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Identifying ITS Opportunities for the HA

Managed Motorways Fact Sheet: February 2010

Summary

The primary focus of this fact sheet is a review of non-UK managed motorway schemes, including where possible evaluation evidence. Case studies include:

- Hard Shoulder Running (HSR)
    - Germany, the Netherlands, Italy, USA
- Variable Speed Limits (VSL) for reducing congestion
    - Germany, the Netherlands, France, Denmark
- VSL for improving safety in poor weather
    - The Netherlands
- Modelling the effectiveness of VSL with micro-simulation tool, VISSIM
    - Sweden

The fact sheet then summarises implemented and planned managed motorways in the UK.

Key Words

Environment, Policy, Project, Traffic management, Safety

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What is a Managed Motorway?

A Managed Motorway uses a range of innovative technology combined with new operating procedures to actively control traffic flow. Techniques such as varying the speed limits and opening up the hard shoulder to traffic at peak times are features of managed motorways all designed to improve traffic flow and reduce congestion.

Technology Toolkit

The 2008 DfT Report, "Advanced motorway signalling and traffic management feasibility study" lists the following as the technology toolkit:

- **Automatic Queue Detection and Signalling** – e.g. the Motorway Incident Detection and Automatic Signalling (MIDAS) system
- **Closed Circuit Television** (CCTV)
- **Advanced Motorway Indicators** (AMI) – Light Emitting Diode (LED) signs that display variable mandatory speed limits (VMSL) above lanes and can also be used to open and close the hard shoulder
- **Semi Automatic Control System** (SCS) – A software based process, which leads operators through a number of steps for inspecting for obstructions via CCTV
- **Highways Agency Digital Enforcement Camera System** (HADECS) – A system to enforce the variable mandatory speed limits associated with schemes
- **Message Signs Mk4** (MS4) – Two-colour message signs that are able to display text, pictures and signals
- **Ramp Metering** – The use of traffic lights on motorway entry slip roads to regulate the flow onto the motorway

Types of Managed Motorway

The technologies described above can be combined in various forms to produce a managed motorway solution that will suit a specific location. The DfT document lists the following as currently in operation or development in England:

- **Hard shoulder running** – "Drivers are permitted to use the hard shoulder of the motorway as a running lane at times of high congestion by message signs and advanced motorway indicators installed above the carriageway"
- **Controlled Motorway** (CM) – "Mandatory speed limits are set automatically using traffic data from MIDAS loop detectors embedded in the road surface,… [in order to] minimise the risk of flow breakdown and reduce accidents"
- **Basic Controlled Motorway** (BCM) – "Currently at a conceptual stage, BCM is a basic version of standard CM,… [which] would set mandatory 50mph speed limits using gantry signalling at the entry and exit of each section, a section being between two junctions. The speed limit message would be reinforced by verge mounted driver information message signs at appropriate intervals. If there is an incident, the system… would display warnings only (e.g. 'Queue ahead') and not speed limits".

The document also lists potential future managed motorway opportunities:

- Traffic segregation (e.g. High occupancy vehicle lanes, bus-only lanes, HGV lanes)

- Differential speed limits – gantry signs could enable different speed limits to be set for different lanes for a range of purposes including improving flow, incident management, designated lanes and climbing lanes
- Digital roadside communication – infrastructure for a managed motorway could support roadside beacons for communication with vehicles
- Monitoring and recording information infrastructure for a managed motorway could enable images to be recorded for traffic monitoring or enforcement

For further information see the DfT Document:
www.dft.gov.uk/pgr/roads/network/policy/mtorsigntrafmanagement/

Objectives and Benefits

The objectives of managed motorways often include a combination of some or all of the following:

- To optimise traffic flow and provide more consistent journey times through smoother flows
- To reduce the number of accidents through smoother flows
- To reduce the number of accidents through slower speeds (e.g. in fog)
- To minimise harmful emissions and fuel consumption
- To reduce delays and disruption due to accidents and incidents

The majority of the implementations discussed in this fact sheet have been successful judged against their own objectives. Details of the evaluation evidence has been included where this information is readily available.

International Experience of Managed Motorways

This section summarises international experiences of managed motorways and active traffic management.

Case studies in this section include:

- **Hard Shoulder Running** (HSR) - Germany, the Netherlands, Italy, USA
- **Variable Speed Limits** (VSL) for reducing congestion - Germany, the Netherlands, France, Denmark
- **VSL for improving safety in poor weather** - The Netherlands
- **Modelling the effectiveness of VSL** with micro-simulation tool, VISSIM - Sweden

Germany

HSR: Nationwide

Germany first trialled hard shoulder running in 1996 and currently the length of the network operating HSR is over 200km. As of 2007, there were six schemes:

- A7 Gotingen
- A1 Holdorf
- A3 Offenbach – Obertshausen.

- A5 Bad Homburg – Frankfurt
- A7 Hamburg – Flensburg
- A7 Hamburg – Hannover

In addition to these (as of 2007), there was one non ITS-based variable road marking scheme in Hannover. This scheme consists of road markings painted in different colours for both carriageway divisions. The different colours apply at different times of the day.

HSR: Offenbach – Obertshausen and A5 Bad Homburg – Frankfurt (Source: DfT, 2008; EasyWay, 2009a)

The most successful hard shoulder running scheme in Germany is considered to be the combined A3 Offenbach – Obertshausen and A5 Bad Homburg – Frankfurt, which is roughly similar in design to the M42 pilot in the UK. As of 2008, it covered 60km and a further 25km was planned.

The hard shoulder is only used in 'emergency' or pre-defined situations to relieve congestion. During operation of the hard shoulder, the maximum speed limit is reduced from 120 km/h to 100km/h.

Hard shoulder running on this section of motorway has increased capacity by 20% (7040 vehicles per hour at 94 km/h with hard shoulder running compared with 5620 vehicles per hour at 75 km/h without). Journey times have therefore improved and traffic flow has improved particularly at the junctions. Public opinion of the scheme has been extremely positive.

No negative impacts on road safety have been reported and a reduction in congestion has led to a reduction in congestion-related accidents. One notable statistic is that there appears to be a significant reduction in accidents on the sections of motorway in advance of the hard shoulder running sections. This would appear to be due to the absence of congestion as hard shoulder running has smoothed flows and reduced slow moving traffic, thereby reducing tail-end shunts. (DfT, 2008)

A managed motorway system was implemented on the A5 autobahn in Hessen, Germany in 2008. This 10km long stretch of motorway in the Rhine-Main Area experiences very high traffic volumes – approximately 330,000 vehicles daily. To cope with the congestion, a managed motorway system with Variable Mandatory Speed Limits (VMSL), Hard Shoulder Running (HSR) and dynamic rerouting was introduced.

The hard shoulder is opened by changing the aspect on roadside 'rotating-plank' signs. These show when it is permitted to use the hard shoulder as a running lane. The hard shoulder running system and dynamic rerouting are controlled by the Hessen Traffic Control Centre. The variable speed limit control system consists of 140 overhead displays on 22 gantries along the 10 km section.

The managed motorway has led to 30% reduction of accidents and a 25% capacity improvement as a result of hard shoulder running. Other benefits include: increased traffic safety; enhanced traffic conditions and reduced environmental impacts. (EasyWay, 2009)

HSR: A81, Leonberg-Pleidelsheim (Source: Easyway, 2009b)

A traffic control system was installed on the A81 autobahn between the motorway interchange at Leonberg-Pleidelsheim and the interchange at Weinsberg. The A81 is characterised by one of the highest traffic volumes in Germany (with up to 110,000 vehicles per day) and regular accidents. Therefore, variable speed limits (called Streckenbeeinflussungsanlagen, SBA), intersection control, ramp metering and temporary use of the hard shoulder were implemented.

After implementation, a study was conducted which showed economic efficiency and a very high benefit-cost ratio of: 16.2 for just HSR; 2.8 for just VSL; and 8.6 for HSR and VSL combined. See Table 1 for further details.

Table 1 Summary of costs and benefits of the whole system between Tunnel Engelberg to Mundelsheim

	Variable Speed Limits (VSL)	Hard Shoulder Running (HSR)	Combined VSL and HSR
Cost (€/year)	€1,423,080	€1,099,345	€2,522,425
Benefit (€/year)	€3,966,820	€17,828,170	€21,794,990
Residual Benefit-Cost (€/year)	€2,543,740	€16,728,825	€19,272,565
Benefit/ Cost ratio	2.8	16.2	8.6

VSL: Nationwide (Source: Easyway, 2009b)

Variable speed limits with lane controls installed on the German Autobahn were found to reduce injury accident rates by 20-29%, saving the equivalent of $4million a year. There was also a good response reported to signage with variable speed limits changed between 60mph, 50mph and 40mph (i.e. 100km/h, 80km/h and 60km/h respectively) (Source: Highways Agency and Mott McDonald, 2007).

The Netherlands

HSR: Nationwide (Source: DfT, 2008)

In the Netherlands, several hard shoulder running schemes have been established. As of 2007, there were 17 schemes and in addition to these there were four variable road marking schemes. Dynamic road markings allow for changes between different road layouts depending on the time of day and capacity required, without the confusion of different coloured lines.

Across the Netherlands, use of hard shoulder running has increased overall capacity at individual sites by between 7% and 22%. Travel time savings range from 1 to 3 minutes, journey time reliability has improved significantly and there has been no negative impact on road safety.

A survey of public opinion of the first hard shoulder running scheme in the Netherlands showed that it was widely supported by drivers, relevant authorities and those living close to the scheme. It was, however, less popular with the emergency services who preferred to view hard shoulder running as a short-term rather than a permanent solution.

VSL: Nationwide (Source: Highways Agency and Mott McDonald, 2007)

In the Netherlands, variable speed limits have been used for two types of traffic control:

- To reduce speed during foggy conditions; and
- To combat shockwaves and congestion.

Results have shown that installation of VSL prompted drivers to reduce their speed by 5-6mph (8-10km/h) during fog. When used to deal with shockwaves and congestion, the majority of drivers were in favour and obeyed the VSL. In addition, shockwave severity and speed was found to be reduced as a result of VSL. Traffic surveillance, lane control signs, variable speed limits, and dynamic message signs in Amsterdam, the Netherlands, have led to a 23% decline in the accident rate.

VSL: A16, Breda, weather-related application (Source: Jeroen, 1995)

The A16 Motorway in the Netherlands between Breda and Rotterdam often experiences heavy fog and as a result has a high accident rate. An automatic fog-signalling system was implemented in 1991 to encourage safer driving behaviour during fog. The system uses 20 sensors along the 12 km stretch to measure visibility. Based upon the visibility distance calculated, a certain speed limit is shown on overhead message signs: for a visibility greater than 140m, no speed limit is shown; for 70 to 140m visibility there is an 80 km/h speed limit; and for visibility less than 70m there is a 60 km/h speed limit.

During most foggy conditions, the system was found to result in an average decrease of speed of between 8 and 10 km/h and a slight reduction in the average amount of variation in speed between different vehicles.

However, in extremely low visibility (< 35m), the system has an adverse effect on safety. Perversely, the average speed with the system in this situation has increased by 31 km/h, matching the recommended speed of 60 km/h, compared to an average of 29 km/h without the system.

The system showed small or no effects in other measures of driving behaviour such as following distance and time headway.

Sweden

VSL: Stockholm (Source: Nissan et al., 2009)

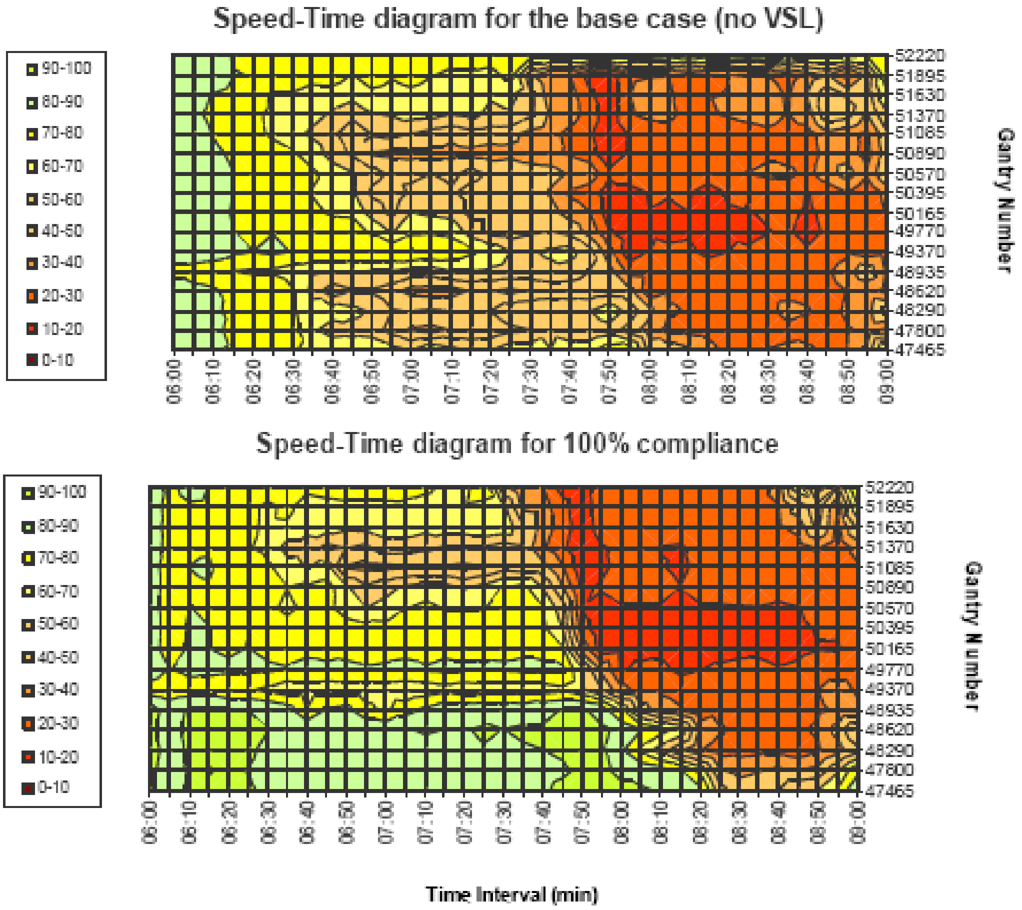
Advisory variable speed limits (VSL) have been introduced on the E4 motorway in Stockholm which is subject to frequent congestion. It has been fitted with an integrated Motorway Control System with advisory VSL and Automatic Incident Detection (AID) logic.

A validated VISSIM micro-simulation model was used to model the effectiveness of VSL, dependent on drivers' compliance with the posted speed limits. Figure 1 shows speed distributions in the case of no VSL (top) and VSL with 100% compliance (bottom). The horizontal axis corresponds to time of day and the vertical axis location along the motorway. Light colours indicate high speeds, whereas red indicates low speeds.

Results show that without VSL there are frequent problems of flow breakdowns which may lead to shunt type accidents. The modelled VSL system with 100% driver speed compliance produces more uniform speeds.

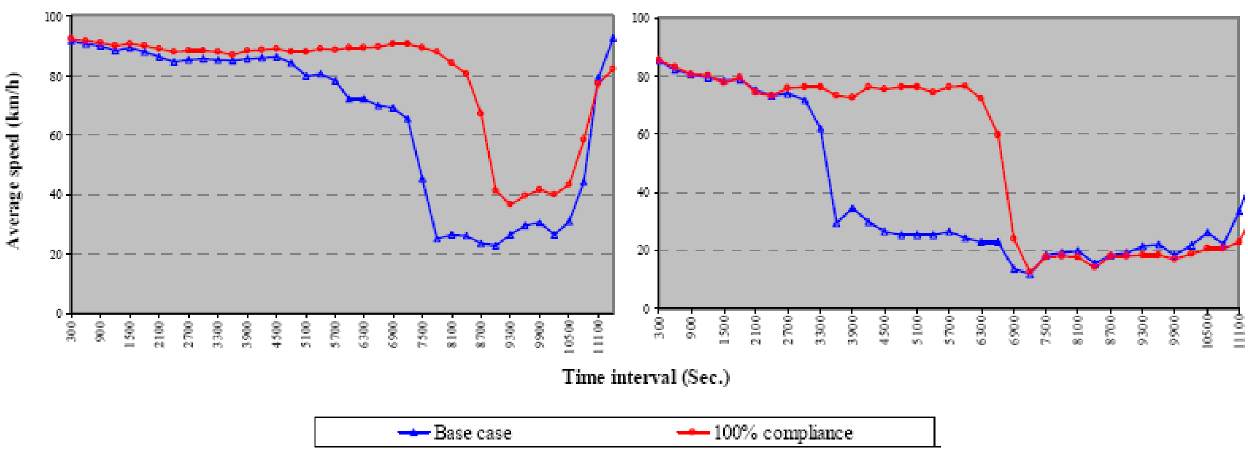
This would provide more consistent journey times and less stop-start traffic. However, once capacity is exceeded, the VSL system appears to delay the onset of congestion for a short while before both scenarios display crawling traffic.

Figure 1 Speed spatial - temporal distribution (Nissan et al., 2009)



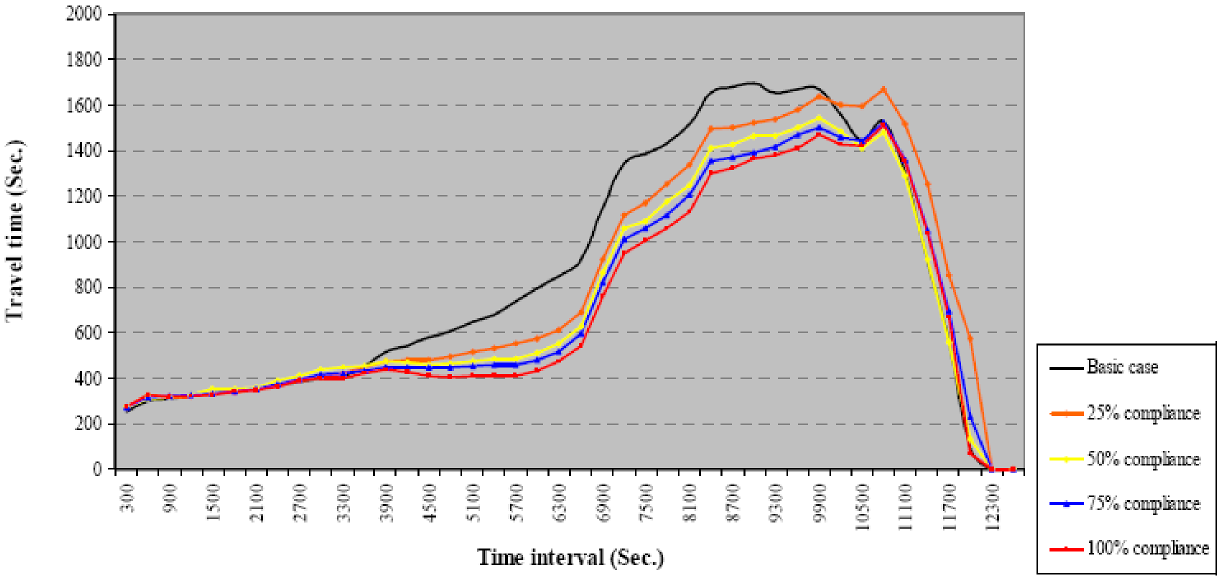
The impact of VSL on speed value at two modelled locations is presented in Figure 2. As the graphs show, VSL appears to delay the onset of congestion by maintaining higher carriageway speeds.

Figure 2 Base case and 100% compliance at two different gantry locations (Nissan et al., 2009)



The average travel times for the entire modelled motorway segment studied for each level of compliance by time of day are shown in Figure 3. Travel times are greatly minimised as a result of VSL and a high level of compliance. This demonstrates that compliance levels do not have to be perfect for a VSL system to perform well.

Figure 3 Travel times in various scenarios (Nissan et al., 2009)



Italy

HSR: Mestre, near Venice (Source: ITS RADAR Intelligence Report 5)

The T3 project (Società delle Autostrade di Venezia e Padova S.p.A.) involved dynamic use of the emergency lane on the highway near Mestre, Italy. The objective of the T3 (third lane) project was to improve traffic flow during peak hours by opening the hard shoulder (emergency lane). HSR was controlled via overhead signs.

Results from the T3 system evaluation showed that traffic flows increased by 7.5% on average in winter during periods when the third lane was more frequently opened, and 8% in summer. The highest average increase was 12.6% and took place during the winter.

Speeds increased by 23.6%, corresponding to 15 km/h, which improved journey times. It was found that speed limits were effective and generally observed.

The number of accidents decreased considerably by 50% to 70% in each direction.

This reduction in accidents, particularly at junctions which were caused by “stop-start” driving, also improved journey times and journey time reliability. Traffic was more consistent as indicated by decreases in the standard deviation of hourly average speeds of -7% in winter and -44% in summer. Vehicle headways increased, which may also have benefited driver safety, as vehicle linear density (the density of vehicles within any one lane) has decreased by -31% in winter and -41% in summer.

France

VSL: Nationwide (Source: Corben)

A study was conducted to assess the benefits of variable speed limits implemented on a range of motorways in France.

The aims of the study were as follows:

- "to delay motorway widening
- to improve safety and convenience
- to test a new type of variable message annunciator panel
- to reduce pollution factors".

The installation of variable speed limits covered 11 local sites along a 12km stretch of motorway. Speed limits were displayed on a Variable Message Sign (VMS), each 1.5m by 1.5m, installed in the median strip.

Data such as flow, average speed of vehicles over a one-minute period and vehicle headway were collected every minute via sensors located in the road. Officers at the local monitoring station determine every six minutes whether or not a speed limit should be displayed, as well as transmitting the data to a central control unit. The central control unit collects data from all local monitoring units and introduces a new speed limit, which is displayed after at least three positive local responses have been received.

The results of a survey showed an improvement in traffic flow, journey time and safety. 98% out of 350 drivers surveyed responded that signs were clear, easy to read and 59% said that the speeds displayed were optimal.

Traffic flow has increased and flows were also harmonised:

- there was a reduction in the number of vehicles travelling at speeds between 90-110 km/h
- an increase in vehicles travelling at between 70-90 km/h
- a reduction in slow traffic travelling below 50 km/h.

USA

"Managed Lanes": Nationwide (Source: FHWA, 2008)

Since the 1980s, schemes such as High Occupancy Vehicle (HOV) Lanes and High Occupancy Toll (HOT) Lanes have been implemented in many places across the USA. The Federal Highway Administration (FHWA) has now gone further than this and defined the concept of 'Managed Lanes' as:

> "Highway facilities or a set of lanes where operational strategies are proactively implemented and managed in response to changing conditions… The distinction between managed lanes and other traditional forms of freeway lane management [such as HOV or HOT lanes] is the operating philosophy of active management. Under this philosophy, the operating agency proactively manages demand and available capacity on the facility by applying new strategies or modifying existing strategies."

HSR: I-66, Virginia (Source: DfT, 2008)

The Virginia Department of Transport currently operates a managed lane strategy on the I-66 in Fairfax County, which allows use of the hard shoulder during peak hours. At the same time the lane adjacent to the central reserve is converted to a temporary High Occupancy Vehicle (HOV) lane. Speed limits both with and without hard shoulder running are 55 mph.

A study recently published by the US Transportation Research Board concludes that the system in Virginia is a cost-effective and efficient means of increasing the capacity of the route.

The study found no evidence that use of hard shoulder running at peak times had any effect on the number or characteristics of accidents in the study area and goes on to recommend hard shoulder running as a strategy that should be considered elsewhere in the US, with the addition of a number of advanced signalling and traffic management features such as incident detection systems and variable message signs.

Denmark

VSL: Copenhagen (Source: Wendelboe, 2003)

The Danish Road Directorate installed a temporary traffic management application to be used on the Køge Bugt Motorway near Copenhagen during the period of construction from summer 2002 to summer 2003. The project aimed at reducing congestion and rear-end accidents, which were more probable during the construction phase.

The VSL system experienced considerable technical difficulties during the deployment, which is likely to have had a negative influence on the impacts of the system. Problems included displaying incorrect speed limits for up to 18% of the morning rush hour periods, and difficulties in responding to congestion during the afternoon peak periods. Questionnaire responses supported these findings, with numerous complaints that the speed limits were set too low for prevailing traffic conditions.

There were speed reductions due to the VSL, however these reductions usually did not exceed 5km/h. As a result of variable speed limits, during congestion traffic flow was found to be more homogeneous. Results of a user acceptance questionnaire showed that 46% of respondents felt safer thanks to the variable speed limits.

■ Managed Motorways in the UK

This section provides a summary of the UK’s Managed Motorways Programme. There is a particular focus on the M42 HSR with VMSL Pilot:

- Features of the pilot
- Results - General
- Results – HSR60 vs HSR50
- Environmental benefits of HSR
- Next Steps – further roll-out of HSR
- Next Steps – Current developments in incident detection

There is also a brief overview of the results of the implementation of VMSL on the M25. Further information can be found from the links below:

HA, November 2009: Managed Motorways webpage, including details of planned HSR schemes. www.highways.gov.uk/business/25827.aspx

DfT, March 2008: "Advanced motorway signalling and traffic management feasibility study" – A study into the feasibility, costs and benefits of extending advanced signalling and traffic management techniques more widely across the motorway network.
www.dft.gov.uk/pgr/roads/network/policy/mtorsigntrafmanagement

M42 ATM Pilot, Solihull – Pilot Hard Shoulder Running with Variable Mandatory Speed Limit

The first Active Traffic Management (ATM) pilot project in the UK with 17km of dynamic Hard Shoulder Running (HSR) together with Variable Mandatory Speeds Limits (VMSL) was implemented on the M42 near Birmingham in 2006, see Figure 4.

Features of the pilot

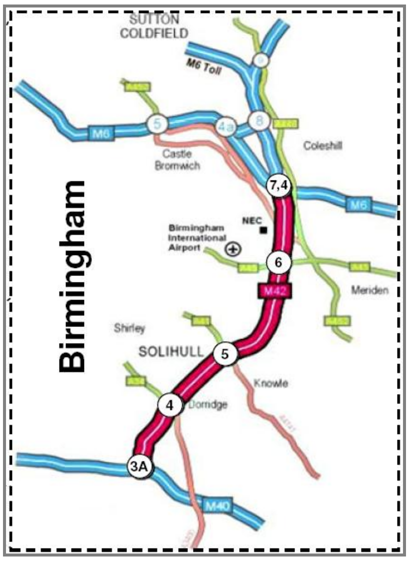
The pilot scheme involved managing traffic volumes to manipulate flow and reducing congestion by using variable mandatory speed limits on overhead gantries.

The hard shoulder was used as a running lane to provide extra capacity during congestion or accidents. Emergency Refuge Areas (ERAs) were constructed at regular intervals for emergency use.

In order to utilise the hard shoulder as a running lane safely, systems needed to be in place to check for obstructions and stationery vehicles on the hard shoulder. The M42 ATM project used a combination of video cameras and induction loops to monitor the carriageway.

Initially the hard shoulder was only used for traffic exiting at the next junction, however through-junction-running has since been introduced at Junction 5 Southbound.

Figure 4 Hard shoulder running on the 17km trial on the M42 near Birmingham (source: Holt et al., 2009a)



Results - General

Many operational benefits of the scheme have been identified (Holt et al., 2009a):

- Improved road capacity
- Improved journey time reliability
- Reduced incident rate (though this needs to be confirmed by analysis over a longer period of time than is currently available)
- Vehicle emissions of most harmful gases have been reduced by between 4% and 10% (CO_2 reduced by 4%) based on constant level of traffic
- Fuel consumption reduced by 4%
- High level of speed compliance
- Driver support for the scheme and concept.

Additional benefits over conventional capacity improvement schemes such as motorway widening have also been identified:

- Reduced capital costs
- Fast track delivery and realisation of scheme benefits – more likely to be able to deliver a managed motorway scheme, without the need for land take and public enquiry (at least 18 months can be removed from a typical delivery programme)
- Faster implementation realises operational benefits sooner
- Reduced CO_2 resulting from implementation and operation.

A 12-month evaluation report on ATM was published in 2008 (Highways Agency and Mott McDonald 2008). The key results were:

- Average journey time improved by up to 24% in the worst PM peak
- Fewer vehicles experience speeds of less than 45mph
- Significantly reduced variability during weekdays, on average a 22% reduction
- Compliance was on average 94% or better at 70 mph, 60 mph and 50 mph speed limits
- Personal Injury Accidents (PIAs) reduced from 5.08 per month for NO-VSL to 1.83 per month for 4-lane VMSL

Results – HSR60 vs HSR50

The maximum permitted speed limit during HSR in 2006 was 50 mph (HRS50). In 2008, HSR at 60 mph (HSR60) was trialled.

The performance of HSR60 over the link between J4 and J3A in the southbound direction was assessed against HSR50 over a comparable period of six weeks. HSR60 reduced the average journey time by 8% and increased the speed on average by 5.4mph. However, a difference of impact on throughput was not identified (Sultan et al., 2009).

As a result, HSR60 was introduced on all links of the M42-ATM section between J3A and J7 in both directions. Additional monitoring and evaluation analysis is currently being undertaken to assess the impact of HSR60.

Environmental benefits of HSR

Research has been conducted into the carbon impact of a change in policy from conventional widening with VMSL compared to HSR with VMSL. The research suggests that a change in policy from widening to managed motorways is likely to result in a saving of approximately 850,000 tonnes of CO_2, the equivalent of the emissions of 155,000 UK households. Carbon emissions as a result of conventional widening are predicted to be nearly four times more than those related to the design and construction of managed motorways. This would contribute to the UK's greenhouse gas emissions reduction targets (Holt et al., 2009a).

Next Steps – further roll-out of HSR

The success of the project encouraged the government to review policy and consider hard shoulder running (HSR) as an attractive alternative to widening.

An announcement by the Secretary of State for Transport in October 2007 published the results of the M42 Trial and commissioned a further study to verify the feasibility of introducing Managed Motorways in England (Holt et al., 2009a; Kelly, 2007). It was found that not only could most of the benefits of planned motorway widening be achieved through using the hard shoulder, but in addition at a much lower cost.

In January 2009 the Department for Transport announced that hard shoulder running schemes would be rolled out on key motorways. 20km of new HSR is already under construction and planned to be completed in 2010 (Holt et al., 2009a). It is estimated that by 2015, a total of 546km will be operating HSR, or will be in the construction phase of implementation (Holt et al., 2009a). Table 2 summarises the schemes which are currently under consideration.

Table 2 - Managed motorway schemes currently being considered

Location	Start on Site	Operational	Details
M40 J16-M42 J3a (B'ham Box Phase 1)	Autumn 2008	End of 2009	VMSL only
M42 J7-9 (B'ham Box Phase 1)	Autumn 2008	End of 2009	VMSL only
M6 J4-5 (B'ham Box Phase 1)	Autumn 2008	End of 2009	VMSL and hard shoulder running
M6 J8-10A (B'ham Box Phase 2)	Early 2009	Spring 2011	VMSL and hard shoulder running
M6 J5-8 (B'ham Box Phase 3)	2010	2012	VMSL and hard shoulder running
M1 J10-13	Late 2009	Unknown	VMSL and hard shoulder running
M4 J19-20 and M5 J15-17	2010	2012	VMSL and hard shoulder running
M62 J25-30	2010	2012	VMSL and hard shoulder running
M62 J18-20	Before 2011	Unknown	VMSL and hard shoulder running

Source: http://www.highways.gov.uk/business/25827.aspx November 2009

M25, London - VMSL

Variable Mandatory Speed Limits (VMSL) were first trialled in the UK on the M25 in 1995. The VMSL currently covers junctions 10 to 16.

Results have shown improvements in overall journey time reliability, with a smoother traffic flow, but overall peak journey times have remained the same. The system has enabled major safety benefits. Injury accidents were reduced by 15% and the ratio of damage only to injury accidents dropped by 20%. It is assumed that this is due to the reduced level of harsh braking as a result of more uniform headways and reductions in the number of flow breakdowns. (Highways Agency and Mott McDonald, 2007).

Stop-start driving behaviour during rush hours has decreased by 6%. The amount of time for which there was a broken down flow on the anticlockwise carriageway decreased by 9%. The overall number of flow breakdowns was reduced by 3%. Weekday traffic noise in the surrounding area has been reduced by 0.7 decibels, whereas the level of harmful emissions has decreased by 2-8% overall owing to more consistent speeds as a result of VMSL (ITS RADAR Intelligence Report 5).

Police and drivers responded that the system is very effective and 68% of drivers admitted that the system should be extended. According to a postal survey conducted among 1600 drivers, 60% of drivers believed that VSL had a positive impact on a traffic condition, only 10% claiming the conditions were worse (Highways Agency and Mott McDonald, 2007).

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Glossary

ATM	Active Traffic Management
ERA	Emergency Refuge Area
FDOT	The Florida Department of Transportation
HSR	Hard Shoulder Running
MIDAS	Motorway Incident Detection and Automatic Signalling
VMS	Variable Message Signs
VMSL	Variable Mandatory Speed Limits
VSL	Variable Speed Limit