CREATING A HOLDING BAY FOR ABNORMAL LOADS WITHIN THE CENTRE OF LARGE ROUNDABOUTS

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Abstract

A holding bay for abnormal loads has been constructed within the centre of M1 Junction 24, a large signal controlled gyratory. One of the key challenges was how to provide a safe exit for abnormal loads by developing a bespoke signal control methodology.

This paper provides an overview of the options assessed, the design decision process, commissioning and lessons learnt.

Background

The East Midlands Gateway (EMG) Strategic Rail Freight Interchange (SRFI) is a nationally significant infrastructure project (NSIP) located just north of East Midlands Airport. It was granted development consent in January 2016 and to facilitate the development major improvements to M1 Junctions 24 and 24A were required. These works were privately funded by Segro, constructed by Winvic, and were completed in December 2018. They consisted of:

- Providing a direct (free flow) link from the A50 eastbound to M1 southbound at J24A
- Providing a direct (free flow) link from the M1 southbound to A50 westbound at J24A
- Realigning the M1 southbound diverge slip road at J24
- Constructing a segregated left turn lane from the A453 northbound to A50 westbound at J24
- Removal of local access junctions from the A50 and providing alternative access routes
- Widening and full signalisation of the roundabout at J24

These works are shown diagrammatically on **Figure 1** below.

The works were carried out at the same time, but separately from, the Highways England project to provide a Smart Motorway from M1 Junction 23A (A42) to 25 (A52). There was a significant interface between the two schemes at Junctions 24 (A453 / A50) & 24A (A50). Between junctions 24 and 25 the Smart Motorway resulted in the loss of the hardshoulder.

In the mid 2000s a long lay-by for abnormal loads was constructed on the A50 eastbound between J24A and 24 just north of the Hilton Hotel (near point g on Figure 1). This facility is by-passed by the revised road layouts and hence an alternative location was required.

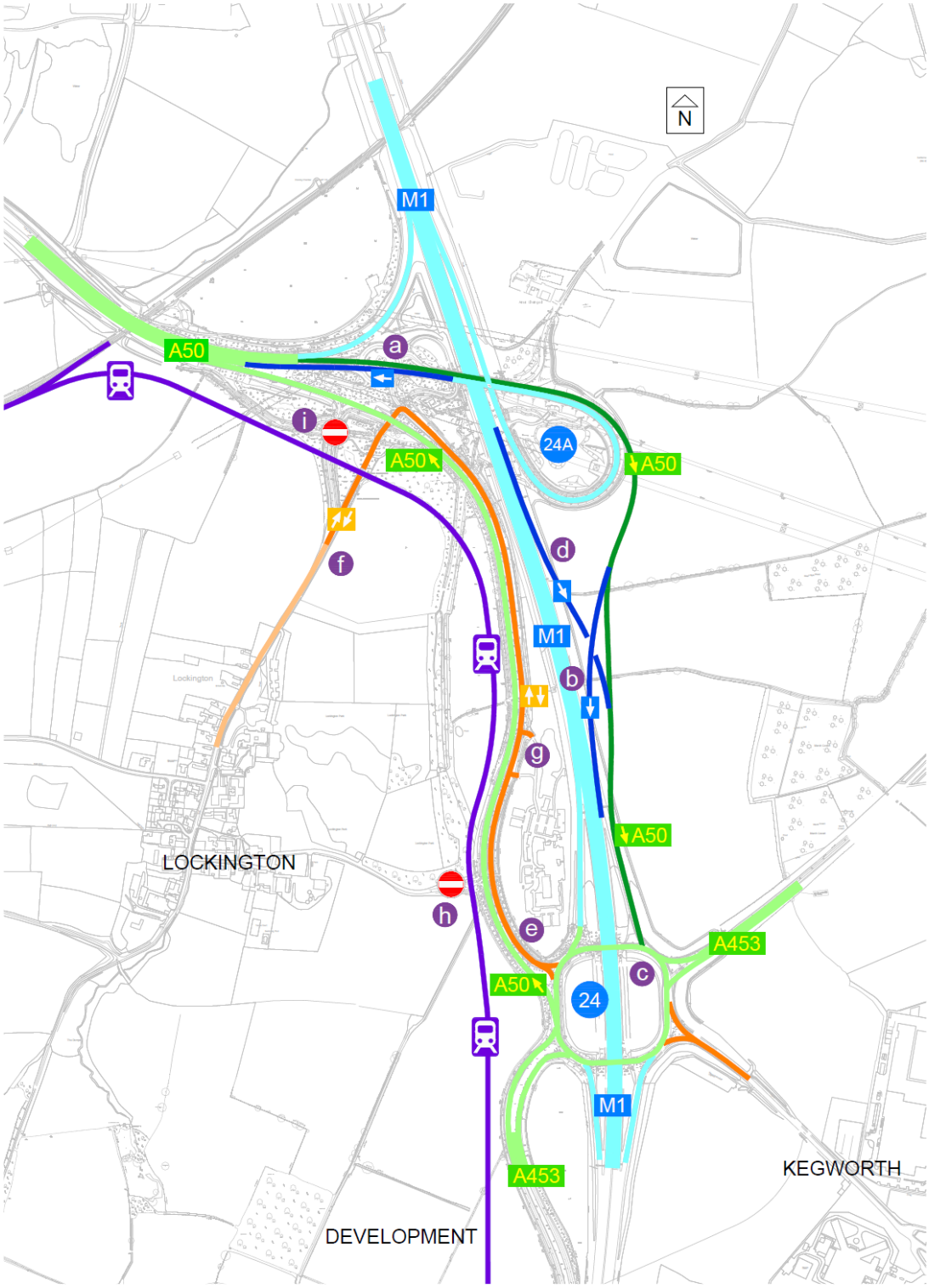


Figure 1 – Extent of Segro funded major improvements to Junctions 24 and 24A

When Highways England dualled the A453 between J24 and Nottingham they also carried out changes to J24 to increase capacity which included a cut-through for A50 eastbound to A453 southbound traffic. This cut-through was made redundant by the wider changes listed above.

The locations of the original abnormal load bay and the cut through in Junction 24 are shown in **Figure 2** below.

A combination of the above meant that altering the redundant 'cut-through' within Junction 24 to form an abnormal load bay was quickly determined to be the most appropriate location for the replacement abnormal load bay.

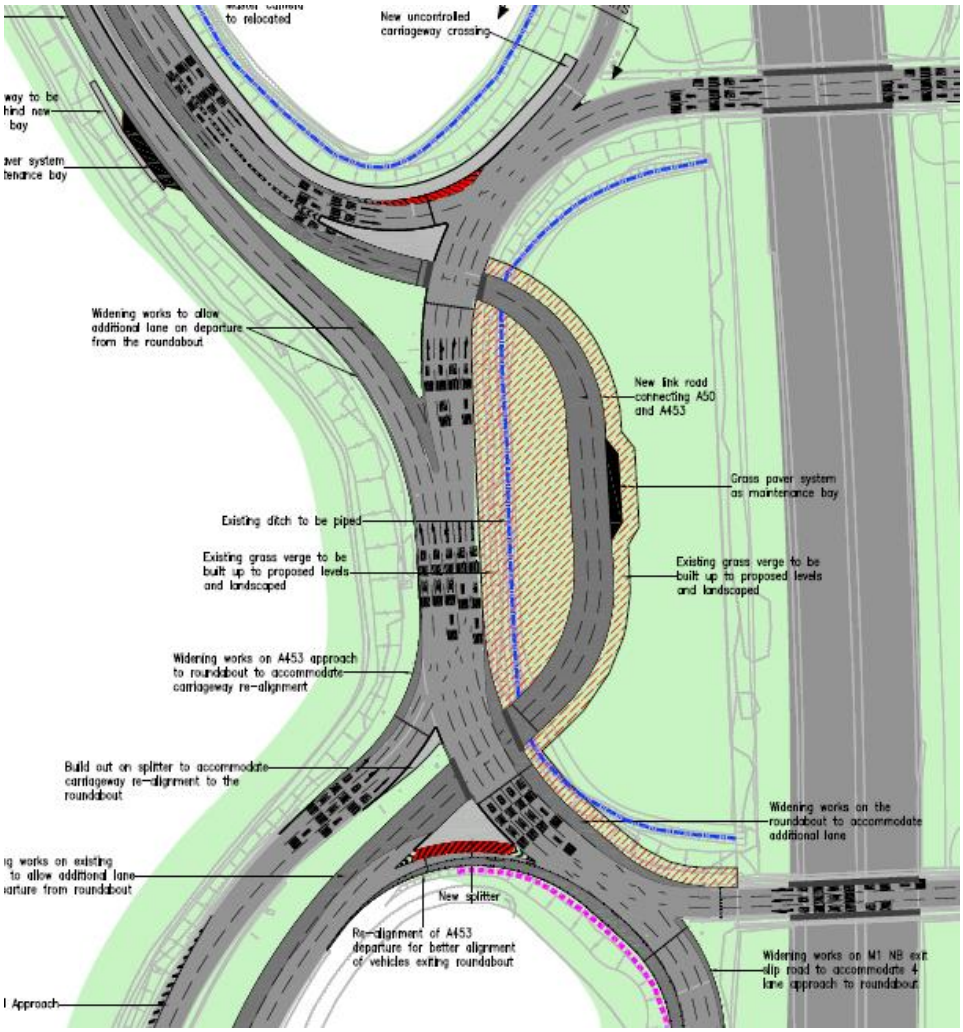


Figure 2 – Junction 24 'pinch point' scheme layout showing the cut-through

Operational challenge

Providing an abnormal load bay within Junction 24 posed several challenges:

- What is an abnormal vehicle and what is the required geometry (see examples of abnormal loads in **Figure 3** below).
- How to deter unauthorised use (not covered by this paper)
- How to allow a safe exit for abnormal vehicles and other authorised vehicles (e.g. maintenance vehicles and traffic officers)

It is the third point, how to allow a safe exit, that is the primary focus of this paper. This is because:

- Abnormal vehicles are by their nature often long, wide and slow
- Exiting vehicles will affect general traffic using the junction
- Escort vehicles usually follow the abnormal load vehicle as their primary purpose is to warn drivers who are approaching from behind in normal running, the escort vehicle does not usually hold back traffic
- There are no design standards for abnormal load bays

Figure 3 – Typical examples of abnormal loads showing the variations in vehicle size
(Images courtesy of Collet & Sons Ltd)

Whilst in no means an exhaustive list, there are other examples of abnormal load bays within large roundabouts:

- M1 Junction 28 (for the A38) (2 no. bays), these were constructed as a result of the Junctions 28 to 31 Smart Motorway Project due to the loss of facilities elsewhere
- M6 Junction 16 (for the A500)
- M42 Junction 10 (for the A5)

All of the above examples have simple give-way exits. However, the bays at Junction 28 were raised as a concern by the operations team at Highways England and the Stage 3 Road Safety Audit for that scheme had recommended that signal control is implemented on the bay exits.

Hence for the abnormal load bay at Junction 24 a 'first principles' type study was undertaken to determine the best option for exiting vehicles and this was written into a detailed safety case assessment which at the time followed standard GD04 (which is now GG104).

Risks and development of options

The principal safety risks considered were:

- Risk of vehicles (including unauthorised vehicles) exiting inappropriately with risks to road safety.
- Risk of abnormal load vehicles exiting at slow speed with risks to road safety and increased congestion.
- Risk of congestion caused by the signalisation of the junction node, with risk of compensating behaviour by drivers which could in turn have safety implications for directly affected and nearby routes.

The following options were identified:

i) Simple 'give-way' exit with no changes to signal control;

ii) Simple 'give-way' exit with an ability to call an extended all-red at the signal node at the A453 NB entry;

iii) Provision of on-demand 'wig-wag' signals on the circulatory carriageway prior to the abnormal load bay egress;

iv) Provision of part-time signal control at the abnormal load bay egress, activated on demand;

v) Provision of full-time signal control at the abnormal load bay egress; and

vi) Provision of full-time signal control at the adjacent node on the circulatory carriageway (at the local road approach) with an extended all-red (activated on demand) to permit vehicles to exit the abnormal load bay.

The above options are shown indicatively on **Figure 4** below. Options were eliminated iteratively in accordance with the GD04 process and that process is summarised below.

Option (i) would result in a significant risk of vehicles exiting inappropriately be they abnormal loads, maintenance vehicles or unauthorised vehicles. Drivers could attempt to cross multiple lanes of traffic which could be travelling at a reasonable speed. Slow moving vehicles, in particular, could have difficulty in exiting. The risks identified above would not be reduced and as such this option was eliminated.

Option (ii) is similar to (i) but would require an all-red at the A453 NB approach where it meets the circulatory carriageway. This would reduce the amount of traffic at the abnormal load bay exit but would not remove traffic from the local road arm, so the risk identified for Option (i) above would be reduced but not eliminated. Furthermore, introduction of an all-red at this node is considered to be too far from the abnormal load bay exit to be effective and would result in congestion issues at peak times. For these reasons Option (ii) is eliminated.

Option (iii) is considered to be a workable solution in terms of safety risk as it would permit abnormal loads to exit onto a clear carriageway. However, in consultation with Highways England specialists and the Department for Transport, it became clear that 'wig-wag' signals cannot be used in this circumstance because emergency vehicles have to comply with such signals (which is appropriate for say a level crossing or lifting bridge, but not in this situation). For this reason this option is eliminated even though the risks would be mitigated appropriately.

Option (iv) would provide occasional use part-time signals at the abnormal load bay egress and the circulatory carriageway. This had the potential to reduce the risks identified to tolerable levels. However, the use of part-time signals in this location would likely result in its own safety risks as the part-time signals would have sporadic and irregular use and may be ignored or cause confusion. Use of part-time signals would result in poor signal co-ordination with the remainder of the junction, thus reducing capacity. Further, the signals would be located very close to the signal crossing at the M1 NB slip road exit from J24 which could result in drivers missing a red signal at the crossing with consequential safety risks. For these reasons this option was eliminated.

Option (v) was considered to reduce the risks at the exit from the abnormal load bay. However, it may result in significant congestion issues around the J24 roundabout especially if there is a detector failure and the stage is called unnecessarily. Congestion is clearly something that the wider scheme improvements are seeking to address. The congestion risk would not be reduced (and in fact could be exacerbated) and as such this option was eliminated.

Option (vi), with appropriate further mitigation measures, was considered to reduce the identified risks so they are 'As Low as Reasonably Practicable' (ALARP). To allow this to be implemented the adjacent node on the junction, previously proposed as a give-way arrangement, needs to have full time signal control. To minimise risks to road users vehicle activated signs are proposed to inform drivers of the presence of abnormal vehicles. To allow the system to operate as intended careful thought was needed to detect abnormal vehicles and this is considered in detail below.

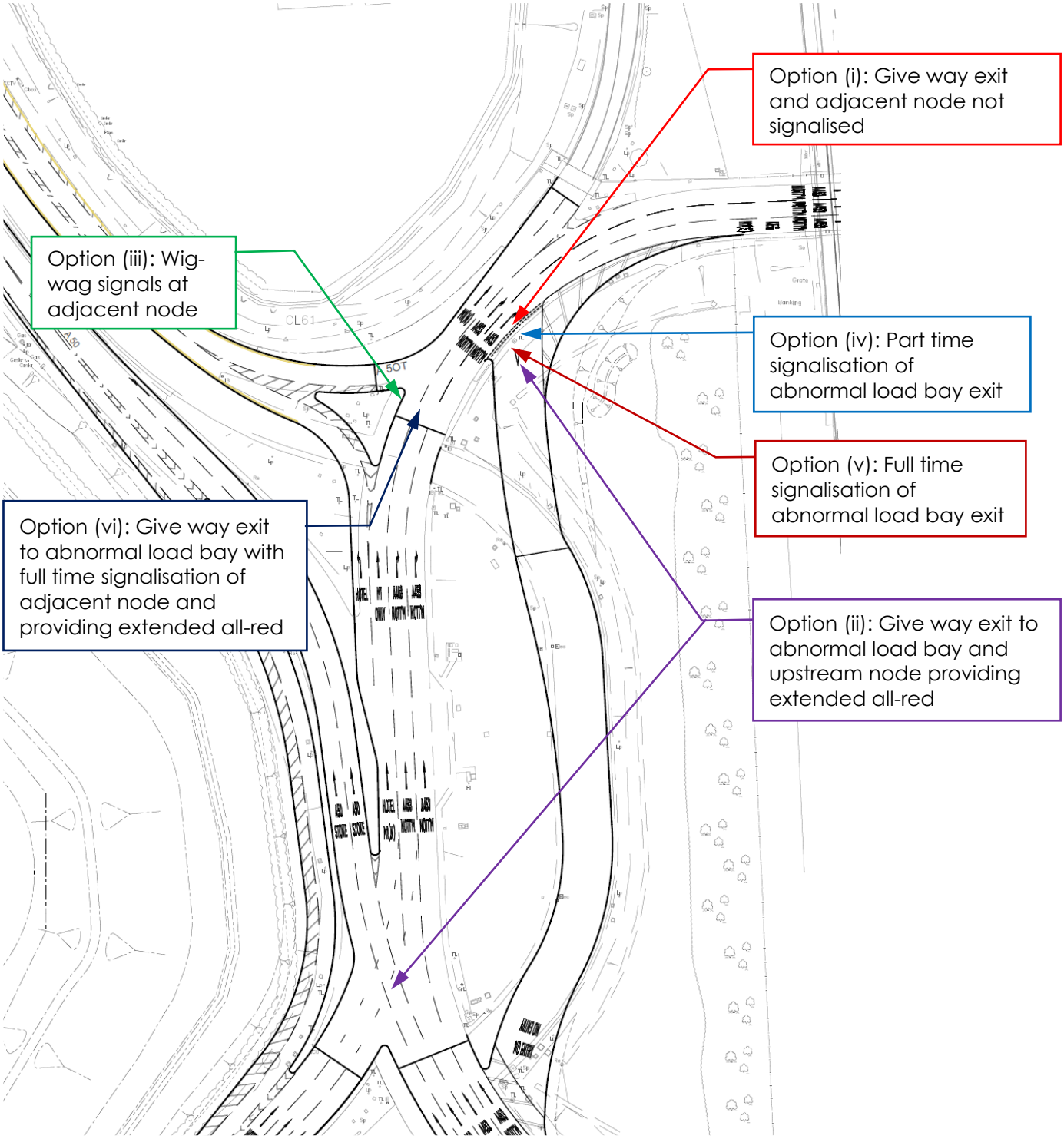


Figure 4 – Summary of options considered

Option (vi) was therefore taken to be the preferred option and all other options were discounted as discussed above. The proposed layout is shown on **Figure 5** below, the vehicle activated signs are located as shown on **Figure 6** and the signs themselves are shown at **Figure 7**.

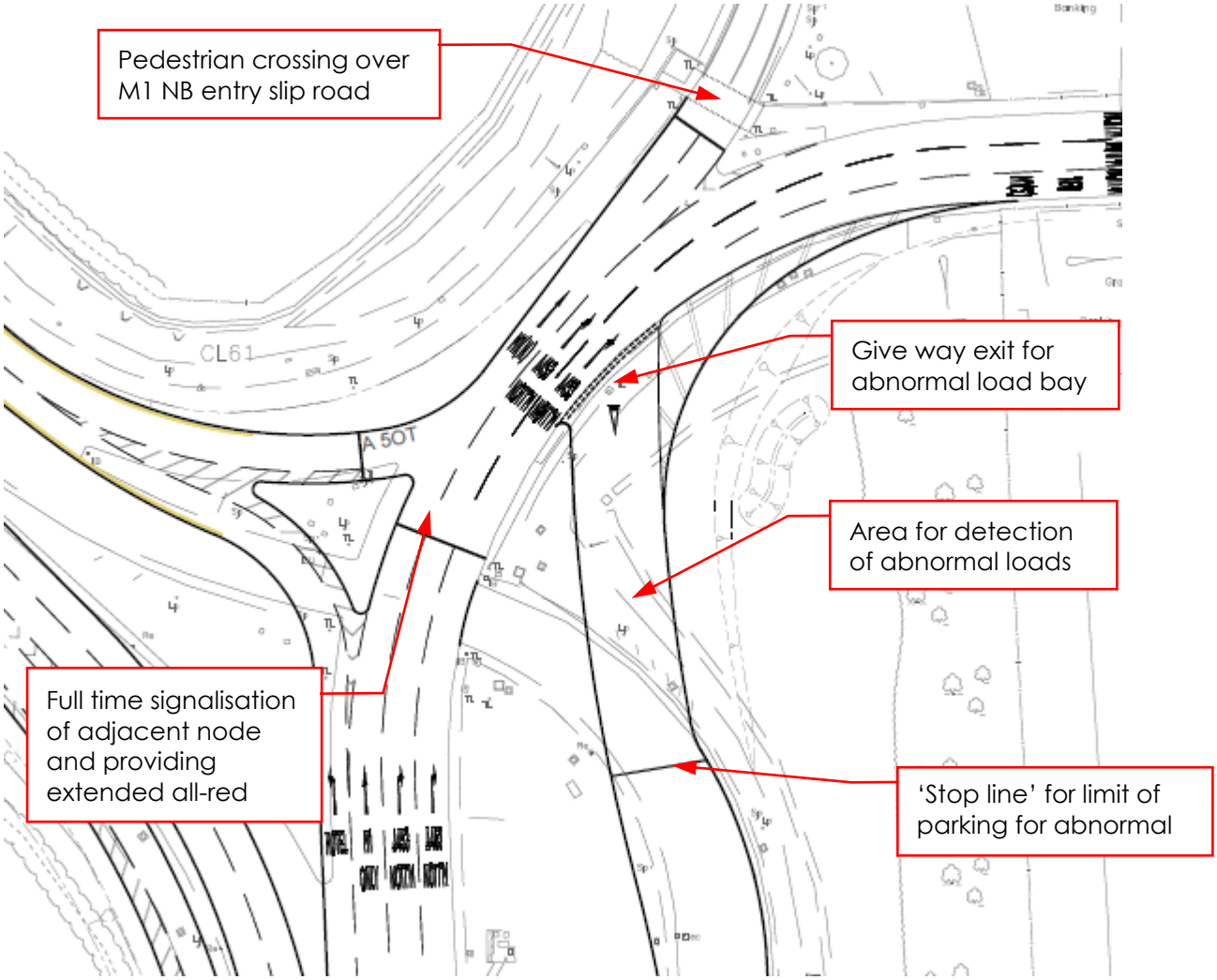


Figure 5 – Overall layout of preferred option

Detection

As noted above one of the challenges is 'what is an abnormal vehicle' as it could be of significantly varying length and significantly varying width. Hence flexibility in detection a series of four echelon loops have been provided at set spacings. The design was that if 3 out of the 4 sets of loops are activated in sequence, without the previous set being deactivated, with the vehicle present for 15 seconds, the "abnormal load" stage would be called.

To minimise the risk of activation by parked vehicles signs and a 'stop' line have been provided within the abnormal load bay.

To allow smaller vehicles (such as maintenance vehicles) to safely exit the abnormal load bay if the front set of loops has a positive detection for longer than 5 seconds an extended intergreen at the adjacent node of 5 seconds is called but the signs do not activate. This is cancelled if the vehicle is able to move away before the extended intergreen is needed.

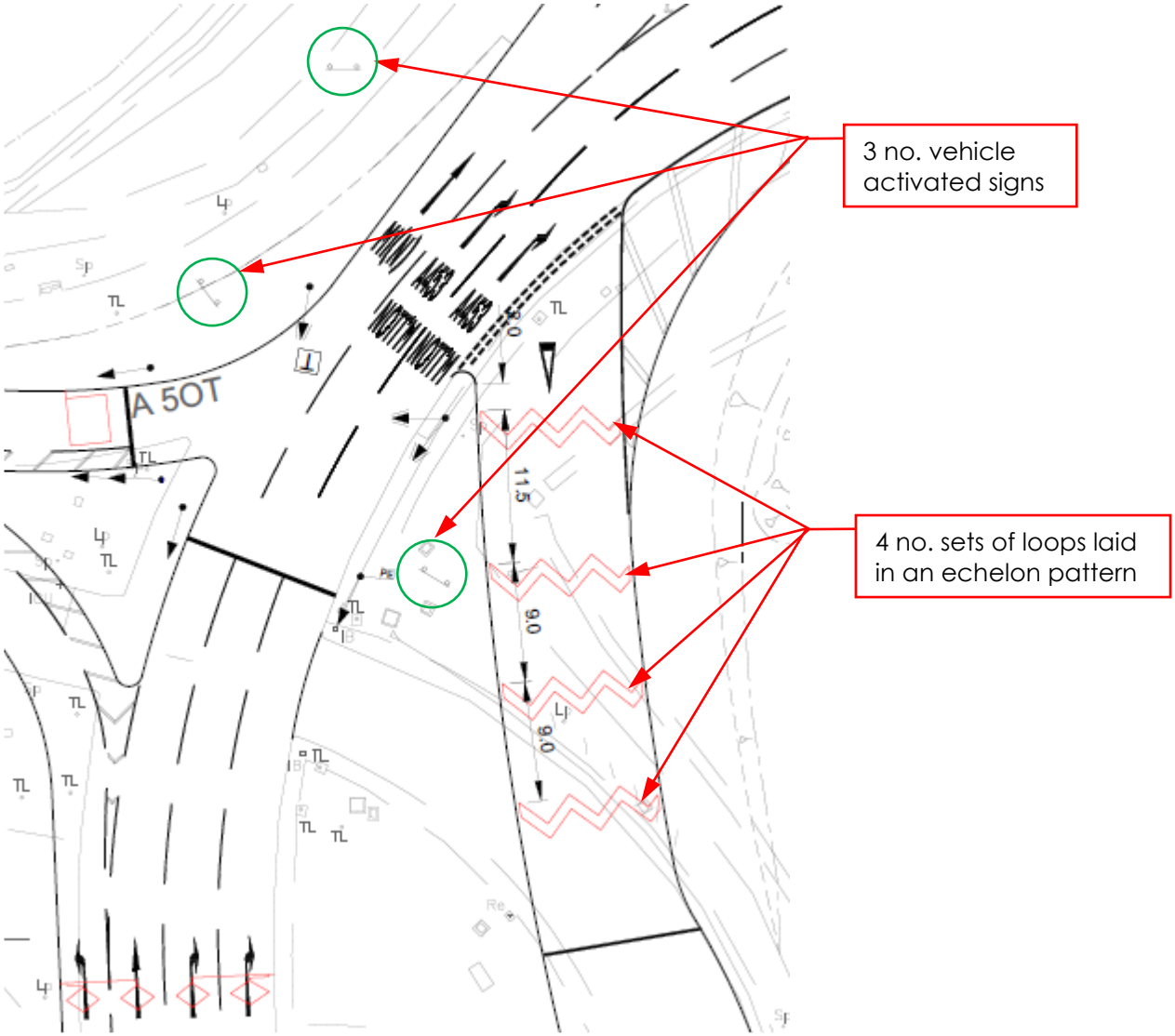


Figure 6 – Detection and vehicle activated signs layout

Operational Sequence

The following detailed operating sequence was developed for when an abnormal vehicle is detected seeking to exit the bay:

1. Set an 'all-red' on the adjacent node, with the slip road pedestrian crossing set to green.

2. Activate signs 1 second after the all-red stage is active.

3. Extend all red stage to maximum of a) 5 seconds after when vehicle presence no longer detected in the abnormal load bay or b) 15 seconds.

4. If queues detected on circulatory implement changes to other signal timings elsewhere on the signalised roundabout

5. Once the all-red stage has ended then set circulatory to green at the adjacent node and revert to normal operation

6. Deactivate signs 90 seconds after vehicle presence no longer detected in the abnormal load bay. This was later reduced to 20 seconds at commissioning (see below) but with flexibility to increase if appropriate.

7. Controller configuration to permit setting of a time-based inhibition on repeated calls.

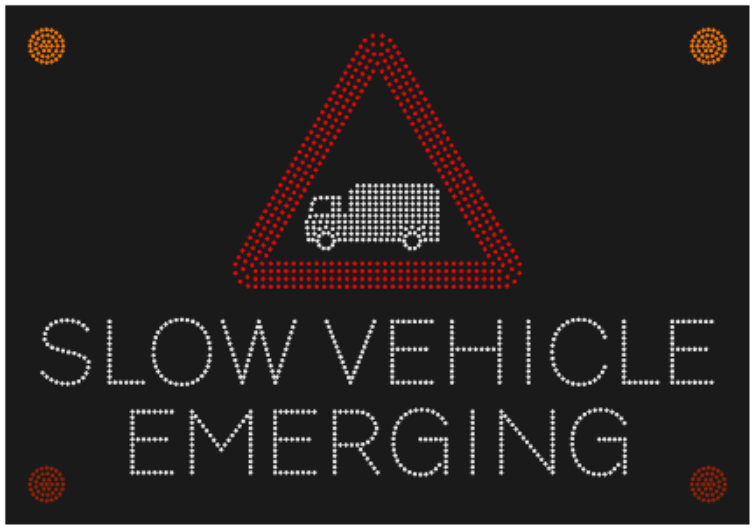
Vehicle activated signs

Three vehicle activated signs stating "SLOW MOVING LARGE LOAD" are provided at Junction 24. One of these is positioned in such a way that it allows drivers of abnormal loads to know when the "abnormal load" stage has been called given that there are no other signals to inform users of the abnormal load bay.

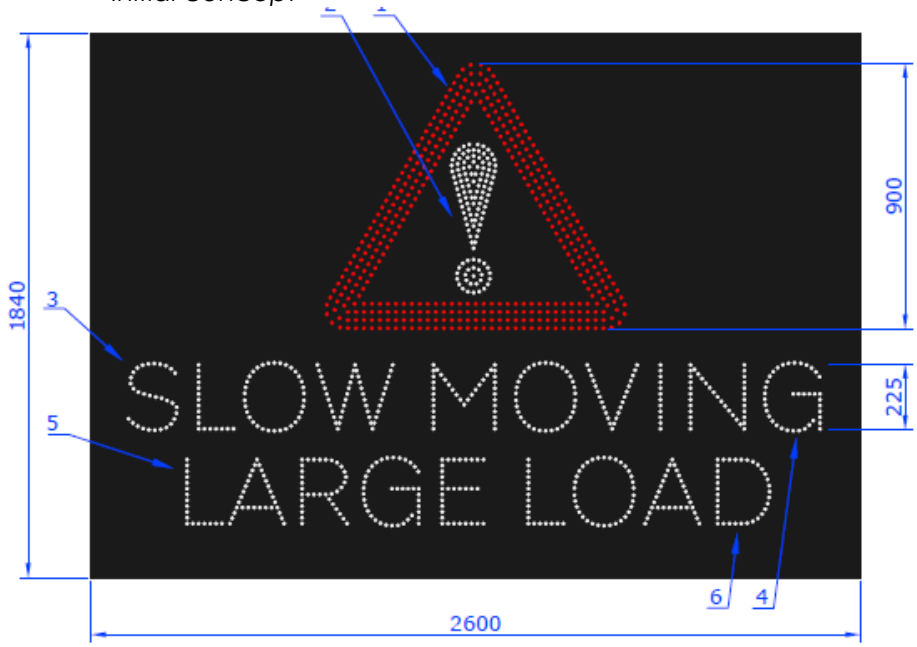
The signs are connected to the traffic signal controller and activate during the "abnormal load" stage and remain on for 20 seconds after the signals revert to normal operation – this delay makes road users aware that the abnormal load vehicle is likely to not be too far ahead of them on the road.

The original design was for a warning symbol to be provided in addition to the text as drivers quickly associate a red warning symbol with a hazard. However, this required a non-prescribed sign authorisation and whilst the specialist sign team in Highways England were supportive the Department for Transport did not grant consent.

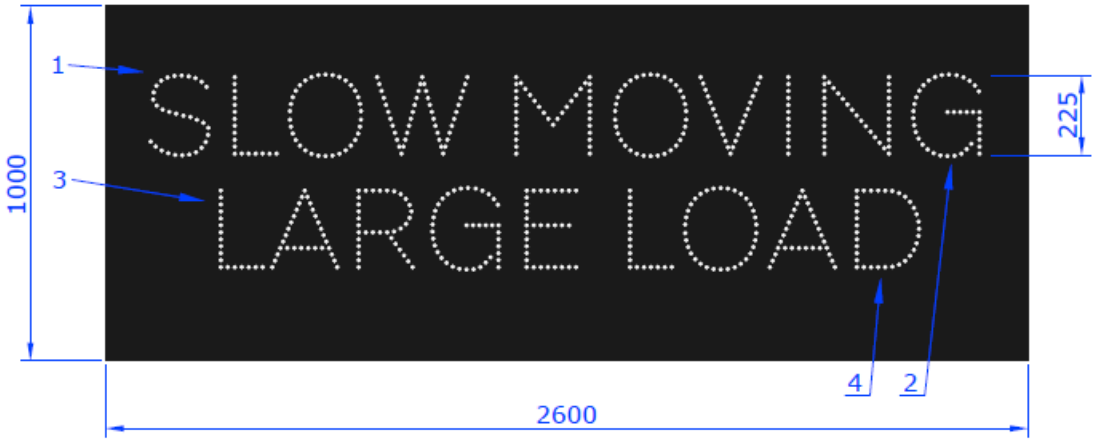
The signs are located where shown on **Figure 6** above, and stages of the sign design are shown on **Figure 7** below.



Initial concept



Detailed proposal (not consented)



Final installation

Figure 7 – Vehicle activated signs – original proposals and final installation

Commissioning

JSTSM were engaged to support the traffic signal design and commissioning and worked alongside Alan Solaini from the Highways England East Midlands Asset Delivery team to commission the overall MOVA control and the abnormal load bay.

To assist with commissioning the contractor for the works, Winvic, sourced a long vehicle. The question of 'what is an abnormal vehicle' re-emerged and short but wide abnormal vehicles were not being detected. It was subsequently agreed that only two consecutive loops need to be activated to set the "abnormal load" stage in the signals.

During the commissioning stage it was determined that the upstream nodes on the gyratory were not being unduly affected during the 'abnormal load' stage and hence only the adjacent node needed to be affected by its operation.

No significant issues regarding the abnormal load bay were identified at the Stage 3 Road Safety Audit, the Audit did recommend that the bay was tested using an abnormal vehicle (which was subsequently carried out as noted above) all other issues noted were minor in nature and subsequently resolved.

Figure 8 – Photograph of work nearing completion

Conclusions and learning points

- Providing a form of signal control addresses concerns raised about the safety and operation of give-way exits from abnormal load bays within large roundabouts
- The solution presented relies on having signal control at the adjacent upstream node
- Early engagement with stakeholders such as the Police, maintainers and abnormal load operators is key
- There is a lot of value in the commissioning process to iron out any unforeseen issues and involving key stakeholders at this stage is beneficial. Having an abnormal load on hand to assist with the testing was very helpful
- There is a need to allow sufficient flexibility in detection and controller configuration to allow easy changes to be made during commissioning
- If there is to be an increasing need for such facilities within large roundabouts then a design standard or other form of guidance would be beneficial

Acknowledgements

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