Jacobs

Technical Note

Project:	M1 Junction 10		
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1. Introduction

National Highways (NH) has commissioned Jacobs to identify potential options that would build upon Luton Risings proposed improvements to M1 Junction 10 to mitigate the traffic arising from the expansion of Luton Airport.

Luton Rising are proposing to increase the capacity of the roundabout at Junction 10 and to install signal control. However, no options are proposed to alleviate the congestion predicted at the south-facing merges and diverges, which are shown to remain congested following implementation of the proposed Luton Rising mitigation scheme.

Therefore, NH considers that there is a need to address the forecast congestion on the south-facing merges and diverges.

2. Methodology

Jacobs has used information from the Luton Rising work within this study. This includes:

- Use of the Luton VISSIM model prepared by ARUP; and
- Inclusion of the Luton Rising junction 10 roundabout signalisation within the option testing.

Jacobs has extracted traffic flow data from the VISSIM model and used these as design flows when preparing layouts for proposed options. The 2043 forecast year VISSIM model has also been used as a platform to test the proposed options. This model includes forecast demand of 32 million passengers per annum at Luton Airport.

The Luton Rising VISSIM model has been used within this task as it covers the study area and was available for immediate use.

It should be noted that the 2043 models gridlock, thus preventing the model from outputting accurate results for the full simulated time periods. Further, dummy speed reductions were deployed on the M1 to simulate the influence of off-network delays, but the configuration and placement of speed markers obscures the assessment of improvement at the junction southbound merge. The level of gridlock,

combined with this method used to validate journey times on the M1, obscures the full assessment of the southbound merge onto the M1 in particular.

Despite this limitation, the Luton Rising VISSIM model is considered to be practical for initial model testing. It is advised that the modelling platform for the assessment of SRN options at junction 10 should be changed or upgraded at the earliest opportunity in order to fully validate the modelling results.

Based on the design flows obtained from the VISSIM model, and a consideration of design constraints, the following key outcomes were identified from the option generation and sifting process:

- In principle, NH have agreed the design of the circulatory with Luton Rising. However, NH remain concerned about the lack of mitigation to alleviate the congestion predicted at the south-facing merges and diverges, which are shown to remain congested following the implementation of Luton Rising's mitigation at Junction 10;

- It would be possible to upgrade the northbound diverge at Junction 10 by providing an additional lane from the current lane drop from 5 lanes to 4 lanes between Junction 9 and Junction 10; and

- An upgrade to the southbound merge at Junction 10 can be provided, whilst still providing sufficient weaving space to the Junction 9 diverge.

Two options have thus been identified on the two south-facing slip roads of M1 Junction 10:

- Option 1: M1 Junction 10 Northbound Diverge (M1_J10_NB_Div_Op1)
- Option 2: M1 Junction 10 Southbound Merge (M1_J10_SB_Mer_Op2)

The next sections of the report describe the two identified improvement options.

3. Option 1: M1 Junction 10 Northbound Diverge

This option aims to improve the capacity, journey reliability and safety for northbound traffic.

The option's key elements are:

- Changing the diverge layout type from 'Layout B option 2 - Two-lane auxiliary diverge' to a higher capacity 'Layout D option 1 - ghost island lane drop'.
- Where lane 5 is discontinued between Junction 9 and 10, the intervention will instead carry the discontinued lane an additional 1.1km where it will be incorporated into the lane drop described above.

An important element of this option is to construct an increased capacity diverge arrangement that is described in 'CD 122 Geometric design of grade-separated junctions'. CD 122 sets out several junction diverge arrangements with increasing capacity performance.

The selection of which diverge layout to be used is set out in CD 122 Figure 3.26b using vehicle per hour (VHP) traffic flows at AM and PM peaks.

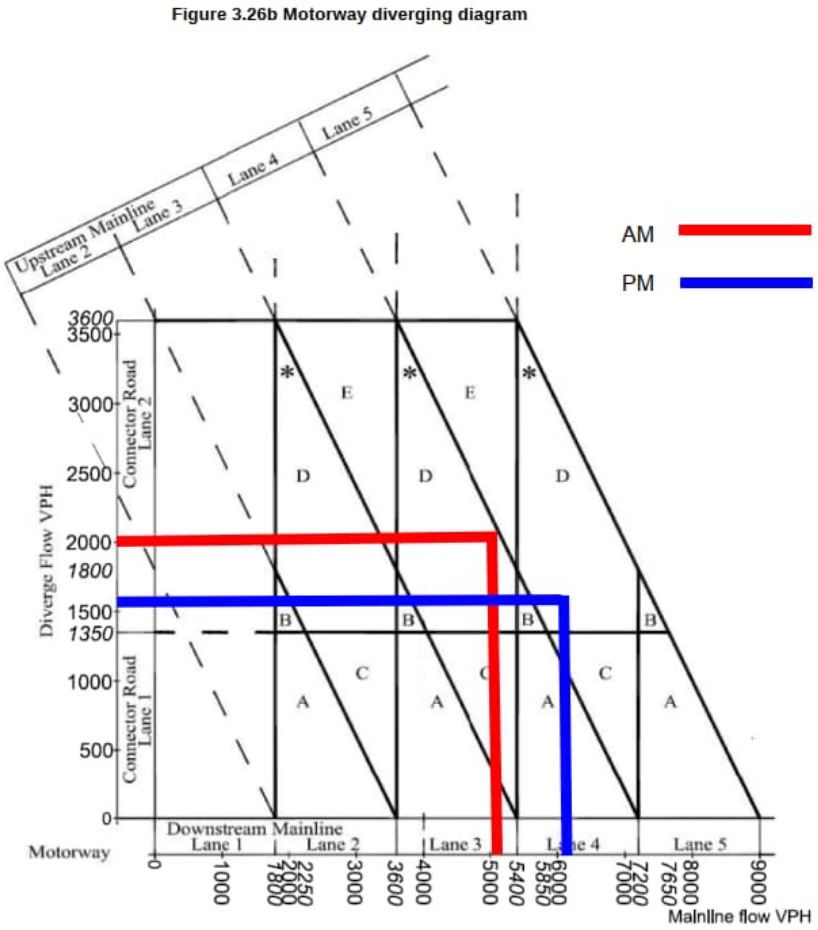


Figure 1 - Figure 3.26b Motorway Diverging Diagram described in DMRB CD122

Both the AM and PM Peak require a 'Layout D option 1 - ghost island lane drop', therefore this layout has been proposed for Option 1. This diverge layout can only be selected if the 5th northbound lane is extended to provide an additional lane which can be dropped at the diverge. If the 5th lane is not extended to the diverge then only a lower capacity diverge layout that uses a taper would be able to be selected, as per the existing provision, which Figure 1 above indicates is inadequate.

The existing Junction 10 southbound diverge arrangement is a 'Layout B option 2 - Two-lane auxiliary diverge':

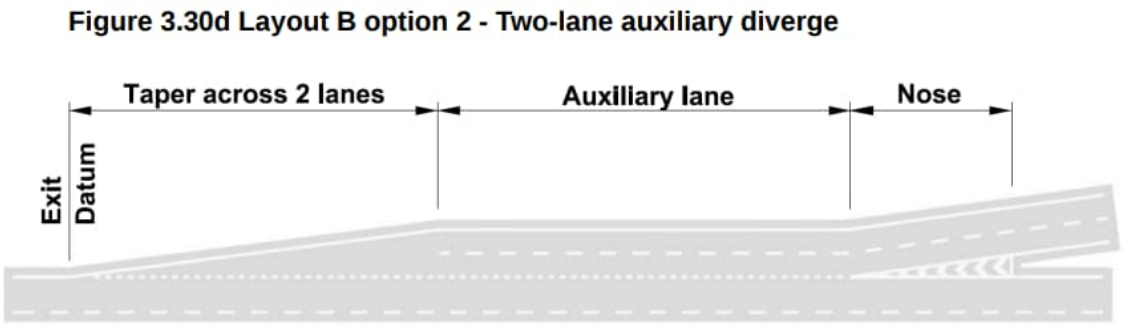


Figure 2 - Figure 3.30d Layout B option 2 - Two-lane auxiliary diverge described in DMRB CD 122

The option proposes to improve the existing arrangement with 'Layout D option 1 - ghost island lane drop':

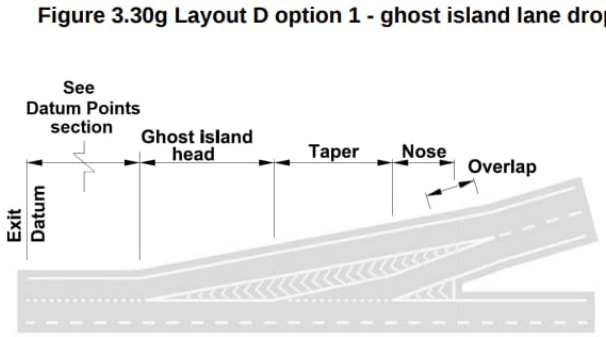


Figure 3 - Figure 3.30g Layout D option 1 - ghost island lane drop described in DMRB CD 122

3.1 Land Take

This intervention would likely require additional land beyond the existing highway boundary, the steepening of the existing earthworks, existing hard should being converted, or a narrowing of the carriageway cross section.

If additional land was to be acquired this would be approximately a 5 metre wide strip that is 1.6km long with a total area of 0.8 hectares. This would be effectively offset from the existing highway boundary, based on the assumption that no additional land was left spare by the previous scheme that defined the highway boundary.

The current land use is agricultural with no obvious ecological concerns beyond normal considerations.

Land acquisition/planning methods should also be considered further, for example, DCO or landowner discussions.

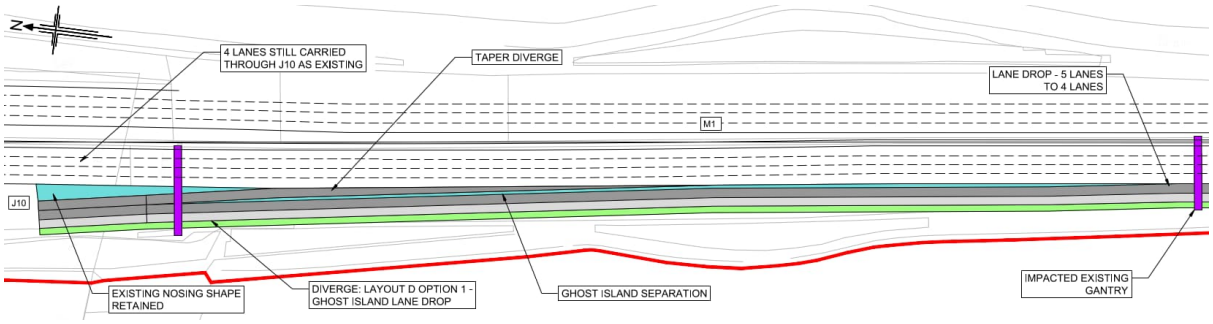


Figure 4 - An extract from the option's drawing M1J10-NB-A-01

4. Option 2: M1 Junction 10 Southbound Merge

This option aims to improve the capacity, journey reliability and safety of traffic travelling from Junction 10 and then merging onto the M1 southbound towards Junction 9.

The option's key elements are:

- Changing the merge layout type from 'Layout B - parallel merge' to a higher capacity 'Layout C - ghost island merge'.

An important element of this option is to construct an increased capacity merge arrangement that is described in 'CD 122 Geometric design of grade-separated junctions'. CD 122 sets out serval junction merge arrangements with increasing capacity performance.

The selection of which merge layout to be used is set out in CD 122 Figure 3.12b using vehicle per hour traffic flows at AM and PM peaks.

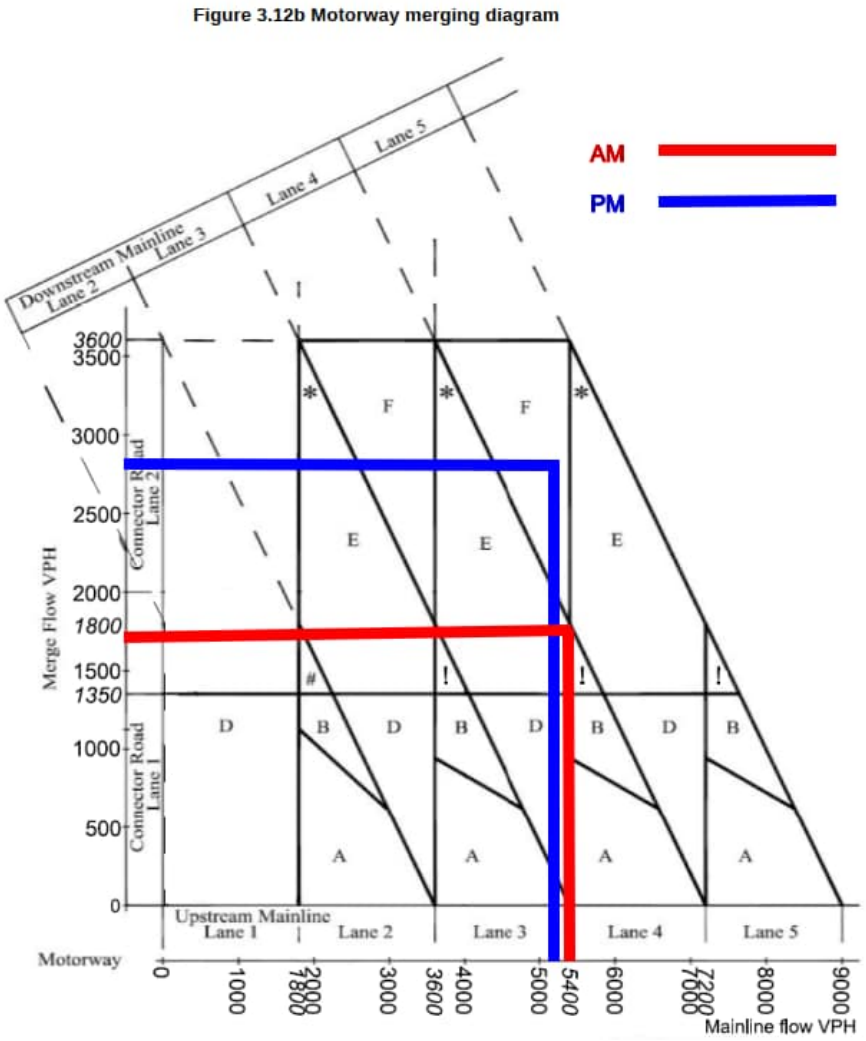


Figure 5 - Figure 3.12b Motorway merging diagram described in DMRB CD 122

The AM Peak requires a '!' type layout which in this circumstance would be a 'Layout C - ghost island merge'. It should be noted that this is border line with a Layout E - lane gain with ghost island offside merge.

The PM Peak requires a 'Layout F - 2 lane gain with ghost island'. However, this has not been proposed due to significant constraints such as this type of layout including a lane gain function which would mean the mainline would gain and carry a 5th lane southbound to Junction 9.

The existing Junction 10 southbound merge arrangement is a 'Layout B - parallel merge':

Figure 3.14c Layout B - parallel merge

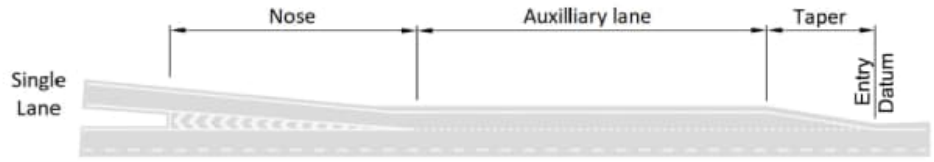


Figure 6 - Figure 3.14c Layout B - parallel merge described in DMRB CD 122

The option proposes to improve the existing arrangement with 'Layout C - ghost island merge' based on AM peak flow in Figure 3.12b:

Figure 3.14d Layout C - ghost island merge

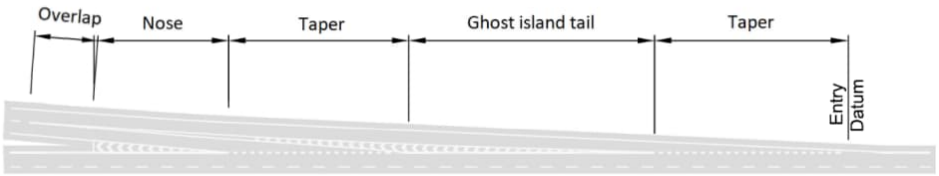


Figure 7 - Figure 3.14d Layout C - ghost island merge described in DMRB CD 122

4.1 Land Take

This intervention may be able to avoid any additional land requirements due to a wider existing cutting slope. This would need to be confirmed with a topographical survey.

If this was not possible, the acquisition of additional land beyond the existing highway boundary, the steepening of the existing earthworks, existing hard should being converted, or a narrowing of the carriageway cross section would be required.

If additional land was to be acquired this would be approximately a 5 metre wide strip that is 800 meters long with a total area of 0.4 hectares. This would be effectively offset from the existing highway boundary, based on the assumption that no additional land was left spare by the previous scheme that defined the highway boundary.

The current land use is agricultural with no obvious ecological concerns beyond normal considerations.

Land acquisition/planning methods should also be considered further, for example, DCO or landowner discussions.

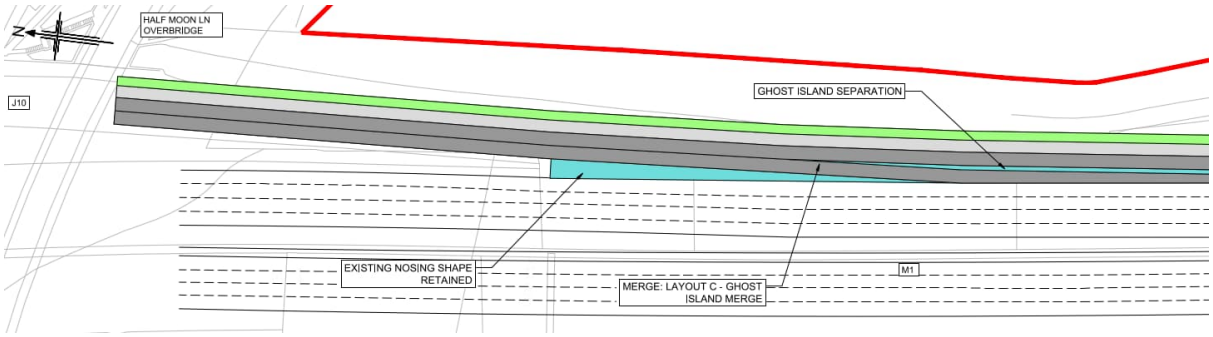


Figure 8 - An extract from the option's drawing M1_J10_SB_Mer_Op2

5. Cost Estimate

5.1 Cost Estimate

A separate cost estimate has been provided for each intervention proposal, as the interventions can be constructed independently and function without the other.

The key construction activities that contribute to the cost estimate are:

- Pavement/carriageway widening
- Gantry replacement/amendment
- Associated earthworks of widening
- Land take costs (however this has not been included in this cost estimate)

Due to the maturity of the proposals, the following cost estimates can be described as an 'Order of Magnitude' with an associated accuracy range to be applied to the estimates. This would be a -50% to +50% expected accuracy range.

Estimate Class	Level of Project Definition	End Usage	Methodology	Expected Accuracy Range
Order of Magnitude	0% to 2%	Concept	Percentage Allowances / Approximate Estimating Rates	-50% to +50%
Options	1% to 15%	Study or Feasibility	Percentage Allowances / Approximate Estimating Rates	-30% to +40%
Preliminary / Initial	10% to 40%	Design Development, Budget Authorisation or Feasibility	Percentage Allowances / Approximate Estimating Rates / Unit Rates	-20% to +30%
Developing	30% to 75%	Control or Bid/Tender	Unit Rates / Resource Costs	-10% to +15%

Final	65% to 100%	Check Estimate or Bid/Tender	Unit Rates / Resource Costs	-5% to +5%

The cost estimates have been summarised in the below table and use a base year of 2020. Risks and exclusions are described in the following section.

Option	Total (£)
M1 Junction 10 Northbound Diverge – Option 1	£7,446,003
M1 Junction 10 Southbound Merge – Option 2	£ 2,918,973

5.2 Risks

Section 3.1.1 of "The Department for Transport Guidance, TAG Unit A1.2, Scheme Costs, dated July 2017" states that a Quantified Risk Assessment (QRA) is required for all transport projects with a cost greater than £5m and is encouraged for smaller schemes.

A QRA has not been developed at this preliminary stage and for this estimate, risk has been included at 60% in line with the recommendations tabled below.

HE PCF Stage (or equivalent)	Estimate Type	Risk
0 & 1: Strategy & Option Identification	Order of Magnitude	40 - 60%
1 & 2: Option Identification & Selection	Options Estimate	25 - 40%
3: Preliminary Design	Preliminary / Initial Estimate	20 - 25%
4: Statutory Procedures and Powers	Developing Estimate	15 - 20%
5: Construction Preparation	Final Estimate	10 – 15%
6: Construction	Cost to Complete Estimate	5 - 10%

The risks associated with this cost estimate include:

- Maturity of option development;
- Recent inflation variance;
- No surveys referenced (GI, Topographical, drainage etc);
- No statutory undertakers' information acquired; and
- No contractor buildability input.

5.3 Exclusions

The following items are excluded from this cost estimate described in the previous section:

5.3.1 General

- Certain highway works such as accommodation works and facilitating works;
- Additional development/project costs such as land costs, and DCO applications;
- Inflation, with a 2020 cost base; and
- All Motorway Communication requirements have been excluded.

5.3.2 Facilitating Works

- Temporary and permanent diversion works including diversion of statutory undertakers' services (e.g. water, electricity, gas and communications);
- Removal of redundant cables or apparatus from highway or within the existing carriageway for any utility companies including, but not limited to Gas, Water, Electric, Fibre Optics, Telecommunications, CCTV and Speed Monitoring;
- Statutory Utility requirements - no utility companies have been contacted at this stage;
- Toxic/hazardous material removal including removal of toxic or hazardous parts of building fabric and hazardous materials or components from existing service installations;
- Removal and/or treatment of contaminated ground material;
- Eradication of invasive plant growth;
- Ground gas venting measures including gas-proof membranes, perforated collection pipes, proprietary gas dispersal fin layers, radon sumps and vent pipes;
- Soil stabilisation measures including cement or chemical grouting, electrochemical stabilisation, sand stowing, soil nailing, ground anchors, compacting, and freezing of groundwater and subsoil;
- Works to existing Structures, however, it does include gantries alterations;
- Site dewatering and pumping to lower the groundwater level of the site, including forming well points, filling, drain tubes and ring mains, sumps, pumps and pumping, off-site disposal of water, running costs and attendance;
- Extraordinary site investigation works including archaeological investigation, reptile/wildlife mitigation measures and other site investigation works;
- Buried asbestos and asbestos removal;
- Unexploded ordinances;
- Attenuation requirements;
- Flood risk assessments;
- Temporary diversions of existing watercourses during construction phases; and
- Decanting and relocation costs, temporary relocation costs, temporary accommodation rents and other running costs.

5.3.3 Other Development / Project Costs

- Land acquisition and compensation costs;
- Employer Finance costs, costs in connection with the funding of the project;
- Fees, planning fees, and fees in connection with agreements between the employer and neighbours to facilitate the project, other fees in connection with licences, permits and agreements;

- Planning contributions, direct financial contributions in connection with planning consent, and environmental improvement works;
- Insurances other than Main Contractors' works insurance;
- Accommodation works;
- Marketing costs, public relations events, site-based advertising, and public relations literature; and
- Legal costs.

6. Assessment of Options

The two options have been assessed within the Luton Rising 2043 Do-something VISSIM model. With regard to the SRN, the key intervention within the model is a capacity upgrade and signalisation at the roundabout of Junction 10. The layout of this option is shown in Figure 9.

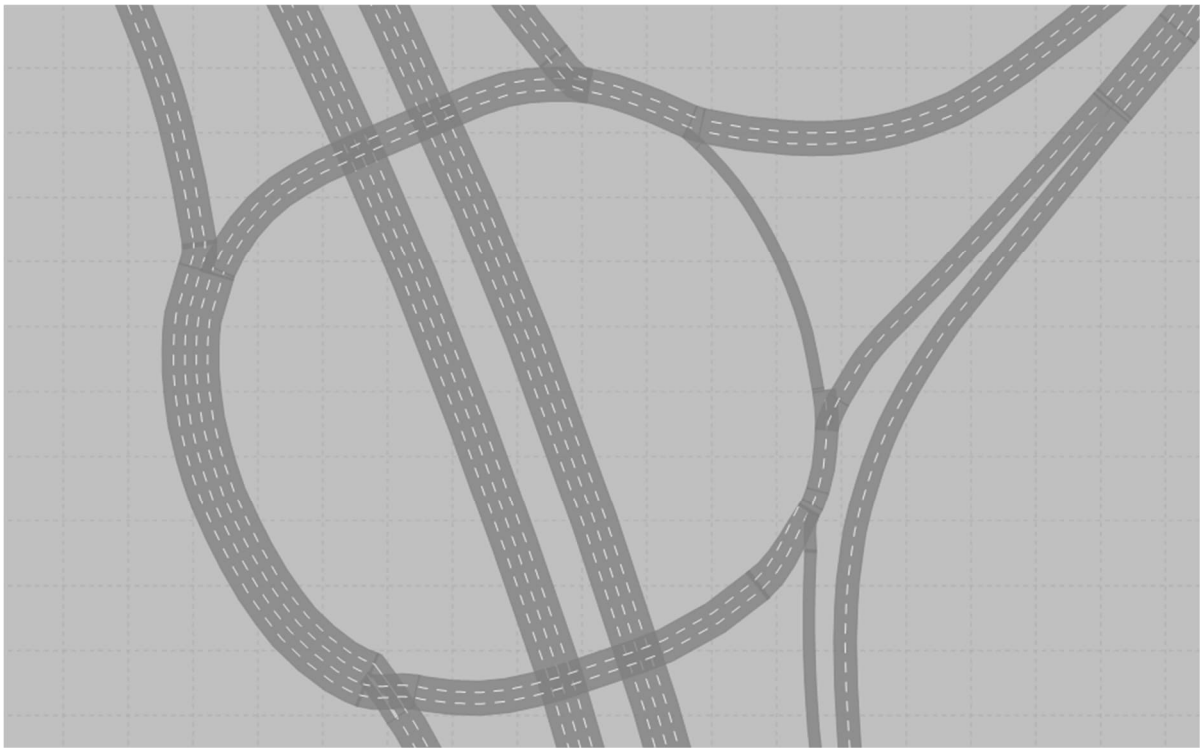


Figure 9 – Luton Rising Proposed Upgrade to M1 junction 10

Gridlock within the VISSIM model means that it is not practical or desirable to present quantitative results regarding option performance at this stage. Instead, a summary of the model operation for each of the options is presented below. The descriptions relate to a 2043 model, with Option 1, Option 2 and the Luton Rising improvement at the Junction 10 roundabout all included.

Option 1: The upgraded northbound diverge ensures that all traffic can be accommodated at this approach to Junction 10. The queuing on the off-slip generally clears during each green phase at the signals. The queue on the off-slip never reaches back to the M1 northbound carriageway. In summary, the tests within the VISSIM model indicate that this option on the northbound slip road would provide a substantial improvement to network operation on top of the capacity improvement already proposed by Luton Rising.

Option 2: The upgrade to the southbound merge provides a slight improvement to the operation of this part of the network compared to the scenario with the Luton Rising proposal only, with the model locking up later, allowing a longer period of free flowing traffic on the SRN. The performance of the option is obscured by the technique used to validate the journey times on the M1. It should also be noted that the parallel merge introduces an element of route choice, however the model has not been converged or stabilised.

Figure 10 – Option 2: southbound merge on to M1

The first merge feeds traffic into the congested section of the M1, forming a queue on the on-slip. Depending on the assignment, this queue can extend back and gridlock the entire model. The new merge lane operates in a free flow manner as it brings traffic onto a part of the M1 that is uncongested in the model. The M1 operates in an unrealistic manner in this part of the VISSIM model. Whilst it would be possible to configure the assignment to have the merging traffic avoid the congested part of the M1 in the model, this is not considered to be a realistic simulation of the network. Therefore, the model has not been manipulated to improve the operation of the southbound diverge, instead Jacobs advise that a new modelling platform should be used at the earliest opportunity.

Whilst Option 2 appears to provide an improvement to network operation relative to the existing single parallel merge used in conjunction with the Luton Rising proposal, it is not possible to draw definitive conclusions due to the network coding and gridlocking of the VISSIM model.

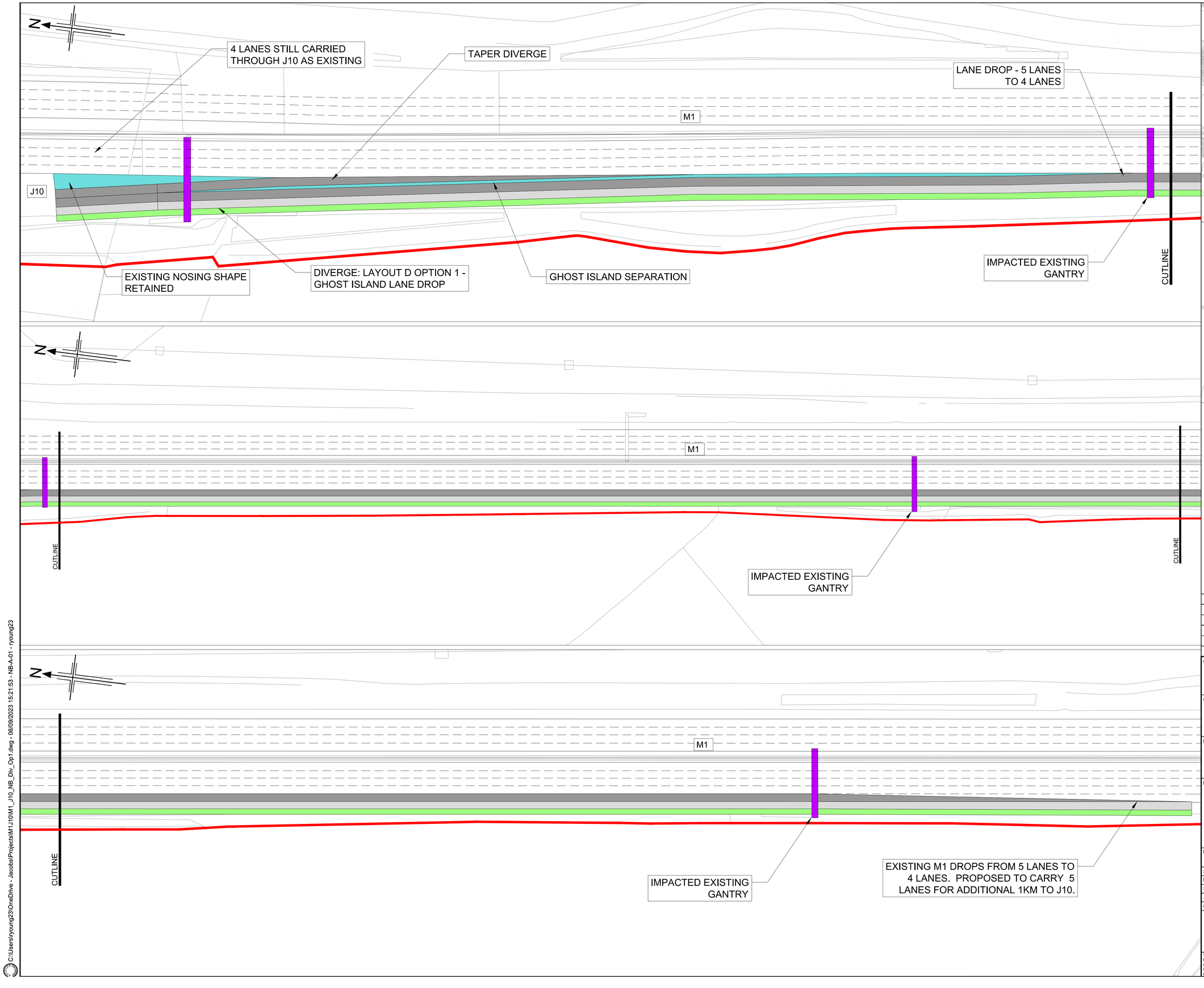
7. Summary

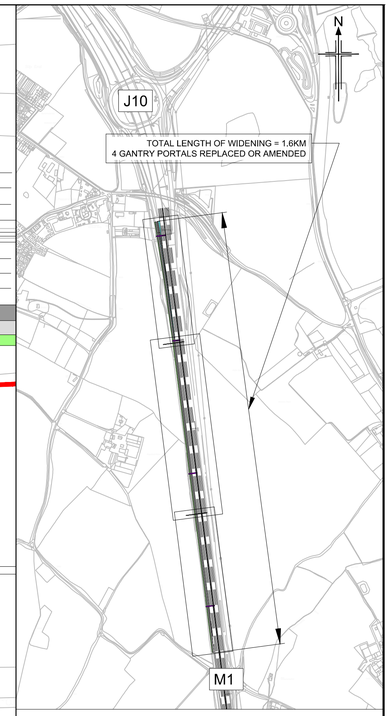
In summary, two options have been identified that would increase the capacity and journey reliability of M1 Junction 10 in 2043 and would enable with maximum airport growth with improved SRN performance.

The options would deliver capacity increases in the Luton Rising VISSIM model with higher capacity DMRB CD 122 merge/diverge layouts proposed than with the proposed Luton Rising layout.

Based on the VISSIM testing, it is clear that Option 1 could provide a substantial benefit to network operation by removing the lane drop on the northbound carriageway on the M1 and enabling Junction 10 to accommodate the released traffic and demand from the Luton Rising airport expansion.

Due to the limitations of the VISSIM model, it is difficult to draw definite conclusions on the performance of Option 2. However, a deliverable option to improve capacity at the Junction 10 southbound merge has been identified. This capacity upgrade leads to a slight improvement in network performance in the VISSIM model, with the model locking up later, allowing a longer period of free flowing traffic on the SRN. It is advised that the calibration of the M1 in this area of the model should be revisited so that the option can be fully assessed.





KEY

- RUNNING LANE
- HARD SHOULDER
- MARKED AREA (NOSING OR GHOST ISLAND)
- VERGE
- EXISTING GANTRY
- HIGHWAY BOUNDARY

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	06/09/23	FIRST ISSUE	RY	AA	AA	IA

Contractor:

Designer:
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Client
national highways

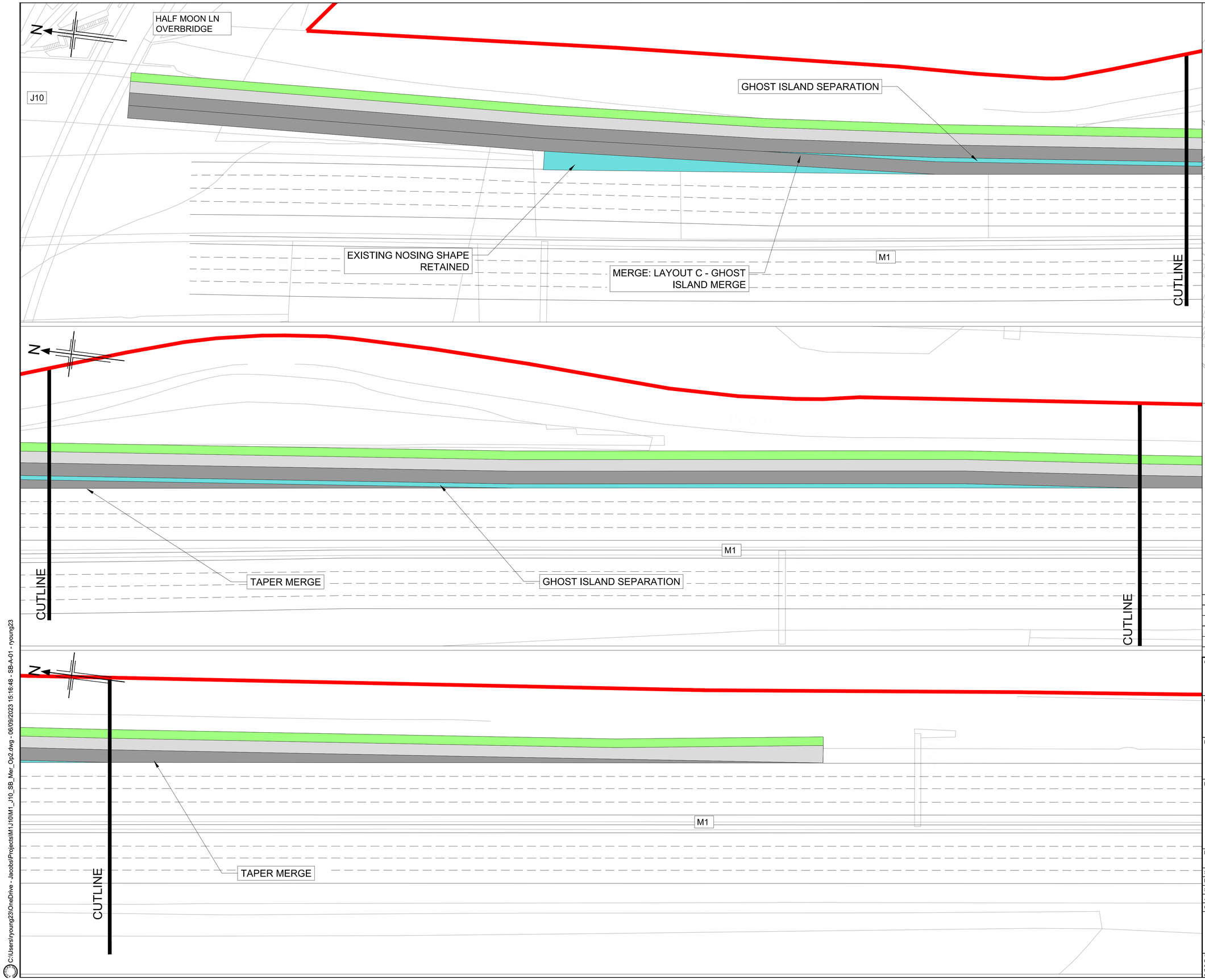
Project
M1 JUNCTION 10
OPTION ASSESSMENT

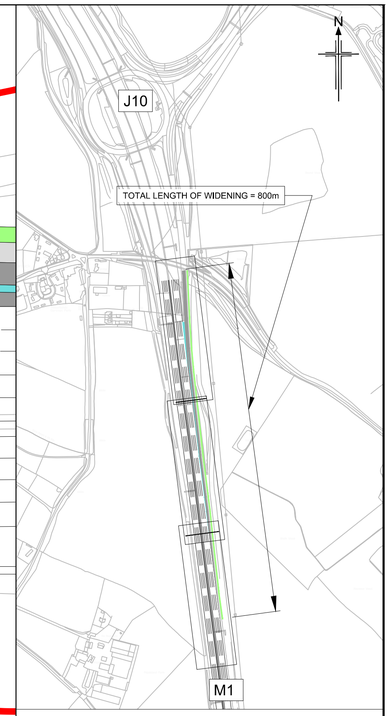
Drawing title
M1 J9 TO J10 NORTHBOUND & DIVERGE

Drawing status
WORK IN PROGRESS

State Code		
Project Stage		
Scale	NOT TO SCALE	DO NOT SCALE
Jacobs No.		Rev P01
Client no.		

Drawing Number: M1_J10_NB_Div_Op1





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Client
national highways

Project
M1 JUNCTION 10
OPTION ASSESSMENT

Drawing title
M1 J10 MERGE

Drawing status
FOR INFORMATION

State Code		
Project Stage		
Scale	NOT TO SCALE	DO NOT SCALE
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Client no.		

Drawing Number: M1_J10_SB_Mer_Op2