Alignment |
| B | 345 | 430 | Horizontal Alignment |

**Table A1/8: Sub-standard Stopping Sight Distances**

*Other Features*

A1.12 To assist in the overall assessment, other features associated with the layout were considered, including:

- Hardstrips not present;
- Carriageway width varies from 6.2m to 7.3m;
- Verge widths generally 2.5m;
- Footway width 0.9m;
- Merge and Diverge tapers not present;
- Road markings and signs;
- Street Lighting not present;
- Cyclist facilities not present;
- Coloured surfacing not present;
- Safety fence not present;
- Drainage functioning satisfactorily;
- Bus stop located opposite junction B;
- Bus bay not provided.

**Preliminary Assessment of Information**

*Traffic*

A1.13 The traffic flows in **Table A1/1** indicate that a 2-way AADT of 1,170 on the minor road could be expected at a single junction. If both junctions were retained the traffic flows on the minor roads would be 336 and 834 at Junctions A and B respectively. These figures indicate that a ghost island layout should be considered only for Junction B, whether or not Junction A was to be retained.

*Accidents*

A1.14 **Table A1/9** provides an overall comparison of the accident proportions compared to the National Average. A detailed assessment was carried out to determine if there were links between the accident types and the geometrical features. For example, all of the accidents at Junction B involved stationary vehicles waiting to turn right towards the village and in some instances buses waiting at the bus stop contributed to the conflict.

*Sub-Standard Elements*

A1.15 As any sub-standard features which are not brought up to current standards by the improvement will become Departures From Standard in the improvement scheme, the "Existing Departures" were identified and summarised in **Table A1/10**.

| Category | Approx National % | Junc. A % | Junc. B % |
|---|---|---|---|
| → | 30 | 25% | 0 |
| ⇘★⇗ | 20 | 12.5% | 0 |
| →★← | 20 | 12.5% | 0 |
| →★→ | 15 | 12.5% | 100% |
| →• | 15 | 37.5% | 0 |

**Table A1/9: Comparison of Accident Proportions Against National Average**

| Existing Departure | Description | |
|---|---|---|
| | **Junction A** | **Junction B** |
| 1 | Junction Visibility to west | |
| 2 | | Junction Visibility to west |
| 3 | Reduction in Stopping Sight Distance on Minor Road Immediate Approach due to Horizontal Alignment | |
| 4 | Substandard Vertical Alignment on Immediate Approach | |
| 5 | | Substandard Vertical Alignment on Immediate Approach |
| 6 | Reduction in Stopping Sight Distance on Immediate Approach due to Horizontal Alignment | |
| 7 | | Reduction in Stopping Sight Distance on Immediate Approach due to Horizontal Alignment |
| 8 | Reduction in Stopping Sight Distance on Immediate Approach due to Vertical Alignment | |
| 9 | No Hardstrips | No Hardstrips |
| 10 | Narrow Lane Widths | Narrow Lane Widths |
| Total | 7 | 5 |

**Table A1/10: Summary of "Existing Departures"**

**Phase 2**

**Identification of Options**

A1.16 From the preliminary assessment of the information, a schedule was prepared which considered the effect of a range of improvement measures against the 'Existing Departures' and Accident Types as indicated in **Table A1/11**. A range of options was then developed by considering the effects of various combinations of the improvement measures.

A1.17 It was possible to reject some options which obviously would not be suitable. For example the provision of a new roundabout at Junction A was rejected because of the relatively small number of traffic movements; and the provision of traffic signals was rejected because of the rural setting.

A1.18 It was readily apparent that there would be significant benefits in closing one junction, and concentrating traffic movements at the other. Junction B was preferred to be retained because the main line carriageway alignment afforded better visibility at the junction. As a consequence all of the options included closure of Junction A.

| **Key**<br>✓ Design addresses existing Departure or accident type | | **Departure Description** | | | | | | | | | | **Accident Type** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Junction Visibility to West | Junction Visibility to West | SSD on Minor Road Approach | Mainline Vertical Alignment | Mainline Vertical Alignment | SSD on Mainline (Horizontal) | SSD on Mainline (Horizontal) | SSD on Mainline (Vertical) | Hardstrips | Narrow Lanes | Loss of Control | Collision with Intersection Vehicles | Collision with Rear of Vehicles | Collision with Oncoming Vehicles | Collision with Non-Motorised Users |
| Departure No. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | | | | |
| Junction Location | | A | B | A | A | B | A | B | A | A<br>B | A<br>B | A | A | A<br>B | A<br>B | A |
| **Improvement Measure** | | | | | | | | | | | | | | | | |
| 1 | Off-line Geometric Improvement | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **2** | **On-line Geometric Improvement** | | | | | ✓ | | ✓ | | | | | | ✓ | ✓ | |
| **3** | **Junction Closure (A)** | ✓ | | ✓ | | | ✓ | | ✓ | | | | ✓ | ✓ | ✓ | |
| 4 | New Roundabout at B | | ✓ | | | | | | | | | | ✓ | ✓ | ✓ | |
| **5** | **Ghost Island Layout (B)** | | | | | | | | | | | | | ✓ | ✓ | |
| 6 | Provision of Hardstrips | | | | | | | | | ✓ | | | | | | ✓ |
| **7** | **Carriageway Widening** | | | | | | | | | | ✓ | | | | | ✓ |
| 8 | Footway Widening | | | | | | | | | | | | | | | ✓ |
| 9 | Cycle Lane Provision | | | | | | | | | | | | | | | ✓ |
| **10** | **Relocation of Bus Stop** | | | | | | | | | | | | | ✓ | ✓ | |
| 11 | Provision of Bus Lay-by | | | | | | | | | | | | | ✓ | ✓ | |
| 12 | Provision of Coloured Surfacing | | | | | | | | | | | | ✓ | | ✓ | |
| 13 | Provision of Highway Lighting | | | | | | | | | | | | ✓ | ✓ | ✓ | ✓ |
| 14 | Road Markings and Signs | | | | | | | | | | | | ✓ | ✓ | ✓ | ✓ |
| Preferred Option F (Measures 2 + 3 + 5 +7+ 10) | | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ |

**Table A1/11: Effect of Improvement Measures on 'Existing Departures' and Accident Types**

**Initial Assessment of Options**

A1.19 Each option was assessed in terms of the number of 'Existing Departures' and Accident Types addressed.

A1.20 Eight options were shortlisted and taken forward for further testing and formal appraisal. The options were chosen to combine measures in practical schemes, likely to provide significant benefits. The options are described below, and are shown together with estimated costs in **Table A1/12**.

- **Option A** Off-line Geometric Improvement.
- **Option B** On-line Geometric Improvement; New Roundabout at B; Provision of Hardstrips; Carriageway Widening; and Relocation of Bus Stop.
- **Option C** New Roundabout at B; Provision of Hardstrips; Carriageway Widening; and Relocation of Bus Stop.
- **Option D** On-line Geometric Improvement; Carriageway Widening; and Relocation of Bus Stop.
- **Option E** On-line Geometric Improvement; Provision of Hardstrips; Carriageway Widening; and Relocation of Bus Stop.
- **Option F** On-line Geometric Improvement; Ghost Island Layout at B; Carriageway Widening; and Relocation of Bus Stop.
- **Option G** On-line Geometric Improvement; Ghost Island Layout at B; Provision of Hardstrips; Carriageway Widening; and Relocation of Bus Stop.
- **Option H** On-line Geometric Improvement; Ghost Island Layout at B; and all other improvement features noted in **Table A1/12**.

A1.21 The bold text in **Tables A1/11** and **A1/12** indicates the preferred option.

| Improvement Measure \ Option | | Cost (£K) | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Off-line Geometric Improvement | 751 | 751 | | | | | | | |
| **2** | **On-line Geometric Improvement** | 56 | | 56 | | 56 | 56 | **56** | 56 | 56 |
| **3** | **Junction Closure (A)** | 3.2 | | 3.2 | 3.2 | 3.2 | 3.2 | **3.2** | 3.2 | 3.2 |
| 4 | New Roundabout at B | 70 | | 70 | 70 | | | | | |
| **5** | **Ghost Island Layout (B)** | 57.6 | | | | | | **57.6** | 57.6 | 57.6 |
| 6 | Provision of Hardstrips | 127 | | 127 | 127 | | 127 | | 127 | 127 |
| **7** | **Carriageway Widening** | 95 | | 95 | 95 | 95 | 95 | **95** | 95 | 95 |
| 8 | Footway Widening | 5.6 | | | | | | | | 5.6 |
| 9 | Cycle Lane Provision | 14.7 | | | | | | | | 14.7 |
| **10** | **Relocation of Bus-Stop** | 0.5 | | 0.5 | 0.5 | 0.5 | 0.5 | **0.5** | 0.5 | 0.5 |
| 11 | Provision of Bus Lay-By | 12.9 | | | | | | | | 12.9 |
| 12 | Provision of Coloured Surfacing | 5 | | | | | | | | 5 |
| 13 | Provision of Highway Lighting | 53 | | | | | | | | 53 |
| 14 | Road Markings and Signs | 2.5 | | | | | | | | 2.5 |
| Total Cost of Option (£K) | | | 751 | 351.7 | 295.7 | 154.7 | 281.7 | **212.3** | 339.3 | 433 |

**Table A1/12: Summary of Options and Costs**

**Preliminary Design of Viable Options**

A1.22 Preliminary designs for each option were carried out to enable these options to be fully tested.

**Identify Departures and Relaxations**

A1.23 For each option the effect on 'Existing Departures' was examined to identify which were addressed, and which would remain to be processed as formal Departures as part of scheme development.

**Test Viable Options and Select Preferred Option**

A1.24 On the basis of the assessment of Departures and accidents in **Table A1/11** and the costs for each option in **Table A1/12**, a general assessment of costs and benefits was undertaken for each of the eight options. The assessment identified that **Option F** provided significant benefits compared to the existing situation, for an acceptable expenditure:

- the on-line geometric improvement enabled alignment problems including Departures from Standard to be addressed;
- the closure of Junction A concentrated all traffic movements at the preferred junction location;
- the ghost island layout at Junction B provided shelter for waiting vehicles and resulted in no delays to through traffic;
- the carriageway widening to a uniform standard provided a safer environment for non-motorised road users and more room for vehicles to manoeuvre safely;
- relocation of the bus stop separated this feature from the junction area, thus reducing potential conflict.

A1.25 Formal appraisals, including safety, economic and environmental aspects, were prepared for the options in accordance with current procedures of the Overseeing Organisation. **Option F** was selected as the preferred option.

**Review of Preferred Option**

A1.26 Following the assessment of options and identification of the preferred option, a review was undertaken with the Overseeing Organisation and its Agent to confirm the selection of the preferred option.

**Detailed Assessment of Preferred Option**

A1.27 Detailed assessment of the preferred option was then completed and scheme approval obtained from the Overseeing Organisation and its Agent.

**Phase 3**

**Preparation of Detailed Design of Improvement Scheme**

A1.28 Following approval by the Overseeing Organisation, the detailed design of the improvement scheme was undertaken. **Figure A1/2** shows the layout of the preferred option.

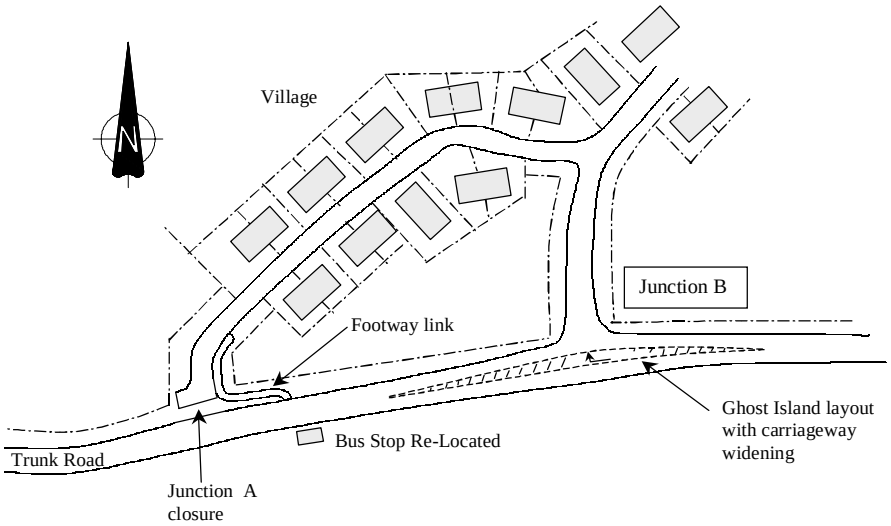


**Figure A1/2: Proposed Layout (Preferred Option F)**