# 4th International Symposium on Highway Geometric Design
# Country Report - United Kingdom

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**ABSTRACT**

This Country report will provide an update on the report presented at the 3rd International Symposium on Highway Geometric Design in Chicago, discuss progress on the new initiatives mentioned in that report and then go on to explain the recent changes that have occurred in the UK on the design philosophy for its residential streets and how the gap in guidance provision for various road types that exist between residential streets and motorways (freeways) is being filled.

In 2007 the UK Government's Department for Transport published a document that laid down new planning and design guidance for residential streets. These guidelines based on case study evidence and research set down, amongst other things, new geometric requirements for streets in residential areas. The document is known as *Manual for Streets*.

The document sees a considerable policy shift in the provision for users with a move towards a philosophy of designing for communities transferring the balance of provision from vehicle movement to provision for all. It aims to increase the quality of life through good design which creates more people-orientated streets. Although the detailed guidance in the document applies mainly to residential streets, the overall design principles apply to all streets within urban areas.

This new document means that the UK now has well defined guidance for low trafficked residential streets and the busiest highways, Motorways (freeways) and Trunk roads (inter urban routes) outlined in the Design Manual for Roads and Bridges. What is missing is guidance covering the roads in between for example, high streets, mixed priority routes, main streets through market towns etc. A new project has commenced to deliver a document that is a companion document to Manual for Streets that will "bridge the gap" between the existing two sets of guidance. The new document which will be titled *Manual for Streets – Wider Application of the Principles* will take the philosophies set out in Manual for Streets and demonstrate through guidance and case studies how they can be extended beyond residential streets to encompass both urban and rural situations.

## INTRODUCTION

This Country report will provide an update on the report presented at the 3rd International Symposium on Highway Geometric Design in Chicago, discuss progress on the new initiatives mentioned in that report and then go on to explain the recent changes that have occurred in the UK on the design philosophy for its residential streets and how the gap in guidance provision for various road types that exist between residential streets and motorways (freeways) is being filled.

## BACKGROUND

The road network in the U.K. is amongst the safest in the world. A large contributory factor in this is the standards that are used to design and build them. Within the road hierarchy in England the motorway network is by far the safest, (up to 5 times safer than 'A' class all purpose roads) once again due to the standards adopted for their design. Incorporating grade-separated junctions, safety fencing, and adequate visibility or stopping sight distance, suitable running lane widths, and hard shoulders into the layout all contribute to that 'in built safety'. In addition to this the consistency that standards deliver gives drivers the familiarity they need to make correct error free decisions whilst driving and drive for long distances at a level of concentration that does not induce excessive driver stress that can lead to errors in judgement.

Geometric standards are developed to include a safety margin. This margin is there to deliver a forgiving road environment, to allow drivers to make minor errors of judgement and for those errors not result in accidents, and to cater for all road users at either end of the spectrum, the young in fast sports cars and the elderly in ageing classic cars. Having that margin of safety allows for the introduction of a minimum standard provision at locations where, for environmental or economic reasons, full standard provision cannot be achieved. Yet the level of design provision provided does not increase the risk users and lower safety levels. These situations are known as Departures from Standard and there is a formal approvals process. These situations tend to be at isolated locations such as junctions or for short sections of road but never wholesale lengths of the network and never below that minimum standard as that would result in an increased in risk to the travelling public and the possibility of heightened accident numbers.

The Department for Transport (DfT) has the responsibility for the development of highway policy in the U.K. The day to day management of that policy and the development of design standards rest with the Highways Agency who are the custodians of a document called *The Design Manual for Roads and Bridges*[1]; it is available on-line as a series of Adobe Acrobat Portable Document Format (PDF) files. It can be found by using this website link www.official-documents.co.uk/document/deps/ha/dmrb/index.htm. In addition a number of organisations produce guidelines for designers to use. The most notable are The Chartered Institution of Highways and Transportation (CIHT), their documents can be found at www.ciht.org.uk and the County Surveyors Society (CSS) whose documents can be found at www.cssnet.org.uk/public/home.htm In 2008 a website was launch which gives access to over 800 documents that relate to the planning, design, implementation and management of UK roads. The website is known as The Traffic Advice Portal (TAP) and can be found at www.tap.iht.org . TAP is a paper-free technical library devised to help locate the up-to-date documents required when planning, designing and operating road networks in the UK. The portal acts as a one-stop-shop depository of web links to core documents produced by a range of organisations. It will help individuals find specific documents already known about but will also direct individuals to helpful information that they may not previously have been aware of.

In 2000, following a review by UK Government into transport policy in the UK, the Highways Agency (highway authority for the strategic road network) was asked to develop a roads improvement strategy that would speed up delivery of large scale road construction schemes over a ten year period. The strategy became known as the Ten Year Plan. One of the elements of the final strategy became know as the "Making Better Use" programme. The philosophy behind this title is to create additional capacity without moving outside the existing footprint of a highway. In addition safety should not be compromised and there should also be minimal environmental impact. In geometric terms this meant looking at the existing standard highway cross-sections and junction layouts to establish where additional lanes widths could be developed or where utilising technology could assist in increasing capacity of existing lane configurations or enable lane control, lane entry and lane designation changes to be made.

This approach can be considered for all levels of road hierarchy whether the route is a single carriageway, dual carriageway or motorway. Some of the specific solutions under development within the generic work area "Making Better Use" are listed and explained below.

1. **Wide Single 2+1**

By remarking an existing 10m wide single carriageway it has been possible to create safe alternating directional overtaking sections.

2. **Displaced Right Turn Junctions (DRT)**
   A new style of at-grade signalised junction which has shown to be very effective at dealing with high turning movements, increasing capacity of normal signalised junctions without moving to costly grade separation.

3. **Rapid Widening to Dual Four Lane Motorway, D4M**
   On-line widening of an existing route without additional land take. This is achieved by steeping or retaining existing side slops and at structures introducing shoulder lane narrowing or discontinuity.

4. **Active Traffic Management, ATM**
   By introducing higher concentrations of IT equipment along a route, in terms of both information signs and lane control signs, backed up by vehicle speed detection equipment. It is possible to manage lane utilisation and running speed to minimise congestion and deal more effectively with incidents.

5. **Hard Shoulder Running – Active Lane Control, ALC**
   The principles are similar to ATM but with the additional facility that the shoulder lane can be opened as apart time running lane.

6. **Permanent Four Lanes, P4L**
   A hybrid cross-section developed to introduce 4 lanes within a standard three-lane motorway (D3M) footprint whilst maximising lane widths. Additional pavement width is potentially available in the central reserve, this is utilised to provide four running lanes of near standard

In 2007 the UK Government's Department for Transport published a document that laid down new planning and design guidance for residential streets. These guidelines based on case study evidence and research set down, amongst other things, new geometric requirements for streets in residential areas. The document is known as *Manual for Streets*[2] an electronic copy of the document can be downloaded from www.dft.gov.uk/pgr/sustainable/manforstreets .

## MAKING BETTER USE – PROGRESS ON OPTIONS

Since the introduction of the "Making Better Use" programme in 2000 the six generic approaches have been developed trailed and implemented to some degree.

### Wide Single 2+1 (WS 2+1)

This option is strictly for single carriageway roads where consideration is being made to upgrade a route from single carriageway (S2) to a dual carriageway (D2). The carriageway is marked in 3 lanes with the centre lane used for overtaking. By re-marking an existing 10m wide single (WS) carriageway or combining it with minor widening to 11m it has been possible to create safe alternating directional overtaking sections (see Figure 1 & 2.). Trials of this type of layout have been undertaken in the UK, as well as similar layouts operating in Germany, Sweden, Finland and Ireland. The approach has proved to be successful both in terms of traffic flow and safety and the Highways Agency (HA) has developed a design standard for use on UK roads TD 70/08 Design of Wide Single 2+1 Roads[3] but its application remains limited, this is more about the level of side road accesses on rural roads in the UK than acceptance by designers of the principles of Wide Single 2+1.

### Displaced Right Turn Junctions (DRT)

A new style of at-grade signalised junction which has shown to be very effective at dealing with high turning movements, It is capable of increasing the capacity of normal signalised junctions without moving to costly grade separation. This junction type is similar to the Continuous Flow Junction (CFJ) currently being introduced in the USA (see Figure 3).

The idea of the DRT intersection is to relocate one or more movements from the centre of the intersection. This reduces the number of conflicts at the central node, which in turn can increase intersection capacity. The concept reduces a conventional T-intersection from 3 stages to 2 or a conventional crossroads from 3 or 4 stages to 2, significantly improving intersection capacity without necessarily increasing the footprint or making an appreciable increase in cost.

Whilst the concept of large signal controlled junctions is well accepted and used in the UK only a limited number of DRT junctions have been installed.

**Rapid Widening to Dual Four Lane Motorway, D4M**

This is the on-line widening of an existing highway without additional land acquisition beyond its existing boundaries. This is achieved by increasing the gradient of or building retaining walls in the existing side slopes and at structures introducing hard shoulder (shoulder lane) narrowing or discontinuity. This is a minimum standard provision (see figures 7 & 8). Generally standard lane width and hard shoulder provision is maintained for much of the improved section of the motorway. Additional lanes are added within the highway boundary, but at locations where no land is available or existing bridge structure would need to be widened, then localised lane narrowing and reduction or loss of hard shoulder provision occur. This removes the need for costly and time consuming widening of structures to accommodate the wider carriageway. But there are safety issues to consider. Its application is not intended for use on new routes or 'green field' sites. Figures 8 & 9 indicate the options for modification of the cross-section at physical constraints that occur where existing structures cannot readily be widened. A constrained location could also occur away from structures where the existing highway boundary is close to the edge of the paved width or a proposed boundary fence is close to a sensitive location which has a protected designation (e.g. Site of Special Scientific Interest).

This approach has been commonplace on widening schemes in the UK since 2000 it is often the first short term measure considered when the flow capacity on a standard three lane section of motorway is exceeded.

**Active Traffic Management, ATM**

By introducing higher concentrations of IT equipment along a route, in terms of both information signs and lane control signs, backed up by vehicle speed detection equipment. It is possible to manage lane utilisation, including the hard shoulder, and running speeds to minimise congestion and deal more effectively with incidents (see figure 4). This approach has now been further developed into what is termed ATM. This is a yet untried layout on the U.K. road network and is still under development and therefore cannot be categorised in terms of a level of design provision, but the elements to be trialled on the M42 will be designed to what is being considered minimum standard provision. This option utilises the use of traffic control from gantry signing to change not only the speed but also lane use allowing under controlled conditions, at certain times of the day, the hard shoulder to operate as a running lane between adjacent junctions.

There are safety issues to be considered with this style of operation. The loss of the hard shoulder during certain times of the day needs to be mitigated. Specially designed emergency rest areas (ERA's) have been developed and will be located generally every 500m for the use by the travelling public in emergency situations (see figure 5).

Since the last country report in 2005 when this was very much a concept a full trial has been in operation on a section of the M42 near Birmingham, England. The section is a three-lane motorway (six lanes plus full hard shoulders). This scheme combines new technologies with well-known motorway traffic management techniques. These include mandatory variable speed limits (such as those in use on the M25), enhanced driver information signs and a new congestion and incident management system. The system allows operators to open and close any lane on the motorway to traffic in order to help manage congestion at busy times of the day or traffic build-up due to an incident. This will eventually include using the hard shoulder as a running lane between junctions under controlled conditions. The infrastructure including new lighting, gantries, electronic and static signing, emergency roadside telephones, refuge areas, CCTV and mandatory variable speed limits. The system includes using the hard shoulder as a running lane between junctions under controlled conditions. The hard shoulder use as an extra running lane during busy peak periods or incidents was introduced in September 2006 as the final phase in the ATM project (see figure 6).

In the first 12 months of the full M42 trial, the use of the hard shoulder in peak periods seemed to be a success, with average journey times falling by more than a quarter on the northbound carriageway. In addition, Highway Agency statistics showed overall fuel consumption reduced by 4% and vehicle emissions fell by up to 10%. Drivers polled about the safety of using the hard shoulder showed that 84% felt it was safe. The average number of PIAs has dropped from 3.17 to 1.83 per month. The full report titled ATM Monitoring and Evaluation[4] can be found at www.dft.gov.uk/pgr/roads/tpm/m42activetrafficmanagement/atm12mthsumrep.pdf

The concept has been a success and the Department for Transport has now agreed to extend this type of traffic management to other areas of the network.

**Permanent Four Lanes, P4L**

When originally looking at developing the P4L option, consideration was given to maintaining a hard shoulder and redistributing the existing three running lanes (standard D3M) of the motorway to provide four narrow traffic lanes. The concept was known as Four–from–Three - a white line solution**.** It was considered that just re-

marking the existing carriageway could provide an operationally safe layout. This idea takes the existing available carriageway width of a three-lane dual carriageway, including the central reserve and hard shoulder, redistributes that carriageway increasing the number of running lanes to four. The resultant effect is, depending on the overall width available, to end up with a cross section that is below the minimum standard, running lanes of 3m (normal width 3.65m) and a hard shoulder of 2-2.3m wide (normal width 3.3)

Whilst in theory the revised layout offers an additional running lane for traffic, in terms of capacity a full lanes worth (1800-200 veh/hr.) is not realised. Observational evidence at road works sites where narrow running lanes are often employed, but with lower speed limits 50mph or 40mph, suggests that running with 3m wide lanes, even at lower speeds, Large Goods Vehicles (LGV's) will not run side by side they run in echelon because of the difficulties and concentration levels required to keep within the tight lane and control the vehicle without hitting the LGV in the next lane. Poor weather conditions heighten this problem. This lowers the capacity of the two near side lanes and can affect lane three as LGV's can run in this on a four-lane carriageway. One way of reducing this problem is to utilise the verge width to create a wider pavement, which will allow wider near side lanes.

It should be noted that since the 3rd Symposium in Chicago research and development of P4L approach has been curtailed. The reasons behind this has been the realisation that mitigation measures required to ensure a safety neutral operation results in it being an uneconomical solution when considering other options like Managed motorways.

**Managed Motorways**

This is the terminology currently being use to encapsulate a range of techniques that can be employed to control the level and speed of traffic on a high speed inter urban route. Managed motorways (MM) has devolved in the UK out of the successful trial of the ATM concept. MM is a context sensitive solution countries are pursuing to mitigate the detrimental effects of congestion within these corridors while optimizing the investment that has or will be made in the roadway infrastructure. Agencies are using innovative geometric design treatments in an attempt to optimize the utilization of the roadway cross-section in support of actively managing traffic and dynamically using different operational strategies (e.g., speed harmonization, vehicle restrictions (e.g., occupancy, trucks), or, pricing or tolling) to improve the performance of specific lanes or the entire motorway.

## RESIDENTIAL STREETS – A NEW APPROACH

There is a need to bring about a transformation in the quality of streets. This requires a fundamental culture change in the way streets are designed and adopted, including a more collaborative approach between the design professions and other stakeholders. People need to think creatively about their various roles in the process of delivering streets, breaking away from standardised, prescriptive, risk-averse methods to create high-quality places. Streets make up the greater part of the public realm. Better-designed streets therefore contribute significantly to the quality of the built environment and play a key role in the creation of sustainable, inclusive, mixed communities.

In 2007 the UK Government's Department for Transport published a document that laid down new planning and design guidance for residential streets. These guidelines based on case study evidence and research set down, amongst other things, new geometric requirements for streets in residential areas. The document is known as *Manual for Streets* (MfS). For too long the focus has been on the movement function of residential streets. The result has often been places that are dominated by motor vehicles to the extent that they fail to make a positive contribution to the quality of life. MfS demonstrates the benefits that flow from good design and assigns a higher priority to pedestrians and cyclists, setting out an approach to residential streets that recognises their role in creating places that work for all members of the community. MfS refocuses on the place function of residential streets, giving clear guidance on how to achieve well-designed streets and spaces that serve the community in a range of ways. MfS updates the link between planning policy and residential street design.

The document sees a considerable policy shift in the provision for users with a move towards a philosophy of designing for communities transferring the balance of provision from vehicle movement to provision for all. It aims to increase the quality of life through good design which creates more people-orientated streets. Although the detailed guidance in the document applies mainly to residential streets, the overall design principles apply to all streets within urban areas. The Manual for Streets has updated geometric guidelines for low trafficked residential streets, examines the effect of the environment on road user behaviour, and draws on practice in other countries. The results of research undertaken by Transport Research Laboratory (TRL) can be found in the Evidence and Research Report[5] an electronic copy of the document can be downloaded from www.dft.gov.uk/pgr/sustainable/manforstreets provides the evidence base upon which the revised geometric

guidelines in the Manual for Streets are based, including link widths, forward visibility, visibility splays and junction spacing.

MfS also recommends the use of tools such as masterplans and design codes. Neighbourhoods where buildings, streets and spaces combine to create locally distinct places and which make a positive contribution to the life of local communities need to become more widespread. MfS provides a clear framework for the use of local systems and procedures; it also identifies the tools available to ensure that growth and change are planned for and managed in an integrated way. The aspirations of MfS – interdisciplinary working, strategic coordination and balanced decision making – will only become a reality if they are developed and applied at a local level.

MfS aims to assist in the creation of streets that help to build and strengthen the communities they serve; meet the needs of all users, by embodying the principles of inclusive design, form part of a well-connected network are attractive and have their own distinctive identity that are cost-effective to construct and maintain; and are safe. MfS discourages the building of streets that are primarily designed to meet the needs of motor traffic bland and unattractive unsafe and unwelcoming to pedestrians and cyclists, difficult to serve by public transport and poorly designed and constructed.

This new document means that the UK now has well defined guidance for low trafficked residential streets and the busiest highways, Motorways (freeways) and Trunk roads (inter urban routes) outlined in the Design Manual for Roads and Bridges. What is missing is guidance covering the roads in between for example, high streets, mixed priority routes, main streets through market towns etc. A new project has commenced to deliver a document that is a companion document to Manual for Streets that will "bridge the gap" between the existing tow sets of guidance. The new document which will be titled *Manual for Streets II – Wider Application of the Principles* will take the philosophies set out in Manual for Streets and demonstrate through guidance and case studies how they can be extended beyond residential streets to encompass both urban and rural situations.

Manual for Streets II will be divided into four Sections.

- Section A (which includes this Introduction) will summarise the key principles of Manual for Streets;
- Section B will provide advice on a range of street types including, Towns and City Centres/High Streets, Boulevards, Ring Roads, Village Centres Rural Lanes.
- Section C will deal with a series of key technical issues such as Risk, Liability, Design and Audit Process, Shared Space, Visibility, Junctions and Crossings, Street Furniture.
- Section D will present a number of detailed case studies that the guidance within the main body of the document is based on.

**Summary**

This paper outlines progress within the U.K. on the development of its highway infrastructure. The paper first updates the "Making Better Use" programme outlined at the 3rd International Symposium. The philosophy behind the title is to create additional capacity and/or ease congestion without moving outside the existing footprint of a highway, but achieving this with minimal environmental impact or compromising the safety of the road. These solutions stem from a growing acceptance within the transportation professionals, politicians and to some degree the general public that we in the U.K., can no longer build our way out of the issues of traffic congestion. Whether that congestion is in our towns and cities or on our inter-urban routes, demand management is no longer the option, we have to manage the demand, make better use of the infrastructure we have and limit further damage or intrusion to our environment. The second part of the paper talks about the work undertaken in recent years to develop new guidance for creation and refurbishment of residential streets and closes explaining a new document that will the link between Manual for Streets (residential streets) and the Design Manual for Roads and Bridges (motorways & inter urban roads).

**References**


1. The Design Manual for Roads and Bridges (DMRB) www.official-documents.co.uk/document/deps/ha/dmrb/index.htm.
2. Manual for Streets www.dft.gov.uk/pgr/sustainable/manforstreets
3. TD70/08 Design of Wide Single 2+1 Roads www.standardsforhighways.co.uk/dmrb/vol6/section1.htm
4. ATM Monitoring and Evaluation www.dft.gov.uk/pgr/roads/tpm/m42activetrafficmanagement/atm12mthsumrep.pdf
5. Manual for Streets Evidence and Research Report www.dft.gov.uk/pgr/sustainable/manforstreets/manualforstreetsevidence.pdf

**List of Figures**

**Figure 1 - Photographs of WS2+1 layout at A68 Soutra Hill Scotland.**

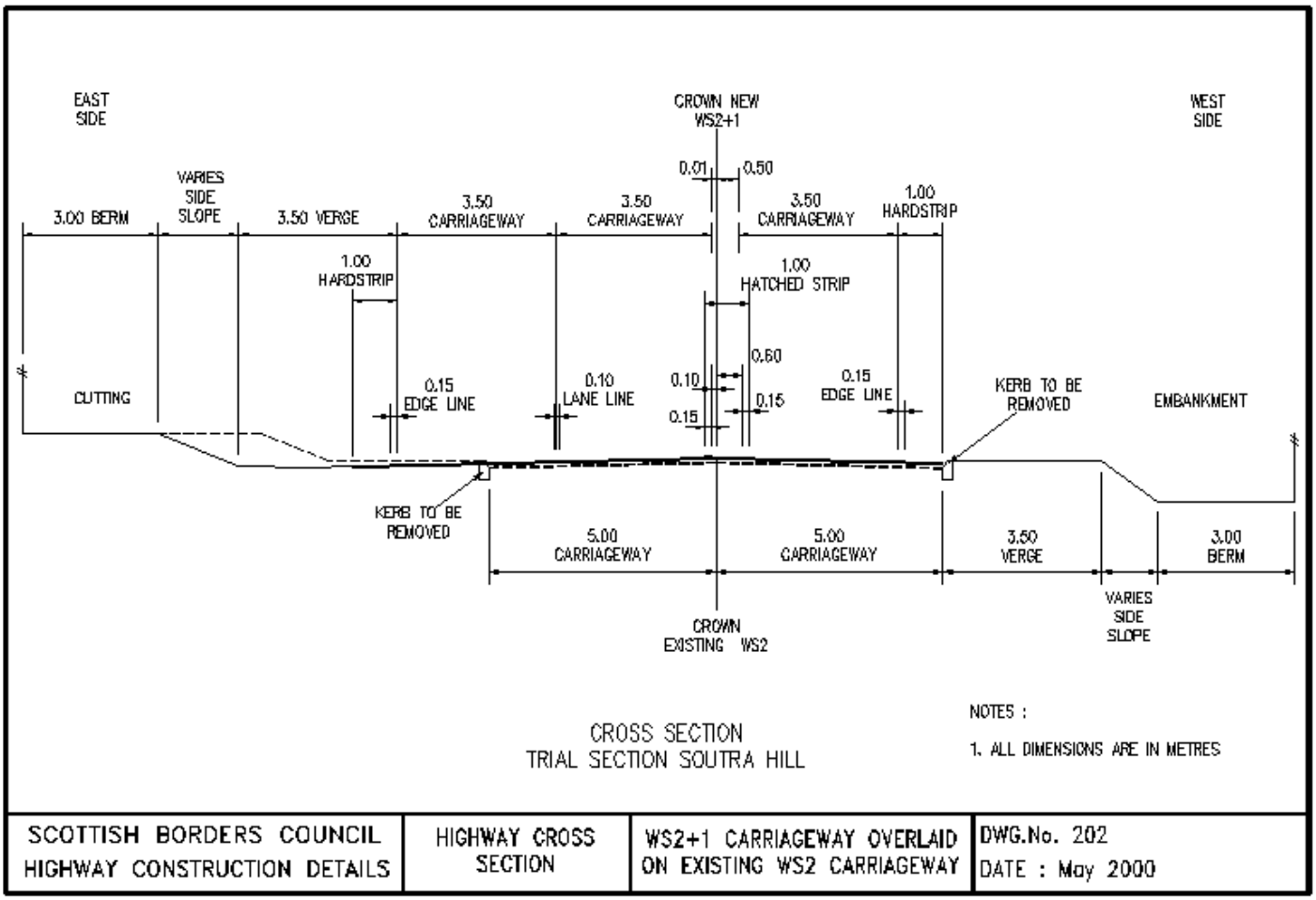



**Figure 2 - WS2+1 cross section at A68 Soutra Hill Scotland.**

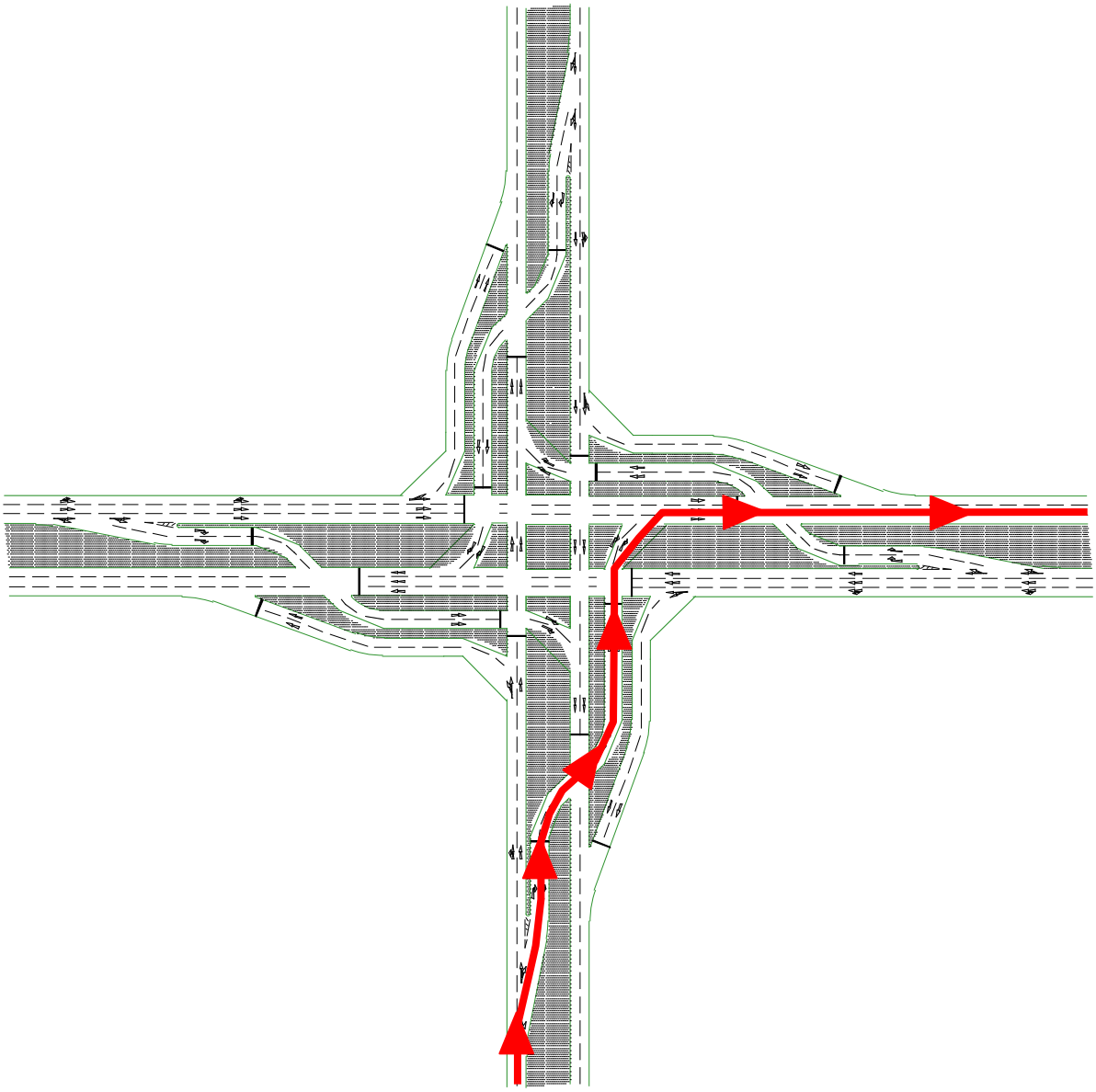


**Figure 3 - 4-arm Displaced Right Turn intersection (DTR)**

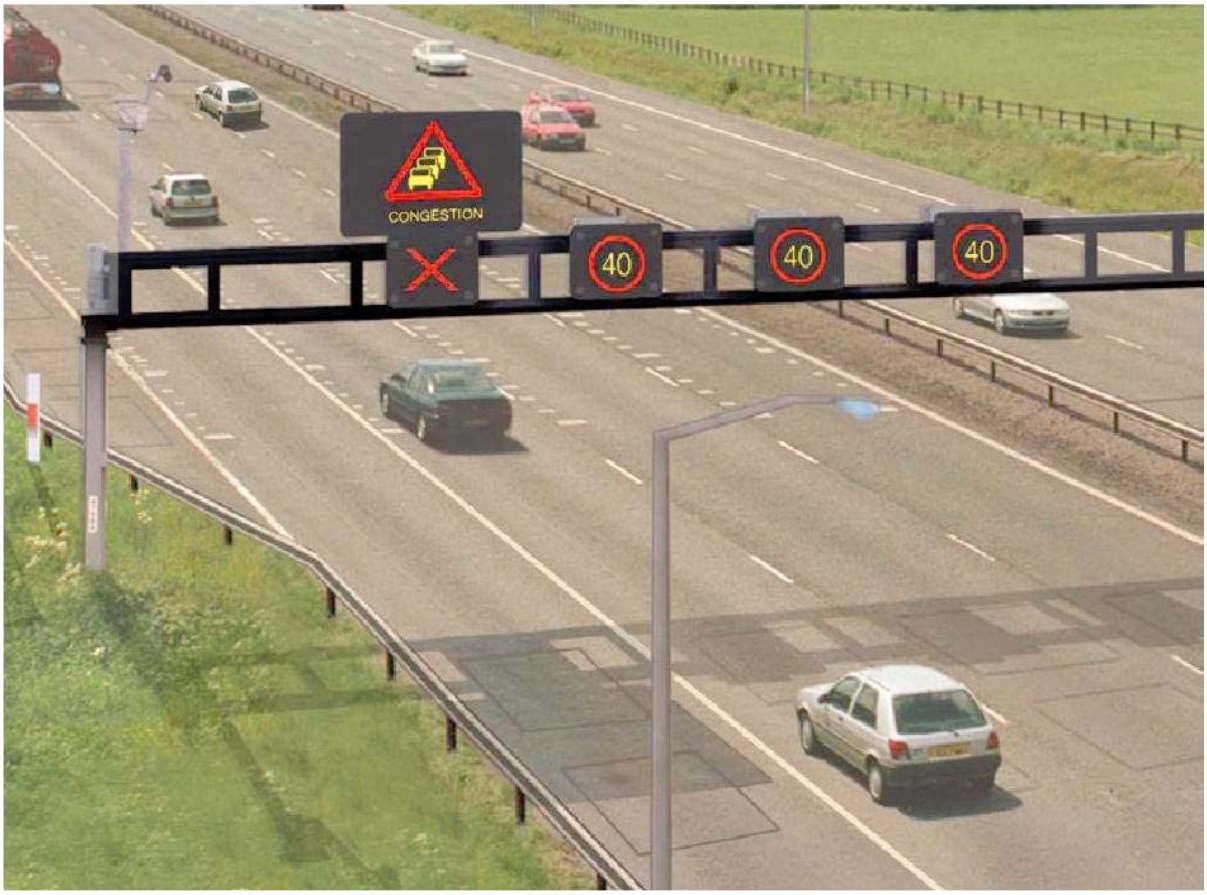



**Figure 4 - Active Traffic Management as proposed for the M42 ATM project**

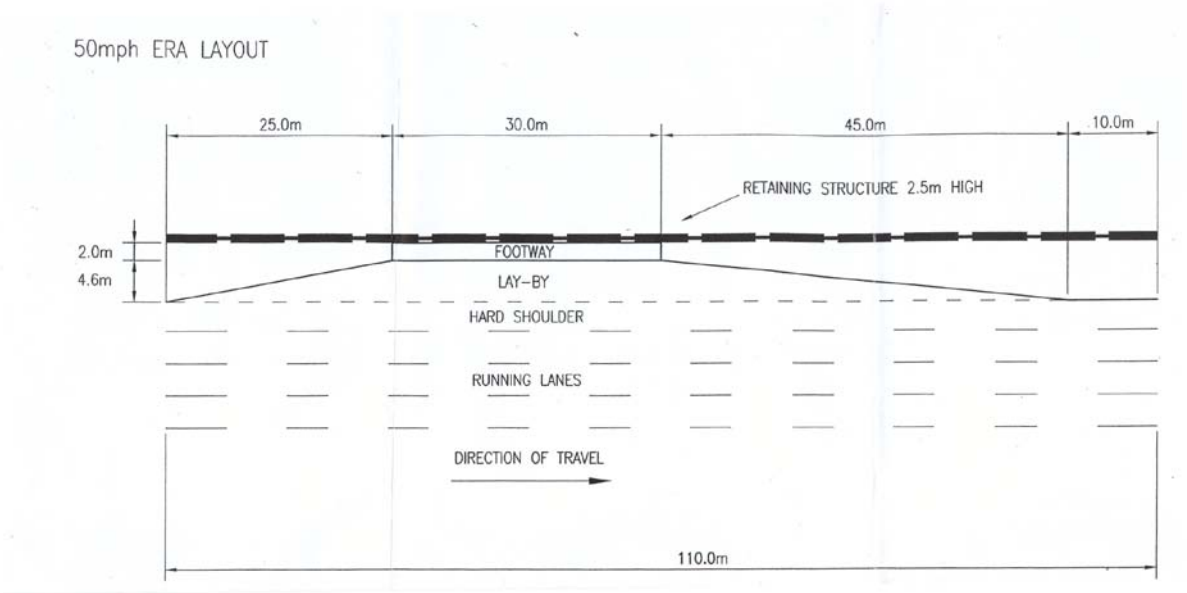
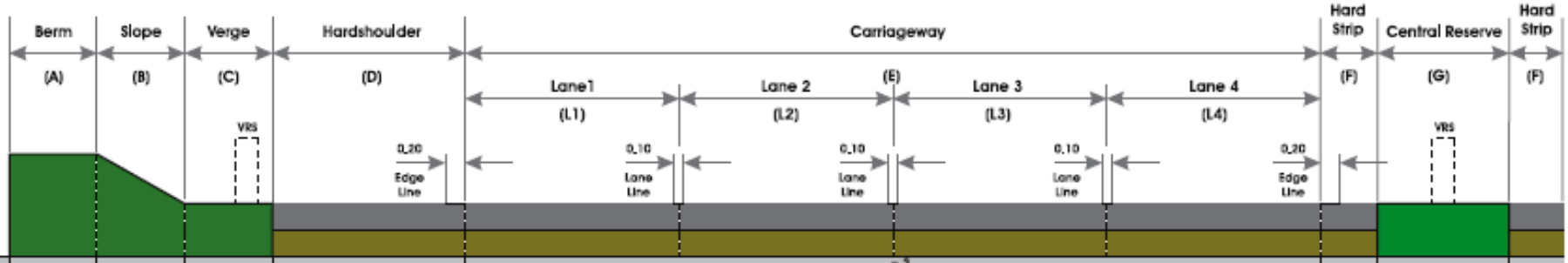



**Figure 5 – Layout for Emergency Rest Area as proposed for the M42 ATM project**

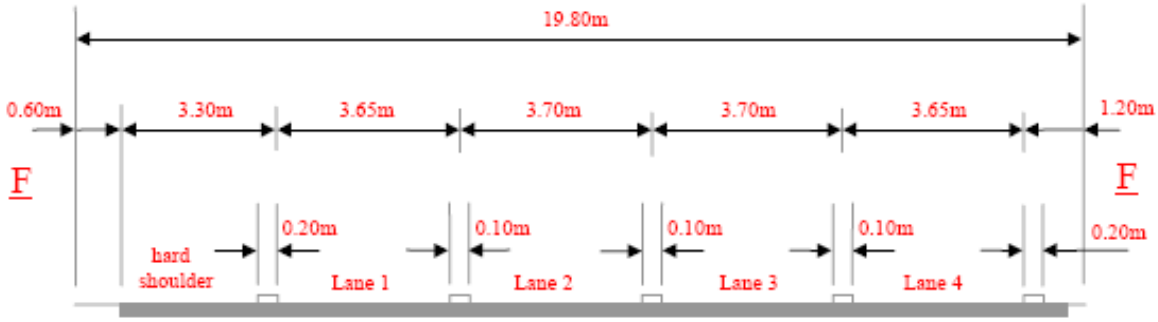

Figure 6 – M42TM in operation




| Road Type | A | B | C [2, 6] | D [3] | E [3] | | | | F [5] | G [2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | L1 | L2 | L3 | L4 | | | |
| Dual 2 Lane (D2M) | Varies | Varies | 1.50 | 3.30 | 7.30 | | N/A | | 0.70 | 3.1 | |
| | | | | | 3.65 | 3.65 [9] | | | | | |
| Dual 3 Lane (D3M) | Varies | Varies | 1.50 | 3.30 | 11.00 | | | N/A | 0.70 | 3.1 | |
| | | | | | 3.65 | 3.70 | 3.65 [9] | | | | |
| Dual 4 Lane (D4M) | Varies | Varies | 1.50 | 3.30 | 14.70 | | | | 0.70 | 3.1 | |
| | | | | | 3.65 | 3.70 | 3.70 | 3.65 | | | |

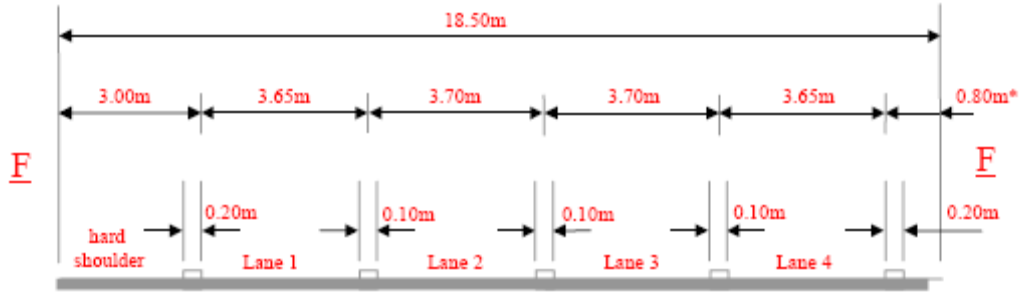
**VRS** refers to Vertical Restraint System

**Figure 7 - Standard Cross section widths for a UK Motorway**
**(Taken from TD27/05 Cross Sections & Headroom's)**



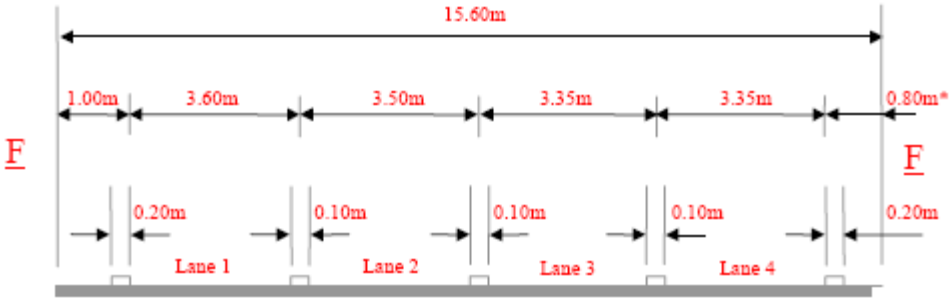

A1 – STANDARD 4 LANE SECTION

Standard section used on links where width is not restricted by structures




Note: Refer to para. 2.7.2 of this Annex B for details on edge treatment.

REDUCED WIDTH HARD SHOULDER & SET BACK




Note: Refer to para. 2.7.2 of this Annex B for details on edge treatment.

A2 – REDUCED WIDTH LANES AND SET-BACK AND MINIMUM EMERGENCY ACCESS

Reduced width cross sections used through junctions, at structures or at other locations where extra width is not available

F is the face of the physical restraint

**Figure 8 - Cross sections for a Rapidly Widened Motorway to D4M (Taken from TD27/05 Cross Sections & Headroom's)**

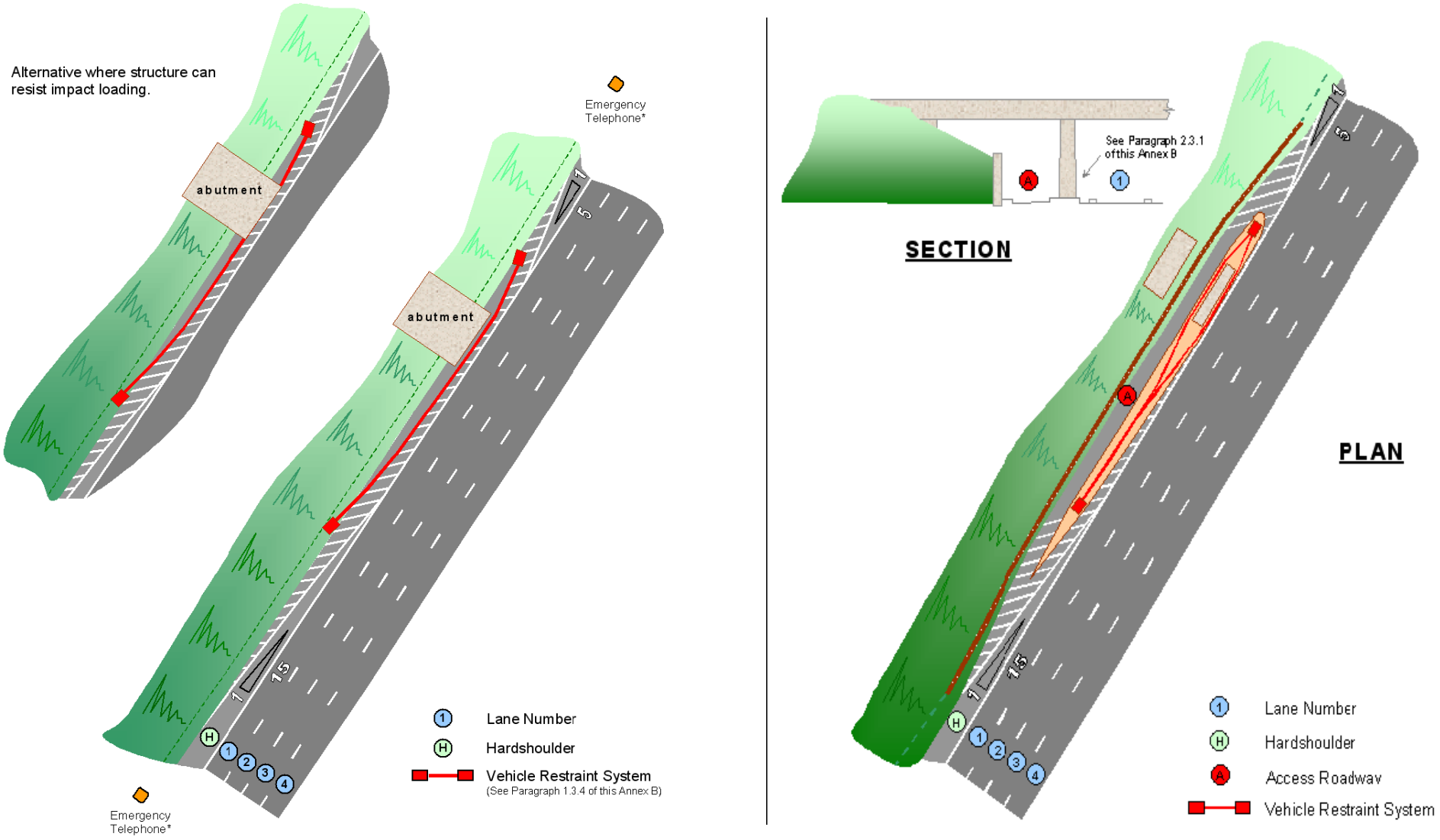



**Figure 9 - Layouts for maintaining emergency access at a discontinuity of the hard shoulder at an obstruction or structure (Taken from TD27/05 Cross Sections & Headroom's)**