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6 SCHEME PROPOSALS

6.1 Overview of Scheme Design

6.1.1 The Scheme is approximately 51km (32 miles) in length from junction 3 (Hayes) to junction 12 (Theale). It will result in the conversion of the hard shoulder of the M4 to a permanent running lane, while providing the necessary signing and technology to manage traffic using variable mandatory speed limits ("VMSL"). This will require the construction of gantries with lane-specific, variable message signs. A motorway with these features is referred to as a "smart motorway" as explained in chapter 5 of this EDR. The operation of the Scheme as a smart motorway is described in chapter 8 of this EDR.

6.1.2 There are a number of hard shoulder discontinuities, i.e. there is no hard shoulder for short lengths where existing bridges limit the available carriageway width, between junction 4b and junction 8/9. ~~It is proposed that~~The Scheme will demolish these bridges ~~are widened or demolished~~ and ~~rebuilt~~rebuild them in order to enable ~~ALR,~~the construction of the smart motorway. As previously discussed in chapter 5 of this EDR, no-TJR (or Dual 3 Lane Motorway ("D3M") is proposed at junctions 5, 6, 8/9 and ~~TJR within the Scheme. Other~~11. At some locations minor works ~~are also~~will be required to enable the appropriate lane widths to be achieved including alterations to the central reserve of the motorway.

6.1.3 The majority of the works along the motorway corridor will be within land currently owned by the Secretary of State. This is because the Secretary of State is the highway authority for, and landowner of, Special Roads such as the M4. ~~The Agency~~Highways England manages and operates the strategic road network on behalf of the Secretary of State. Additional land will be required permanently to accommodate the Scheme, such as for side road realignment at overbridges and underbridge widening. This will be kept to the minimum area required. Land will also be required temporarily for access, storage and construction activities, and in most cases will be reinstated to its former use on completion of construction. Both permanent and temporary land-take is included within the Order limits shown on the General arrangement drawings in Annex F of this EDR. ~~A preliminary design has been prepared for the Scheme to allow EIA to take place and the Application to be made. There are aspects of the Scheme design which are not yet fixed or where alternatives are still under consideration. Where alternatives are still under consideration, then all options are included within the Order limits. As such, the areas affected by the Scheme are shown indicatively at this stage, and are expected to reduce as the design is developed and Scheme areas are refined.~~

6.1.4 ~~Design~~An Environmental Impact Assessment was carried out based on the preliminary design for the Scheme. The DCO was granted based on the preliminary design and at that stage there were aspects of the design which were subject to further development ~~will continue to be informed by the EIA through iterative working between designers and environmental specialists, and through consultation with stakeholders.~~ However,

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the design ~~being~~that was assessed in the ~~EIA is considered to represent~~Environmental Statement ("ES") represented a worst-case scenario considering the factors known at the time, in terms of environmental impact and required land-take, to ensure that all foreseeable ~~significant~~ environmental effects of the Scheme ~~have been~~were assessed~~.~~ and stakeholders informed.

~~6.1.5 Detailed design for implementation purposes will commence after the Application has been submitted. Some details of the preliminary design may change as a result, but any changes will be within the previously assessed parameters. This will be secured by the wording of the DCO.~~

~~6.1.6~~

6.1.5 The Scheme design has subsequently matured through, detailed surveys, discovering previously unknown utilities and site conditions as well as iterative working between designers and environmental specialists and through the discharge of the DCO requirements.

6.2 Design guidance

6.2.1 The development and design of major highway projects are addressed by guidance and standards set out in the Design Manual for Roads and Bridges ("DMRB") (Ref 17). The DMRB is supplemented by a number of ~~IANs~~Interim Advice Notes ("IAN"s) that provide ~~up-to-date~~current advice and ~~detailed~~ guidance on standards in relation to certain aspects of design, assessment and network management. DMRB and IANs are published by the DfT and ~~the Agency~~Highways England respectively.

6.3 Improving a traditional motorway

6.3.1 This section describes the civil engineering works to the existing M4 motorway that are required for the Scheme. It provides an overview of the general approach to the Scheme~~, describing the principles of TJR and the general works required to structures along the M4. The preliminary design~~ which is illustrated on the General arrangement drawings in Annex F ~~and an~~of this EDR. . An explanation of the specific works proposed within each section of the M4, on a junction-by-junction basis (referred to as links), is contained in chapter 7 of this EDR.

Improving the traditional motorway: general approach

6.3.2 Wherever possible, the proposed alignment of the road(s) for the Scheme has been designed to remain within the extent of the existing carriageway and the Secretary of State's land ownership. Some carriageway widening will be required at junctions to accommodate slip roads~~,~~ and in areas where there is no existing hard shoulder (generally at overbridges above the M4 between junction 4b and junction 8/9).

6.3.3 The majority of the M4 within the Scheme will be converted to four-lane ALR. In addition, five-lane carriageways are proposed between junction 4b (M25) and junction 4 (Heathrow), which currently has four lanes in each carriageway~~.~~. This is to provide

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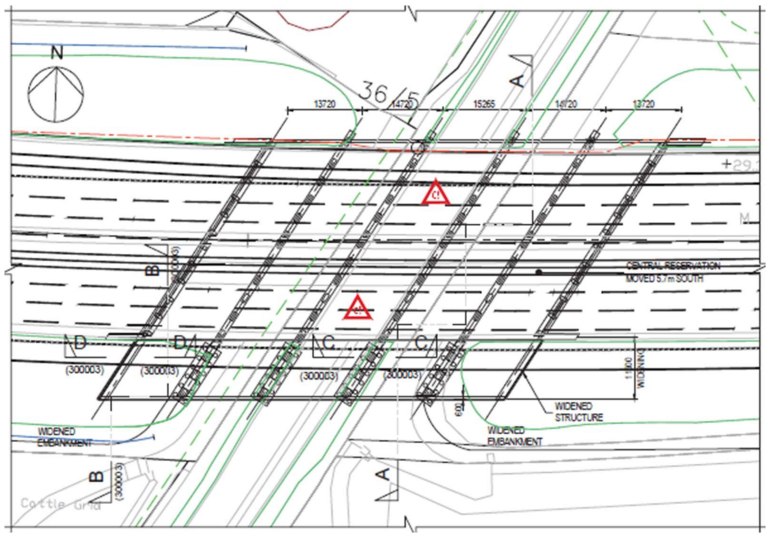
additional capacity for traffic exiting/joining the main carriageway, whilst enabling TJR at junction 4. Five lanes will also be provided on the eastbound carriageway from Sutton Lane overbridge (east of junction 5) to junction 4b to give additional diverge capacity for traffic leaving the M4 to join the M25. These sections are shown on the Scheme plans.

6.3.4 . At Windsor Branch Railway Bridge, the existing central reserve is to be reconstructed. This is achieved by installing new bridging slab spanning between the two existing bridges.

6.3.5 The existing motorway ~~will be~~has been re-aligned over ~~the~~ Thames Bray~~ and Windsor Branch Railway underbridges~~Bridge to allow for asymmetric widening ~~(widening one side of the motorway rather than both sides – see~~ Figure 3~~)~~. This is required in some locations due to engineering constraints and as a means of minimising disruption to the motorway during construction.~~ These areas of asymmetric widening are indicated on the underbridge General Arrangement drawings in Annex F.~~



~~**Figure 3 Typical arrangement of asymmetric widening at Windsor Branch railway bridge**~~

Improving the traditional motorway: lane widths

~~6.3.3~~6.3.6 The proposed lane widths of the improved motorway are shown in Table ~~8~~9 with regard to four-lane ALR and five-lane ALR operations.

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Table 89 ALR lane widths

		Lane 1	Lane 2	Lane 3	Lane 4	Lane 5	
Four lane ALR	nearside	3.65m	3.50m	3.40m	3.20m	n/a	offside
Five lane ALR		3.65m	3.65m	3.50m	3.40m	3.20m	

~~6.3.4~~6.3.7 In locations where the existing carriageway width is insufficient to accommodate the minimum ALR lane widths, the additional width will be achieved by widening the carriageway into the central reserve. In most locations, this widening will be between 0mm and 500mm. Between junction 8/9 (Holyport) and junction ~~5 (Langley),~~3, this widening will reduce the central reserve width to a minimum of 2.6m, which is nevertheless within the required safety standards.

~~6.3.5~~6.3.8 Any ~~proposed~~ deviation from the proposed lane widths quoted above is noted in the relevant part of chapter 7 of this EDR.

Improving the traditional motorway: hard shoulder discontinuities (junction 8/9 to junction 4b)

~~6.3.6~~6.3.9 The structures on the M4 from junction 8/9 (Holyport) to junction 4b (M25) were mostly built during the 1960s to accommodate a dual two-lane motorway. In the 1970s the motorway was widened to three lanes, but the structures were generally not modified. This resulted in the hard shoulder being discontinuous at some overbridges, as shown in Figure 43, and at some underbridges.

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Figure 33 Typical existing overbridge with discontinuous hard-shoulder

6.3.76.3.10 ~~These discontinuities prevent ALR, so provision~~Provision of ALR will require these constraints to be removed so that the hard shoulder can function as a continuous running lane. In total, 11 overbridges, all situated between junction 8/9 (Holyport) and junction 4b (M25), will be demolished and replaced. There are two broad approaches to such works - replacement in situ, or "online", and replacement alongside/ nearby, or "offline" (in this context). Of the 11 bridges, it is proposed that ~~seven~~6 will be replaced as offline improvements to the side roads, allowing the existing bridges to remain in use to carry traffic during construction. It is proposed that the remaining ~~four~~five will be replaced as part of online improvements to the side roads requiring temporary closure of the side road. See chapter 7 of this EDR for details.

6.3.86.3.11 ~~It~~Where there is insufficient width at underbridges, it is proposed to widen the existing structure(s~~) where there is insufficient width at underbridges. Four underbridges, two subways~~). One underbridge, one subway, and four culverts require widening. See chapter 7 of this EDR for details.

Improving the traditional motorway: ~~TJR~~Through Junction Running

6.3.12 ~~The provision of TJR along a route corridor allows long distance, through traffic to remain in lane 1 and not make successive lane changes, prior to and after each junction. This reduces the number of lane changes and the associated hazards. TJR is the preferred operating regime for ALR schemes, with the exception of motorway-to-motorway interchanges and at junctions at either end of the Scheme, i.e. junction 3 (Hayes) and junction 12 (Theale) where the Scheme ties back into the existing lane configuration. TJR is proposed at junction 4 (Heathrow), junction 5 (Langley), junction 6 (Chalvey), junction 7 (Huntercombe), junction 8/9 (Holyport) and junction 11 (Three Mile Cross) and at the access to Reading MSA.~~The Scheme was originally designed to IAN161/13 which required all junctions (other than free flow motorway to motorway links) within ALR schemes to have Through Junction Running ("TJR"). Therefore, junction 4 (Heathrow), , junction 7 (Huntercombe), and the access to Reading MSA will be widened to accommodate TJR.

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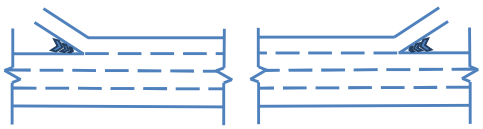
6.3.13 The Scheme is fully compliant with IAN 161/13. However, the latest guidance IAN 161/15 recommends that schemes identify the "most appropriate layout following analysis of the design year traffic flows and any operational or physical constraints". As a result of IAN 161/15, a review into the most appropriate layout for all junctions within the Scheme was undertaken, considering operational and physical constraints, traffic modelling/forecasting and safety assessments, along with feedback from operational All Lane Running ("ALR") schemes.

~~6.3.9~~6.3.14 As detailed in chapter 5, the review found that the most suitable operating regime at junctions 5, 6, 8/9 and 11 would be No-TJR, i.e. retaining the existing lane loss/lane gain provision at those junctions. This decision was endorsed by the scheme's Safety Control Review Group ("SCRG").

~~6.3.10~~6.3.15 TJR is not proposed at the terminal junctions where the Scheme begins and ends, namely junction 12 and junction 3. On the approach to these junctions, from outside the Scheme, the left-hand lane of the entry slip road ~~would~~will feed into the new lane 1 of the four-lane motorway (lane gain). At the end of the Scheme, lane 1 would diverge from the motorway (lane drop) into the exit slip road. The remaining three lanes will continue through the junction and align with the existing layout beyond the Scheme boundary.

~~6.3.11~~6.3.16 TJR is also not proposed at junction 4b (M25) ~~o~~rand junction 10 (Winnersh). These two junctions have free flow motorway-to-motorway two lane slip roads with high traffic flows. Use of TJR at these junctions would create additional traffic flow conflict between through traffic in lane 1 and diverging traffic approaching the junction in lane 2. At these junctions a "lane drop, lane gain" layout is proposed as shown in Table ~~9~~10.

Table ~~9~~10 Junction schematics

Junction Schematics	Description
Traffic Flow 	Typical lane gain and lane drop junction layouts.
 LANE GAIN LANE DROP	
Traffic Flow 	Typical lane layout for through junction running.

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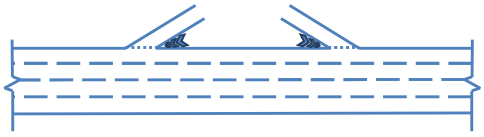
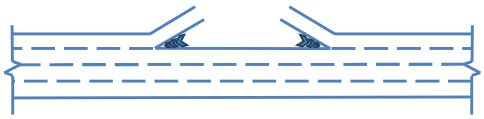
Junction Schematics	Description
	
THROUGH JUNCTION RUNNING	
Traffic Flow 	Typical lane drop / lane gain layout at a junction ~~without~~with no through junction running.
	
~~NON~~NO-THROUGH JUNCTION RUNNING	

Improving the traditional motorway: ~~ERAs~~**Emergency Areas ("EA"s)**

6.3.17 ~~For a motorway with ALR, ERAs, 'Emergency Areas' ("EA"),~~ which are similar to laybys, are required to provide a safe area for vehicles to stop in an emergency without interrupting the flow of traffic~~.~~ on ALR motorways. This is because there will no longer be a hard shoulder.

~~6.3.12~~6.3.18 The ~~current design for the~~ Scheme ~~is for 33 ERAs,~~has 34 EAs, with no more than 2.5km ~~apart,~~between places of relative safety (including hard shoulders, motorway service areas and EAs), as indicated on the General Arrangement drawings in Annex F of this EDR. These ~~will measure~~are 100m in length (25m entry taper, 30m ~~full width~~length, 45m exit taper) and ~~will be~~are a minimum of 4.~~6m~~3m wide. So far as possible, they ~~will be built~~are constructed on existing highway verges and within the existing highway boundary (and hence within the existing ownership of the Secretary of State).

~~6.3.13~~6.3.19 In the event of a vehicle using an ~~ERA~~EA in an emergency, ~~additional~~ signing in the ~~ERA~~EA encourages drivers to contact the Regional Control Centre ("RCC"). The RCC will offer safety advice and ask if the driver requires assistance. Operators in the RCC will be able to monitor the vehicle using CCTV, and if necessary dispatch a traffic officer patrol and/or set signs and signals to assist the vehicle's safe exit, either under the vehicle's own power or under tow from a recovery agent.

~~6.3.14~~6.3.20 Although it is expected that the majority of drivers will not need assistance to exit the ~~ERA~~EA, options range from setting warning legends on the variable message

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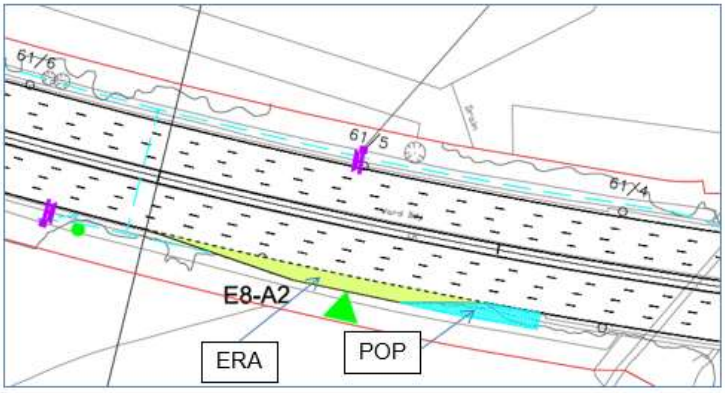
signs, through reducing carriageway speed limits, to setting up a rolling road block to allow a slow -moving vehicle to leave. These procedures are tried and tested, and are currently used on the Agencymotorway network.

Improving the traditional motorway: Police Observation Platforms

6.3.156.3.21 Police Observation Platforms ("POPs") provide a safe area for stationary police vehicles. On the M4 currently the police access the POPs by pulling up on the hard shoulder and reversing into the POP. On completion of their observation they then re-access the motorway after accelerating to motorway speed on the hard shoulder.



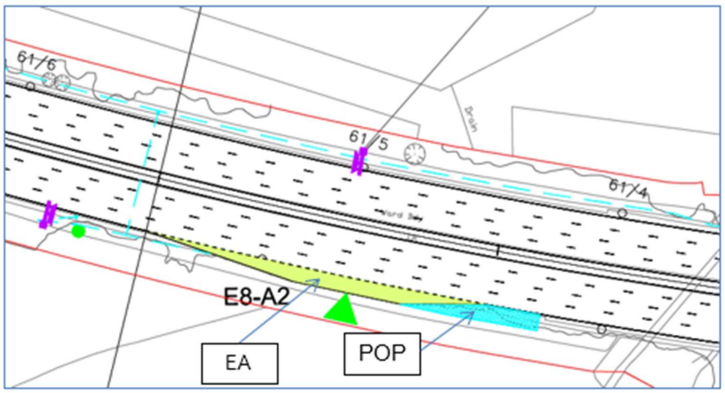


Figure 44 Typical ERAEA with Police Observation Platform

6.3.166.3.22 With no hard shoulder on the Scheme it will not be possible to operate in this manner, so the existing POPs will be removed and new POPs positioned adjacent to ERAs (Figure 5).EAs (Figure). An assessment of the number and location of the new POPs is currently beingwas undertaken in conjunction with key stakeholders (Police

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and ~~Agency~~HE Customer Operations). The assessment ~~will include~~included sight lines to the POPs and available space to construct the raised platform. There are 9 POPs in total.

Improving the traditional motorway: overbridges

~~6.3.17~~6.3.23 For the 11 sites where bridge reconstruction work is required, ~~four~~five will be replaced online and ~~seven~~six offline as follows:

a) where a suitable temporary road diversion route is agreed with the local authority (i.e. an alternative way of reaching the same areas without a significant increase in distance~~)~~), then a temporary closure of the side road will be implemented~~, the~~. The existing bridge demolished and the new bridge built at the same location as the old bridge (online replacement). Traffic, pedestrians, cyclists and equestrians will be diverted on to this alternative route during the active construction; ~~and~~ or

b) where a suitable temporary diversion route does not exist~~,~~ and closure during construction is not feasible, then the new bridge will be built to one side of the existing bridge (offline reconstruction), whilst the existing bridge remains open to traffic. Following completion of the new bridge, traffic will then be diverted onto the new bridge and the old bridge will be demolished.

~~6.3.18~~6.3.24 As part of the replacement of overbridges, the existing carriageway and footpath/cycleway/equestrian provisions will be maintained on a broadly like-for-like basis.

~~6.3.19~~6.3.25 The height or "vertical alignment" of each of the 11 side roads will be increased to provide the required clearance height above the motorway and to accommodate the increased depth of the new replacement bridge.

~~6.3.20~~6.3.26 Before describing the bridge works included in the Scheme in the link-by-link explanation provided in chapter 7 of this EDR, it is useful to outline some of the terms used:

a) "Super-structure" is the term used for the deck and parapets of the bridge;

b) "Sub-structure" is the columns and other supports on which the super- structure rests;

c) an "abutment" is the sub-structure at the end of a bridge. Abutments provide vertical and lateral support for the super-structure;

d) a "full height abutment" sits at the back of the ~~under-road~~ verge and acts as a retaining wall to hold back the earthworks fill material of the bridge approach embankments;

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e) a “bank seat abutment” is smaller than a full height abutment. It sits at the top of the approach embankment and results in a bridge with a more open aspect, but with a longer deck; and

f) a “pier” is an intermediate element of the sub-structure required on multi- span bridges. A pier usually consists of a column, a group of columns or a wall.

g) All “overbridge” is a bridge supporting a road or footpath over the motorway

h) “underbridge” is a bridge supporting the motorway as it crosses over an obstacle such as a road or river

6.3.216.3.27 It is proposed that structural steelwork is proposed to for all overbridges except the Oldway Lane footbridge (which would be a welded steel truss) is fabricated usingfrom “weathering” steel. This steel has improved atmospheric corrosion resistance “weathering” steel that , and it does not require painting. A number of different structural configurations have beenare considered for each of the replacement bridges. A summary of these options is contained in Table 6Table for overbridges and 7Table for underbridges.

6.3.226.3.28 ThreeThere are four different overbridge span arrangements are used in the current iteration of the Preliminary Design:for the Scheme;

a) single-span deck supported on full height abutments (Figure 6). This is proposed rather than a (Figure). This is the preferred solution at most sites, because of its advantages over the multi-span options. A two-span bridge which would need requires a pier to be built in the central reserve with consequential, usually, close to live traffic delay., which leads to traffic delays, and impacts on safety, cost and programme disadvantages. It is the preferred solution at most sites:;

a)b) two-span deck supported on abutments, (Figure). This arrangement is proposed in locations where there are significant statutory utilities close to and parallel with the motorway verges. In this situation, one span of the bridge is over the widened M4, the second span is over the statutory utilities. This option is preferable because it eliminates the need for costly diversions of utilities, minimises construction work and the presence of operatives around live statutory assets.

a)c) three-span deck with piers at the back of the verge and bank seat abutments (Figure 7) are (Figure). This arrangement is proposed for the two longest bridges: Datchet Road and Huntercombe SpurMonkey Island Lane. A three-span bridge is preferred because of construction benefits. The use of bank seats, rather than full height abutments, will reducereduces the amount

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of temporary works required to construct immediately adjacent to the existing structure; and

~~a)~~d) single-span steel truss footbridge ~~(Figure 8).~~(Figure). This is suitable only for non- vehicular loading and is proposed only at Oldway Lane.

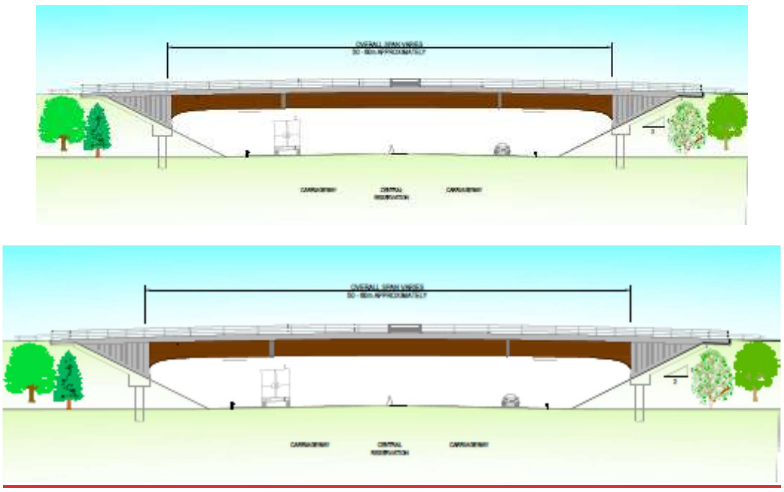
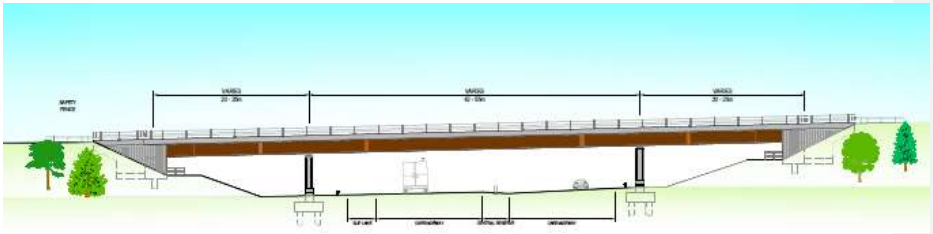


Figure ~~5~~5 Typical elevation of proposed single-span structure



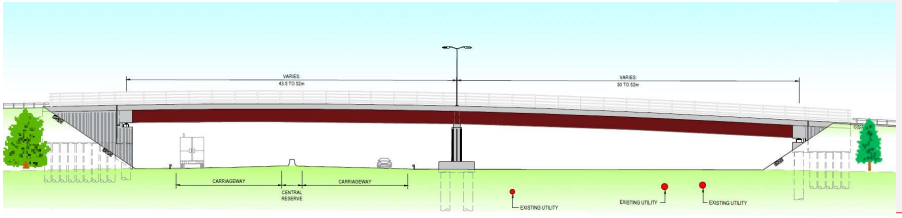


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Figure 6 Typical Elevation of an asymmetric two-span structure

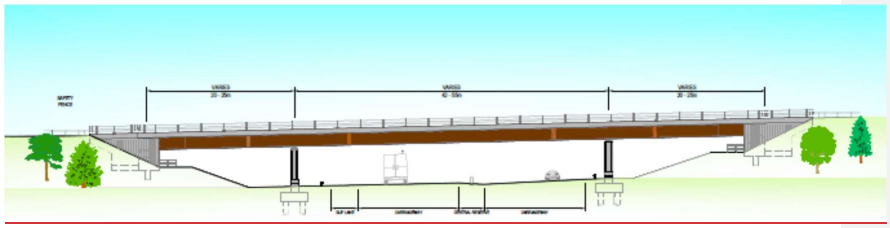
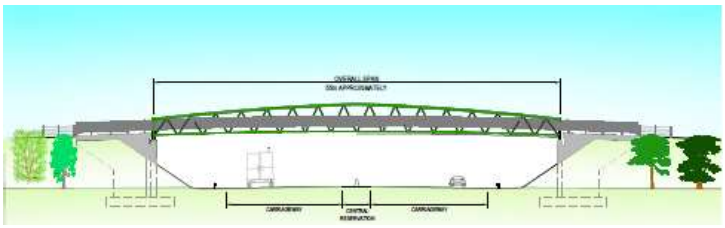


Figure 67 Typical elevation of proposed three-span structure



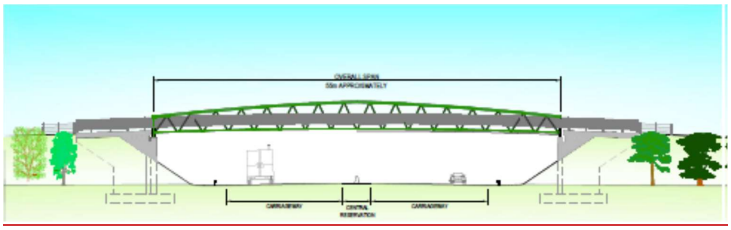


Figure 7 8 Typical elevation of proposed footbridge

6.3.236.3.29 Construction of overbridges and embankments willmay require works on land not currently owned by the Secretary of State.National Highways. Both temporary and permanent land requirements are within the Order limits shown on the General Arrangement drawings in Annex F of this EDR.

6.3.246.3.30 The locations of structures that need to be demolished and reconstructed are indicated on the General Arrangement drawings in Annex F of this EDR and details. Details of the specific proposals at each location are included in chapter 7 of

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this
EDR. The 11 overbridges to be demolished and replaced are listed in Table ~~10~~11.

Table ~~10~~11 Overbridges to be demolished and reconstructed

Overbridge	Location	Replacement structure
Ascot Road	J8/9 – J7	Offline, single-span
Monkey Island Lane	J8/9 – J7	Offline, ~~single~~three-span
Marsh Lane	J8/9 – J7	Online, single-span
Lake End Road	J8/9 – J7	Offline, ~~single~~two-span
Huntercombe Spur	J7	~~Offline, three~~Online, single-span
Oldway Lane	J7 – J6	Online, single-span footbridge
Wood Lane	J7 – J6	Offline, ~~single~~two-span
Datchet Road	J6 – J5	Offline, ~~three~~two-span
Recreation Ground	J6 – J5	Online, single-span
Riding Court Road	J6 – J5	Offline, single-span
Old Slade Lane	J5 – J4b	Online, single-span

Improving the traditional motorway: underbridges, subways and culverts

~~6.3.25~~6.3.31 As explained above, there are currently a number of links where the existing hard
shoulder is discontinuous due to the width of the underbridges, subways and culverts. To accommodate ALR ~~the four underbridges, two subways~~one underbridge, one subway and ~~four~~ five culverts listed in ~~Table 11~~Table require widening.

~~6.3.26~~6.3.32 The preferred solution ~~for~~at each bridge is to extend the existing structure with a
matching structural form. A number of different structural configurations have been considered for the widening of underbridges. A summary of ~~these~~the chosen options
are contained in Table ~~7.~~ 12.

~~6.3.27~~6.3.33 As with the overbridges, widening of the underbridges and embankments will require works on land not currently owned by ~~the Secretary of State.~~National Highways. Both
temporary and permanent land requirements are within the Order limits shown on

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the General Arrangement drawings in Annex F of this EDR.

6.3.286.3.34 The most notable of the underbridges areis Thames Bray underbridge, which requires 7.8m of widening~~, and Windsor Branch Railway underbridge, which requires 8.85m of widening.~~. The locations of structures that need to be widened are indicated on the General Arrangement drawings in Annex F of this EDR and details of the specific proposals at each location are included in chapter 7 of this EDR.

Table 1112 Underbridges, subways and culverts to be widened

Underbridge	Location	Nature of widening
Thames Bray	J8/9 – J7	7.8m asymmetric widening to the north
~~Calvey~~Chalvey Culvert	J7 – J6	~~4.0m symmetric~~Asymmetric widening ~~both sides~~of 4.65m to the south and 4.11m to the north.
~~Windsor Branch~~ Railway Culvert	J6 – J5	~~8.85m asymmetric~~7.6m widening to the ~~south~~north.
Water and gas main culvert	J6 – J5	~~2.1m symmetric~~Asymmetric widening ~~both sides~~of 1.35m to west and 2m to the east ends selected.
Water main culvert	J6 – J5	~~3.1m symmetric~~Asymmetric widening ~~both sides~~of 2m to the west and 3.8m to the east selected
Ashley's Arch culvert	J6 – J5	1.~~5m~~25m asymmetric widening to the north
~~Langley Interchange West~~	~~J5~~	~~4.5m symmetric widening both sides~~
~~Langley Interchange Subway~~	~~J5~~	~~2.1m symmetric widening both sides~~
~~Langley Interchange East~~	~~J5~~	~~4.5m symmetric widening both sides~~
Sipson Road North Subway	J4b – J4	~~5.0m asymmetric~~1.2 m widening to the ~~south~~north.

Improving the traditional motorway: earthworks widening

6.3.296.3.35 Existing earthwork embankments and cuttings will need to be widened ~~and/or retained~~ in the following situations:

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a) ~~where localised widening is required~~ to accommodate motorway and slip road widening;

b) for ~~all~~ realigned side roads;

c) ~~to support~~for foundations for new structures and gantries ~~in areas of narrow~~ where the existing verge width is inadequate;

~~d)~~ for ~~the purpose of~~ constructing ~~ERAs~~EAs and POPs~~; and~~

~~e)~~d) ~~to support cabinets or chambers,~~ where the existing verge width ~~will not accommodate these elements.~~ is inadequate;

e) for cabinets and chambers where the existing verge width is inadequate; and

f) for new environmental barriers where the existing verge width is inadequate.

Improving the traditional motorway: drainage

~~6.3.30~~6.3.36 Highway drainage is designed to remove rainfall from the carriageway surface to ensure safe operation of the road network. ~~The drainage strategy for the Scheme has been produced by the Agency and is included with the suite of Application documents (Volume 7, Document 7.5).~~

~~6.3.31~~6.3.37 New drainage systems ~~will be~~are required in the central reserve and the verges where appropriate.

~~6.3.32~~6.3.38 ~~Drainage in~~Superelevated sections, where the running carriageway is falling towards the central reserve ~~will largely be replaced with~~, drainage is provided by slotted linear ~~drains in sloped/cambered sections of carriageway. New~~drainage channels. In locations along the motorway, where the existing hard shoulder falls in the opposite direction to the carriageway, new coplanar (in the same plane) lengths ~~(areas~~are proposed, such that both the hardshoulder and carriageway drain in the same direction. Lengths of existing hard shoulder that currently ~~slopes~~slope in the opposite direction to the carriageway ~~are~~will be changed to slope ~~l~~in the same direction as the carriageway camber ~~and where liner drainage is necessary.~~. Redundant drainage as a result of correcting no-coplanar sections will be removed. The new drainage system for the main carriageway will be sized to accommodate the additional run-off arising from the reprofiled hard shoulder.

~~6.3.33~~ In the ~~verge~~verges of embankments, it is proposed to replace the existing kerb and gully system with slot drains, linear ~~drains~~drainage channels and combined kerb and gully systems where appropriate. ~~Verges are typically 1.5m to 2m wide. On that basis, it is likely that there will be a requirement to provide a bound surface above~~Combined carrier filter drains ~~to prevent stone scatter. Therefore, an alternative surface water collection system (i.e. surface water channel or slot drain)~~ will be ~~required.~~

~~6.3.34~~6.3.39 provided when the road is in cutting. Where ~~existing areas of non-coplanar hard shoulder are to change to coplanar surfaces, modelling of the~~ the road is at-grade (level with existing ground), the choice of drainage system ~~would~~will be ~~undertaken to confirm the extent of any upgrade requirements.~~as per the measures for

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embankments.

6.3.356.3.40 At ERAsEAs, attenuation of run-off from the additional carriageway areas will be in the form of oversized kerb drainage units; pipes and/or manhole chambers with flow and spillages control devices prior to connection into the existing drainage system or a soakaway. This will maintain the existing established discharge rates.

6.3.366.3.41 In line with the Agency'sHighways England design standards, existing maximumpeak discharge rates from the highway drainage system to the receiving watercourses will not be increased, and therefore there will be no impact on flood risk from the mainline works (see ES chapter 15 (Water)). Spillage control devices and other pollution interceptors containment devices will be provided at all ERAEA sites, prior to the outfalls.

6.3.376.3.42 Flood risk to third parties could increase as a result of the works to alter the overbridge alignments being located within the floodplain. Mitigation to compensate for any loss of floodplain as a result of the proposed side road alignmentScheme will be provided. There is sufficient land available within the Agency's land to provide suitable with floodplain compensation areas within Order limits. The flood compensation. In addition slopes of the scheme must ensure that compensation works provide sufficient compensation to ensure that the authorised development will not increase flood risk for all events up to and including the 1% annual exceedance probability plus a 20 per cent allowance for climate change. For example, new road embankment may be adjustedslopes are steepened in floodplain areas to minimise loss of floodplain capacity, or bridge spans increased to further reduce the impact on flood levels.compensate for reduction due to embankments.

Improving the traditional motorway: signs

6.3.386.3.43 Detail in relation to the signage to be used for the Scheme is provided in chapter 7. The majority of new advanced direction signs required for the Scheme will be mounted overhead on gantries.

Improving the traditional motorway: road restraint system

6.3.396.3.44 It is proposed to provide aA 900mm high rigid concrete barrier (RCB) (see Figure 9Figure 9 for an example) and paved central reserve throughoutis included in the Scheme. This will preventprevents cross-over accidents, resulting in improved safety for road users. RCBs also require minimal maintenance and therefore reduce the amount of maintenance works required, improving safety for road workers.

6.3.406.3.45 TheWithin the RCB will includeare removable steel step barrier sections at maintenance cross-overs which take the formover points. These steel sections of steel sections of barrier that can be unbolted and removed to facilitate implementation of allow contraflow TMtraffic (i.e. reversingtraffic moving in the opposite direction of a lane) and to how it should normally flow) it also allowallows access for emergency services during severe incidents.

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Figure ~~8~~9 Rigid concrete barrier

~~**It is envisaged that the**~~

~~6.3.41~~6.3.46 The majority of the existing safety barrier in the verges will be removed and replaced with a new safety barrier~~, in order to facilitate the construction of the works.~~. Additional safety barriers will be provided at new hazards in the verge, such as gantries, signs and CCTV cameras. Where a new safety barrier is ~~to be~~ provided in the verge, this will normally be a steel safety barrier system~~, either using tensioned corrugated beams or open box beams as illustrated in Figures 10 and 11 respectively.~~ (see Figure 1 for an example).

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Figure 1 Steel Safety Barrier~~: Tensioned Corrugated Beam~~

~~Figure 10Steel Safety Barrier: Open Box Beam~~

Improving the traditional motorway: lighting

6.3.47 ~~The full~~Within the extent of the Scheme~~, except for the link from~~ (junction ~~8/93~~ to junction ~~10,~~12), the existing M4 is ~~currently~~ lit with either central reserve or verge lighting~~.~~ between junction 3 to junction J8/9 and junction 10 to junction 12.

6.3.48 The Scheme ~~includes the retention~~will replace the existing lighting between junctions 3 and 7, and remove the lighting between junction 7 and junction 8/9 and junctions 10 to 12.

6.3.42 ~~The height~~ of lighting ~~in the links that are currently lit as shown on the schematic plan in Annex F~~columns varies and is a maximum ~~of this EDR.~~ 12.9m above the carriageway. Lighting ~~Columns will be~~ columns are mounted on top of the central reserve RCB ~~to~~and carry LED luminaires ~~12m above the carriageway. The lighting design will be finalised during Detailed Design on the following assumptions:~~

~~f) all the existing sections of the motorway and slip roads that are currently lit will remain lit;~~

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~~g) the unlit section between junction 8/9 and junction 10 will remain unlit; and~~

~~a)~~6.3.49 ~~where lighting is required, existing lighting will be removed and replaced with modern light emitting diode ("LED") lighting with a central management control system.~~.

~~6.3.43~~6.3.50 The LED luminaires use much less energy than the existing luminaires.

Improving the traditional motorway: road surfacing

~~6.3.44~~6.3.51 The existing hard shoulders are surfaced in either Hot Rolled Asphalt ("HRA") with stone chippings or Thin Surface Course System ("TSCS"). HRA is the traditional asphalt surfacing material that has been used in the UK since the 1960s. TSCS has been available since the early 1990s and is classified as 'low-noise surfacing'. It is ~~the Agency's~~Highways England policy (Ref 17) to use TSCS for all new roads and for replacement of life-expired surfacing.

~~6.3.45~~6.3.52 The Scheme will provide TSCS throughout. ~~It is assumed that lane 1 and lane 4 (existing hard shoulder and lane 3 respectively) will require a new surface course following the verge and central reserve works. HRA in lane 2 and lane 3 (existing lane 1 and lane 2 respectively) will be replaced with TSCS.~~The existing TSCS at junction 5 will be retained. This will reduce the noise impact of the Scheme, and will minimise the need for further maintenance work in the five years after Scheme opening.

Improving the traditional motorway: noise barriers

~~6.3.46~~6.3.53 Barriers, in the form of fencing to mitigate noise effects, ~~will be~~are included within the Scheme where the ~~EIA identifies~~ES has identified that this form of environmental mitigation is required. This is addressed in greater detail in chapters 8 (Landscape) and 12 (Noise) of the ES. Noise Barriers are shown on the Environmental Masterplan in Annex A.

Improving the traditional motorway: replacement planting

~~6.3.47~~6.3.54 Vegetation lost to construction activities will be replanted where possible with locally appropriate species. Environmental enhancement will also be applied in appropriate circumstances, see chapter 8 of the ES. ~~This will be developed through the preparation of an Environmental Masterplan, which will set out the proposed approach to environmental design. The Environmental Masterplan will be secured by a requirement attached to the proposed DCO. The draft Environmental Masterplan is discussed in section 7.12 of this EDR and the vegetation clearance and Environmental Masterplan drawings are included as Annex A to this EDR.~~

This is shown on the Environmental Masterplan drawings included at Appendix A to this EDR, and as have been discharged under the DCO.

~~6.3.48~~6.3.55 Semi-natural habitat cleared during construction ~~will be~~is re-planted using local species that are considered appropriate to the nature of the soil and the pre-existing vegetation composition. In the medium to long-term, this planting will mature to provide habitats and visual screening, which will replace the vegetation removed.

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6.4 Features of a smart motorway

6.4.1 This section describes the technology, signal and gantry works that are required for the Scheme. It provides an overview of the general approach to the Scheme, describing the individual items that will be used in the Scheme. An explanation of what specific works are proposed at each section of the M4 on a junction-by-junction basis is contained in chapter 7 of this EDR. The operation of the smart motorway using this infrastructure to manage traffic flow and speed is described in chapter 9.

Features of a smart motorway: motorway signals

6.4.2 Operation of the smart motorway will be controlled via LED signals mounted on overhead gantries. There are three main types of LED signals which are described below.

6.4.3 Advanced Motorway Indicators ("AMI") ~~(Figure 12)~~(Figure 2) are used to display VMSL for each lane using programmable high~~-~~resolution LEDs. These will be located on gateway gantry structures after each entry slip road to the Scheme and on intermediate gantries at intervals of not more than 6km.

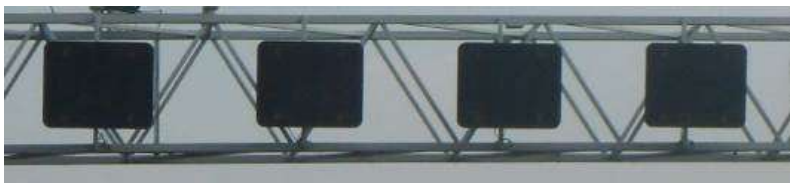

Figure 2 Typical view of AMI signals

6.4.4 Motorway Signals Mark 4 ("MS4") (shown in ~~Figures 13~~Figure 3 and ~~14)~~Figure 4) is a type of variable message sign (“VMS”) used to provide driver information in the form of text and pictograms. These will be located at regular intervals along the Scheme either above a gantry boom, generally positioned over lane 1, or on the verge, mounted on a cantilever structure.

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Figure 3 Typical MS4

Figure 4 A cantilever gantry solely supporting an MS4 over lane 1

6.4.5 The other type of VMS proposed for use in the Scheme is a Message Sign Mark 3 ("MS3") ~~(Figures 15 and 16).~~(Figure 5 and Figure 6). These will be deployed in advance of strategic junctions and provide information to road users in the form of text messages (3x18 Characters). MS3s are located on cantilever gantries in the verge.

Figure 5 Typical MS3

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Figure 6 A cantilever gantry solely supporting an MS3 over lane 1

6.4.6 VMS signals will be located on the gateway gantries and on additional gantries all along the scheme. The distance between successive VMS signals varies but, generally the distance between one signal and the start of the visibility of the next signal will not exceed 500m. The average distance between VMSs in the ~~preliminary design~~Scheme is 900m.

Features of a smart motorway: signs

6.4.7 Overhead signs ~~will be~~are mounted on gantries to provide drivers with information and to help them select the most appropriate lane. Signs types include Advance Direction Signs ("ADS") (shown at ~~Figure 17),~~Figure 7), route confirmation signs and other information signs. All gantry mounted signs ~~will be~~are illuminated at night.

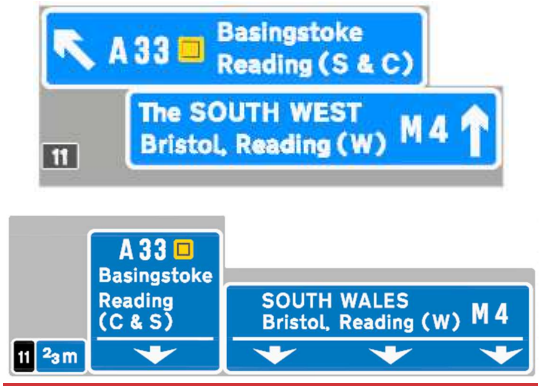

Figure 7 Typical 'lane drop' direction sign (westbound approach to junction 11)

Features of a smart motorway: gantries

6.4.8 Gantry structures are required to support overhead signs, signals, vehicle detection and enforcement equipment. To minimise the number of new gantry structures

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required, the design includes multi-function gantries, e.g. a single gantry may carry ADSs, AMIs and/or a VMS. The positioning of the gantries ~~has also been~~is optimised to ensure maximum reuse of existing gantry structures.

6.4.9 Each existing gantry has been structurally assessed to determine if it is sufficient to carry the required signs and signals. Where there is sufficient structural capacity the gantry is retained. Where there is insufficient capacity the gantry is replaced, or the signs and or signals were redesigned to reduce loading.

6.4.10 In some cases a full super span gantry replaced existing cantilevers to improve sign and signal provision.

~~6.4.9~~6.4.11 Cantilever structures are used to mount signs located in the motorway verge. A cantilever structure is supported on a single leg in the verge of the motorway ~~(Figure 18).~~(Figure 8). There are various types of cantilever depending on the equipment or signs that they are supporting. The largest cantilever gantries support signs and signals; these are known as super-cantilever gantries ~~(Figure 19).~~(Figure 9).

Figure 8 Typical sign-only cantilever gantry (one leg)

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Figure 9 Typical super cantilever gantry

~~6.4.10~~6.4.12 Portal gantry structures are used to provide overhead support for signs over one motorway carriageway. A portal gantry has two supporting legs, one at each end of the horizontal boom ~~(Figure 20).~~(Figure 10).

Figure 10 Typical portal gantry (two legs)

~~6.4.11~~6.4.13 Super-span portal gantries ~~(Figure 21)~~(Figure 11) provide overhead support for signs over both motorway carriageways. A super-span portal gantry is a lightweight structure which enables a single portal to span the entire motorway with no support in the central reserve. A super-span portal gantry is not designed for maintenance loading and has no walkway.

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Figure 11 Typical super-span portal gantry

6.4.126.4.14 The anticipated quantity of each type of gantry included in the Scheme is shown in Table 12. LocationsTable . The location of the individual signsgantries are shownprovided in the Scheme plansGeneral Arrangement drawings in Annex F of this EDRreport.

Table 1213 Gantry types used in the scheme

Gantry type	No.Number
Portal	54
Super-span portal	18
Super cantilever	2542
Sign only cantilever	2612
MS4 cantilever	5150
MS3 cantilever	86
Existing portal	95
Existing MS4 cantilever	2019
Existing MS3 cantilever	0

6.4.13 These estimates are maxima, and are subject to the iterative design process for the Scheme. As detailed design will continue beyond the application for development consent, the numbers of signs and gantries needed may reduce. However, the design assessed in the EIA for the Scheme will be based on a worst-case scenario.

Features of a smart motorway: Temporary Traffic Management ("TTM") signs

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6.4.14 Remotely controlled signs (Figure 22) will be provided to support TTM to allow for ongoing maintenance activities once the Scheme is completed. These will be located in the central reserve or the verge and can be turned on remotely to warn road users of lane closures ahead.

Figure 21 Typical TTM sign

6.4.15 At Preliminary Design the Scheme proposed use of Remotely Operated Temporary Traffic Management Signs ("ROTTMS") for signing Temporary Traffic Management ("TTM") to allow maintenance activities post-completion. However, advances in techniques to use gantry mounted signage to provide this feature mean that ROTTMS are no longer proposed on the Scheme. The use of gantry mounted signs for this purpose is called Signalling for Roadworks ("SfR").

6.4.16 The implementation of SfR has been subject to extensive risk assessments to ensure the safety of road workers and users. The proposal to remove ROTTMS from the Scheme's design has been endorsed by the National Safety Control Review Group. The National Safety Control Review Group reviews and advises on complex or unique safety issues and network consistency items and reviews the highest level of safety categorised matters.

Feature of a smart motorway: camera cameras

6.4.156.4.17 Approximately 130115 Pan, Tilt and Zoom ("PTZ") CCTV cameras (Figure 23)20) are provided. They are installed on a combination of gantries and 15m masts will be provided to ensure there is full coverage of all driving lanes. This enables Traffic Officers at the Agency'sHighways England existing RCC at South Mimms to manage incidents and set the appropriate signs and signals. A typical detail for a CCTV camera is included in Annex F of this EDR. As part of the mainline scope, the CCTV locations were re-assessed using requirements to achieve Interim Advice Notice, (IAN) 161/15 and consequently a comprehensive review of the CCTV design was undertaken. This comprehensive review considered the use of "full CCTV coverage" in accordance with the principles of this Engineering and Design Report ("EDR").

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Figure 12 Typical mast mounted CCTV camera

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Figure 13 Typical **gantry mounted CCTV camera**

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