



# M6 Junction 33

## Engineering Options Report

Document Reference 14-RO-ENGOP-04

[www.lancashire.gov.uk](http://www.lancashire.gov.uk)



**Document Control**

**Project Title:** M6 J33

**Report Title:** Engineering Options Report

**Document Reference:** 14-RO-ENGOP-06

**Version No:** 6

	<b>Created By</b>	<b>Checked By</b>	<b>Date Comments provided</b>
<b>Version 1</b> <i>February 2020</i>	Victoria Walmsley	Alan Eastham	June 2020
<b>Version 2</b> <b>June 2020</b>	Victoria Walmsley	Niamh O'Sullivan	09/06/2020
<b>Version 3</b> <b>15<sup>th</sup> June 2020</b>	Victoria Walmsley	Alan Eastham	17/06/2020
<b>Version 4</b> <b>18<sup>th</sup> June 2020</b>	Victoria Walmsley	Alan Eastham	30/07/2020
<b>Version 5</b> <b>31<sup>st</sup> July 2020</b>	Victoria Walmsley	Alan Eastham/Niamh O'Sullivan	16/09/2020
<b>Version 6</b> <b>17 September 2020</b>	Victoria Walmsley		
<b>Document Status</b>	Final		

# 1 Introduction

## 1.1 Summary

- 1.1.1 South Lancaster Strategic Growth Area (Bailrigg Garden Village, Lancaster) is a proposed mixed-use development of 3,500 homes as well as opportunities for employment and economic benefits. The development of the South Lancaster Strategic Growth Area will depend upon providing new infrastructure including the re-configuration of Junction 33 (J33) of the M6.
- 1.1.2 This engineering options report provides the detailed route descriptions of the M6 Junction 33 and sets out the process of the identification of a preferred route option.
- 1.1.3 A total of six route corridors on the Eastern, Central and Western side of J33 have been identified and will be subject to more detailed assessment within this report.

## 1.2 Introduction to the Routes

- 1.2.1 In total, there are six route options to explore, with a preferred option identified and rationalised. The preferred route option is identified purely from a highway engineering perspective.

### **Eastern Route Options:**

- 1.2.2 For the Eastern routes options of this scheme these two options are known as, Eastern 1 and Eastern 2. These options involve following a route within a corridor 0.6km to 0.9km to the east of the M6 motorway. Both options involve the closure of the southbound off and the northbound on slipways at Junction 33 and replacements at Hazelrigg Lane. The land to the east of the M6, on the opposite valley side to Galgate, Ellel, Lancaster University, is

rural in nature characterised by undulating low hills, and shallow valleys set in an elevated location in relation to the M6 motorway.

1.2.3 The two options would finish at Hazelrigg Lane.

Figure 1: Eastern 1

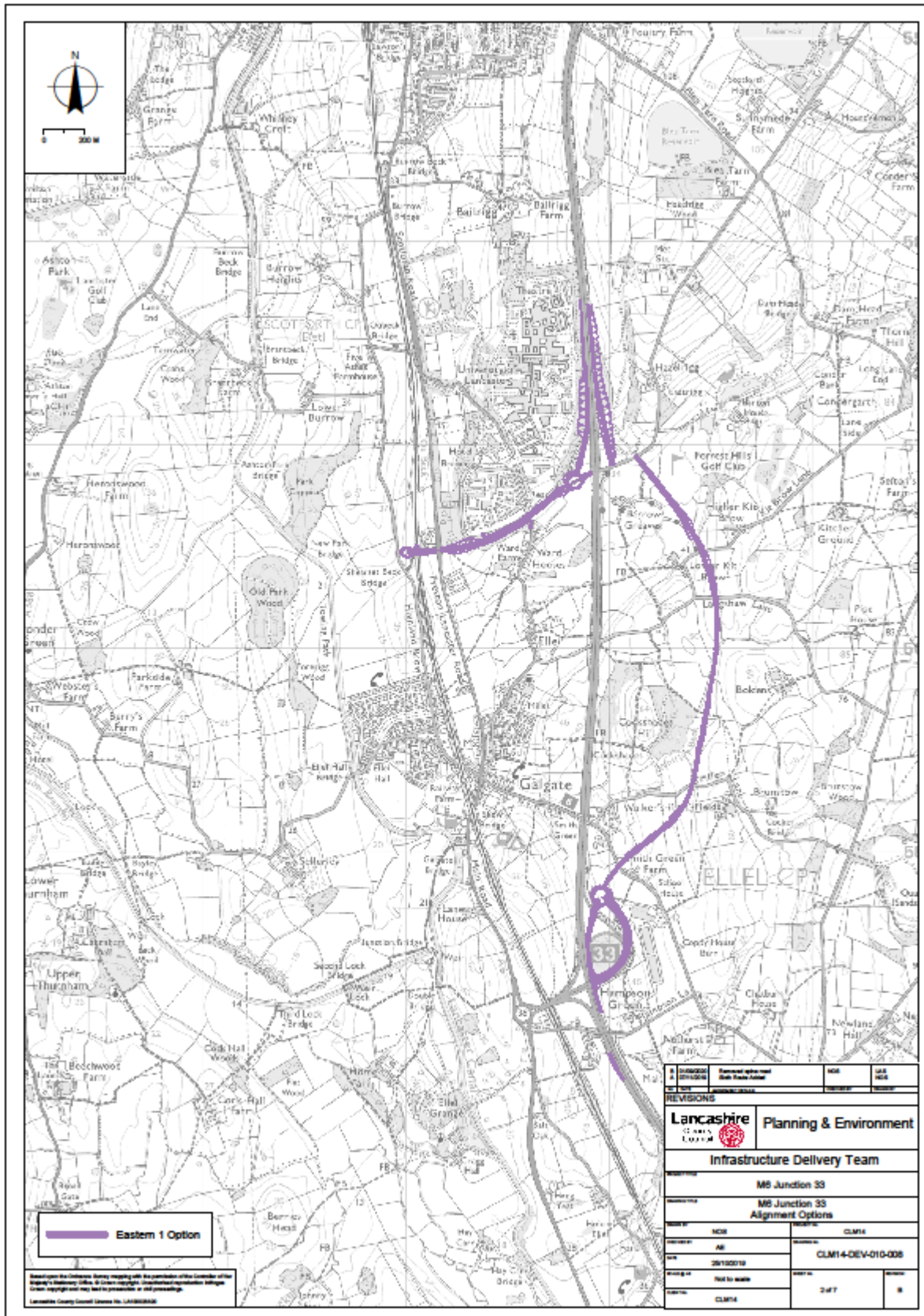
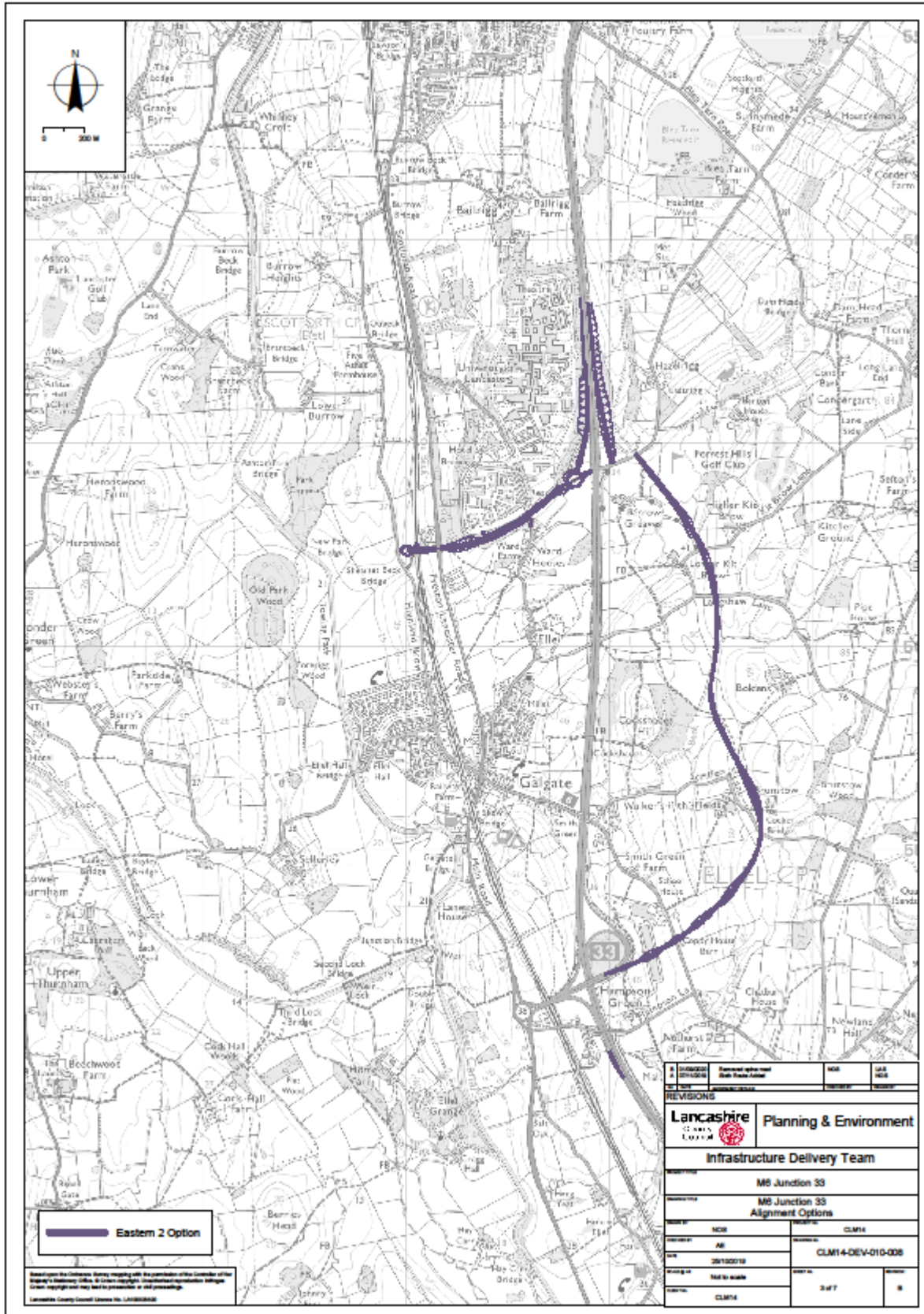


Figure 1: Eastern 2



## Central Route Options

1.2.4 For the Central routes options of this scheme these two options are known as, Central 1 and Central 2. The Central route options would provide a link road, which closely follows the western boundary of the M6 motorway between the motorway and the villages of Ellel and Galgate. The central road option would join with Hazelrigg Lane similar to the Eastern route options but on the Galgate/university side of the motorway. The route includes the improvement of Hazelrigg Lane to approach the Bailrigg Garden Village via the A6 junction/new bridge under the West Coast Main Line railway.

Figure 3: Central 1

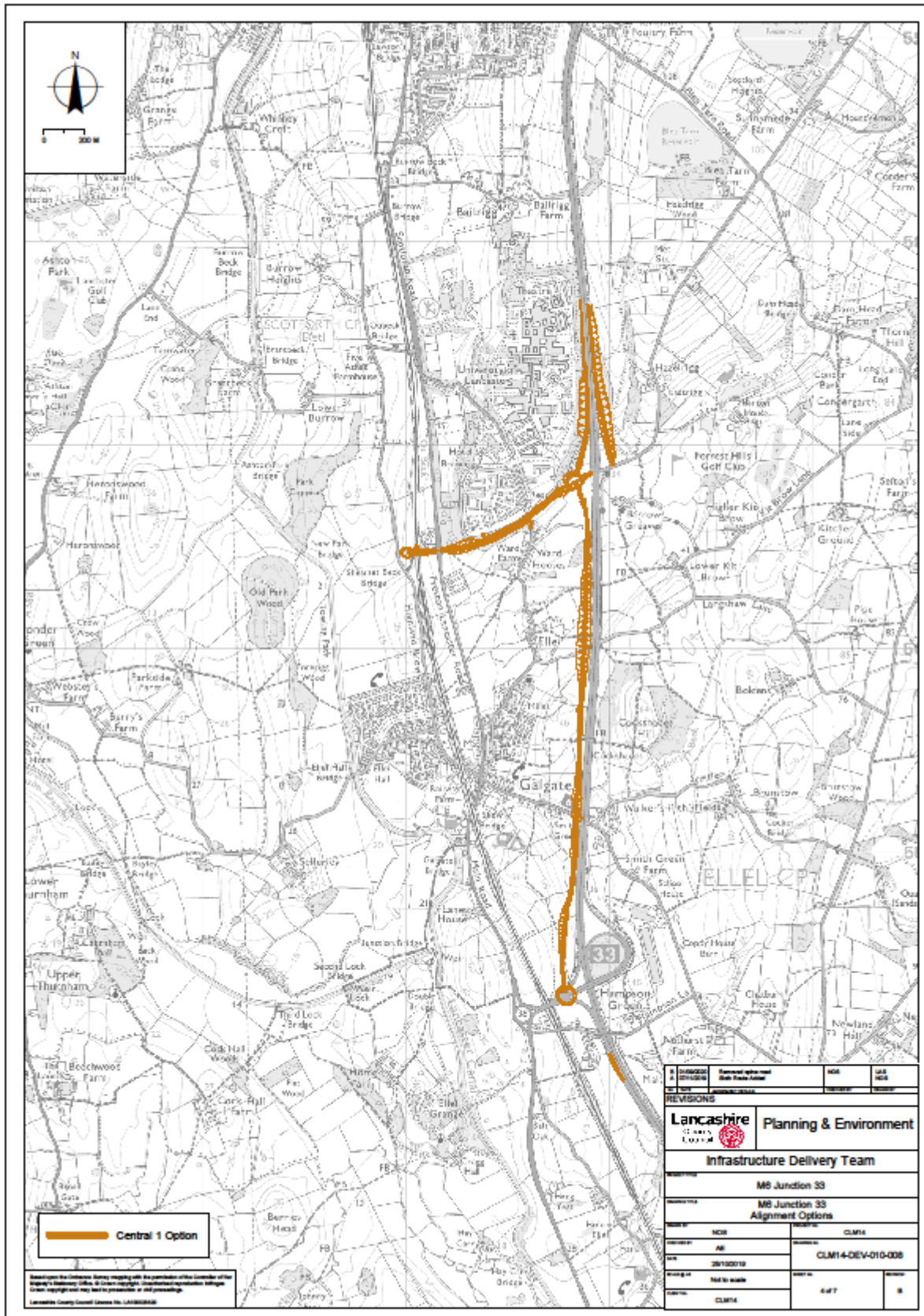
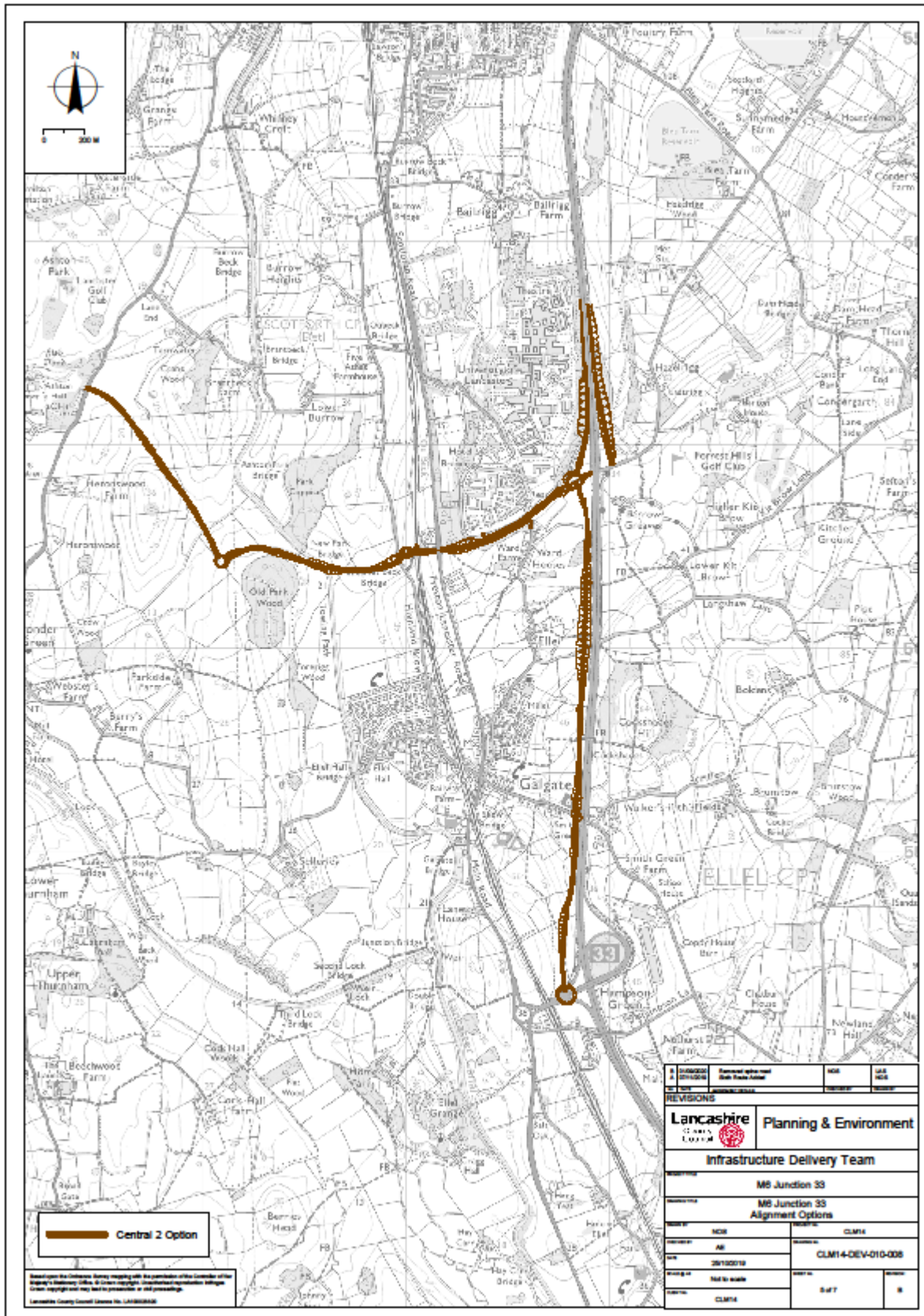




Figure 4: Central 2



### **Western Route Options:**

- 1.2.5 For the Western routes options of this scheme these two options are known as, Western 1 and Western 2. Some elements of both options follow similar route options. Neither Western route options propose changes to M6 J33.
- 1.2.6 The route option for Western 1 originates at Preston Lancaster Road/M6 roundabout where Junction 33 and the M6 meet. This route option then continues in a North West direction and would finish on the Bailrigg Garden Village.
- 1.2.7 The route option for Western Two originates further north than the route option for Western 1, in between 'Lane House' and 'Lane House Cottage' before moving in a North West direction and would finish at Hazelrigg Lane.

Figure 5: Western 1

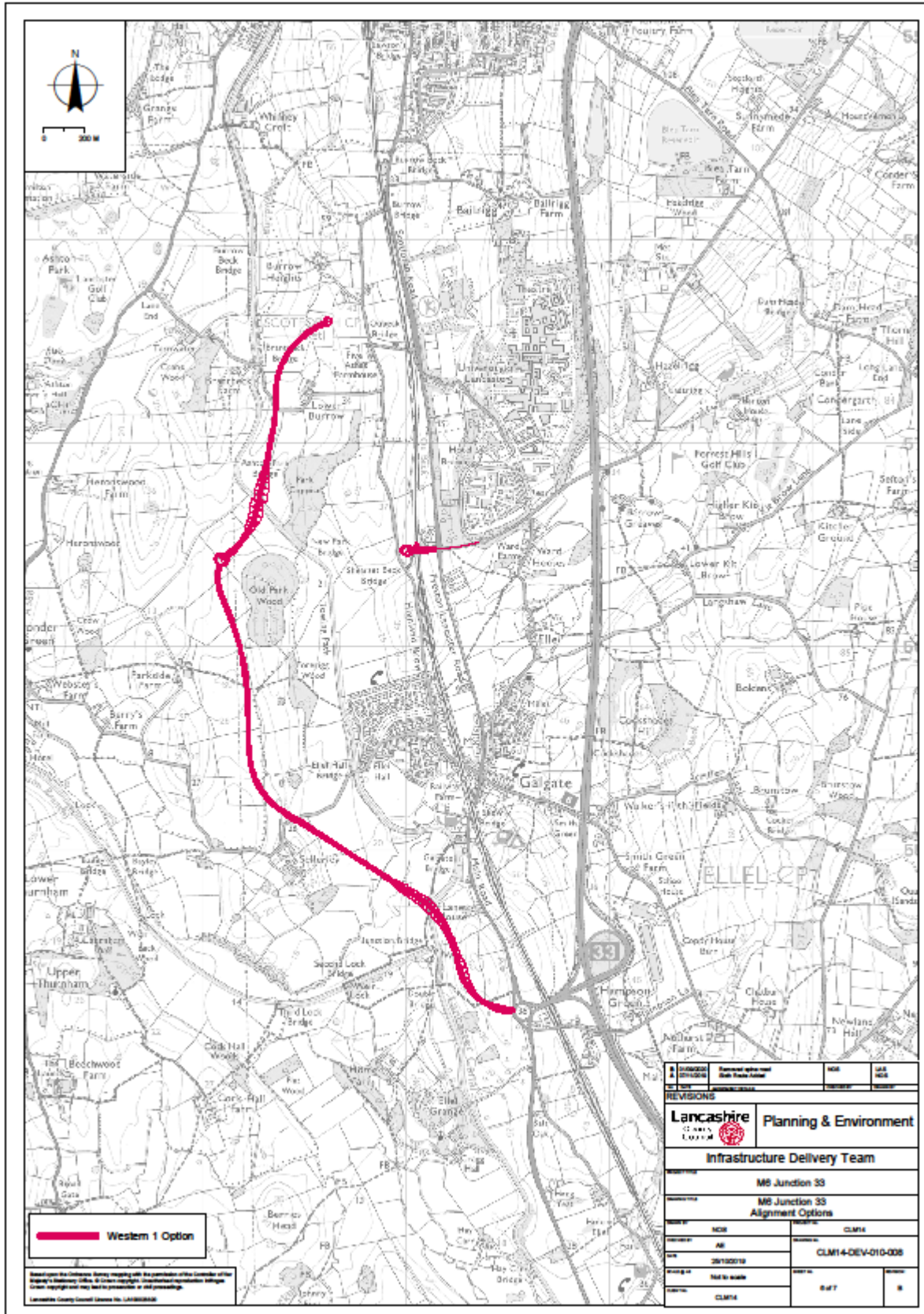
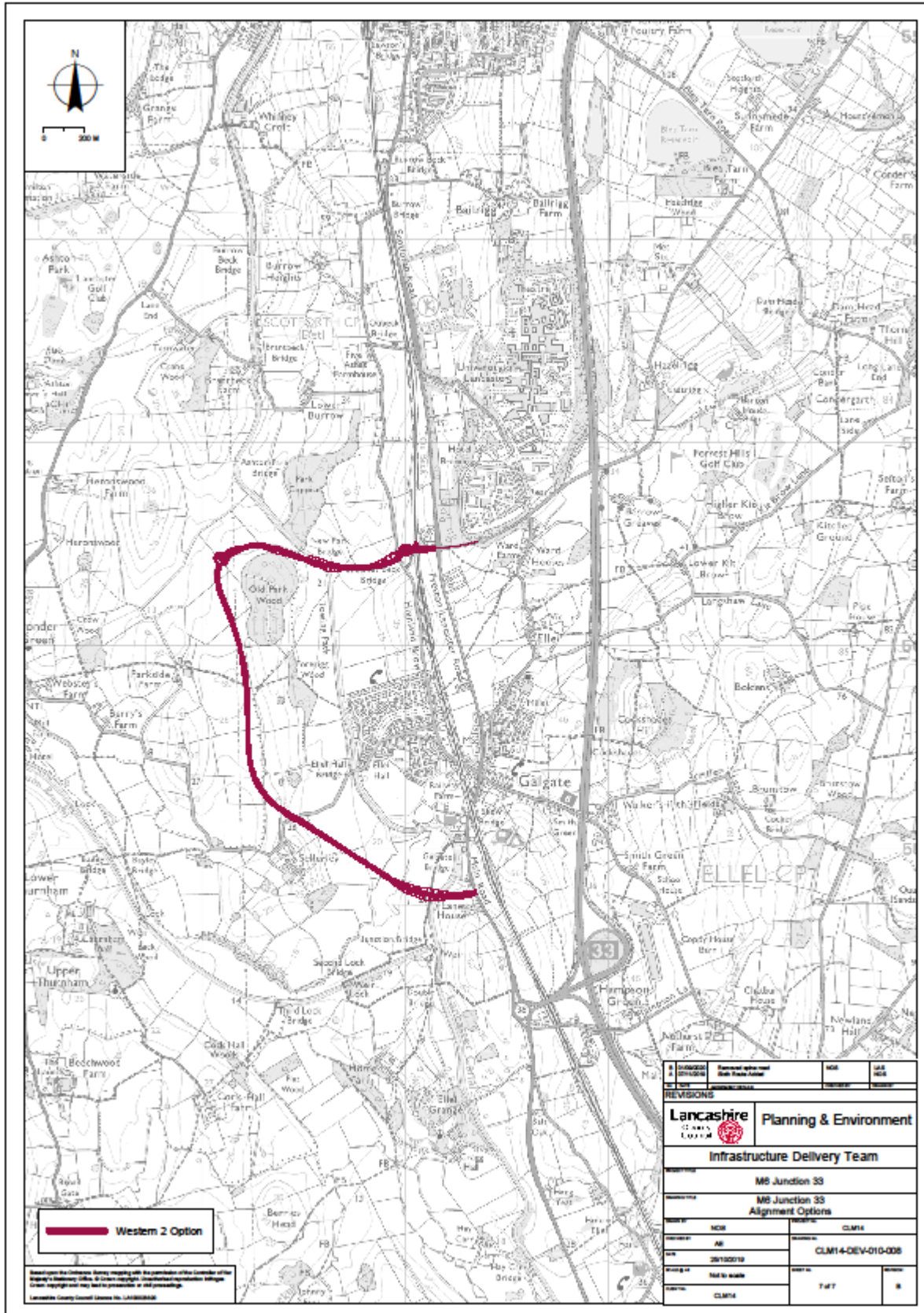


Figure 6: Western 2



## 2 Engineering Description of Route Options

### 2.1 Eastern Route Options

2.1.1 For the Eastern route options of this scheme, there are two potential options that will be considered within this report. These two route options are known as, 'Eastern 1' and 'Eastern 2'. Some elements of both options follow similar route options, nevertheless, the reasons for each option will be explored below. The speed limits for these routes would be between 40 and 60mph.

#### Eastern 1

2.1.2 Immediately after the existing J33, the route option curves to the north in order to avoid 'Hampson farm' until it meets a proposed new roundabout, which would enable a change in direction for the motorway slip road.

2.1.3 However, should this roundabout be moved further north by 100 metres, it may be possible to upgrade the slip road to full Design Manual for Roads and Bridges (DMRB) standards rather than just improving the junction. It is expected that the existing drainage system in this area can be used for outfalls, as all the proposed carriageway areas have already been attenuated.

2.1.4 It has been assumed that 'Stoney Lane' will be severed as the DMRB standards only allow a maximum gradient of 6% (please refer to appendix 1), however there isn't sufficient space at this gradient for the route option to bridge over Stoney Lane. The local dwellings on Stoney Lane would also make a bridge crossing over the new route option difficult to construct.

2.1.5 The route option would climb just west of 'Smith Green Farm' (Chainage 170) to just north of Sciffen Lane (Chainage 710), where the route option would start at a shallow gradient but it quickly reaches a maximum gradient of 5.1% before reducing to 4% as it reaches the summit.

- 2.1.6 To the west of 'Smith Green Farm' (Chainage 170) to just 150m west of 'Walker in the Field' (Chainage 500), the route option would pass over two areas of fill with a cutting in the centre. The excess could be used to provide fill for the areas either side of the route option. The whole length of this section to the summit just north of Scriffen Lane, 160m west of Harefield House (Chainage 710) will be drained back to the M6 and several attenuation areas will be required to hold back the flow in stages.
- 2.1.7 The route option would then pass between two hills, 'Little Cockshades Wood' to the west and 'Brunstow Wood' to the east. By following this route, the amount of excavation and filling is reduced and the visual impact on the surroundings should be reduced. There is a low topographical feature 300m west of 'Boldens Farm' (Chainage 1100) which is close to 'Whitley Beck' and this could be used for drainage once the flows have been reduced through attenuation.
- 2.1.8 The route option would continue from just south of Langshaw Lane (Chainage 1550) as it begins to fall into the valley, and the gradient reaches the DMRB maximum allowable of 6%. Due to the landscape topography and as the hillside would be far steeper than the 6% gradient allowed under DMRB regulations, extensive excavation would be required where the route option passes down the hillside between Langshaw Lane (Chainage 1550) and east of 'Lower Kit Brown Farm' (Chainage 1850).
- 2.1.9 Immediately after, the route option switches to high embankment, which gradually reduces as it reaches the valley floor at approximately 300m north west of 'Kit Cottage' where it meets the River Condor. This gradient would be unavoidable unless more extensive excavation is undertaken between Langshaw Lane (Chainage 1550) and east of 'Lower Kit Bank Farm' (Chainage 1850). The depth of cut in this area is already around 2.5m and due to the topography, the likelihood of reaching bedrock at this depth is high with the consequent increase in costs.

2.1.10 From there, the route option continues on an embankment over the valley floor, before finally reaching ground level as it ties into the existing Hazlerigg Lane. The river would provide an outlet for the drainage in this area.

## **Eastern 2**

2.1.11 This route option is provided as an alternative to Eastern 1, the northern section of Eastern 2 uses the same route as Eastern 1. The topography east of this route option does not provide a suitable economically or engineering route.

2.1.12 On leaving the existing motorway junction, the route option falls into a valley before then rising to the hill beyond. In the base of this valley is 'Hampson Farm', which the route option would pass straight through, thereby, removing the farm. This would keep the gradients on either side of this valley within acceptable DMRB limits, as an embankment of over 4m high is required.

2.1.13 The route option then climbs continuously at various grades up to 60m east of 'Walker in the Field' (Chainage 1320). There would be two areas on this climb of quite deep excavation and one of fill. The first area of excavation would be where the route option would cross Stoney Lane and would allow the route option to cross Stoney Lane by bridge. Consideration has been given to the nearby dwellings by allowing the existing Stoney Lane to be kept closer to its existing ground levels and therefore should not have any further considerable effect on the landscape.

2.1.14 The second area of excavation would be where the route option would pass between two hills. This area of excavation would prevent a steeper gradient if the area between the hills were further excavated. Nevertheless, these two areas will provide enough fill material for the area of embankment. This second area of excavation would be upwards of 4m deep, and it is likely that rock will be found. Furthermore, it would not be feasible to increase the height of the route option in this particular area in order to reduce the amount

of excavation required, as the gradients would be necessary for this route option.

- 2.1.15 Drainage in this area will be undertaken by allowing flows to the M6 junction. There is also a beck south of the pond at 'Walker in the Field' (Chainage 950) mark that could also be utilised, after flows are attenuated. The highest point of the route option is around 60m east of 'Walker in the Field' (Chainage 1320). There is also a large cutting in this area, this would be necessary as the route option passes through the side of a quite steep hill with the purpose of avoiding Footpath 29 which links two farms – 'Walker in the Field' and 'Boldens Farm'. As the road falls in both directions and the proposed drainage could divert to either direction, the drainage would go through attenuation and then to the nearby streams.
- 2.1.16 The route option would continue from just south of Langshaw Lane (Chainage 1550) as it begins to fall into the valley, and the gradient reaches the DMRB maximum allowable of 6%. Due to the landscape topography and as the hillside would be far steeper than the 6% gradient allowed under DMRB regulations, extensive excavation would be required where the route option passes down the hillside between Langshaw Lane (Chainage 1550) and east of 'Lower Kit Brown Farm' (Chainage 1850).
- 2.1.17 Immediately after, the route option switches to high embankment, which gradually reduces as it reaches the valley floor at approximately 300m north west of 'Kit Cottage' where it meets the River Condor. This gradient would be unavoidable unless more extensive excavation is undertaken between Langshaw Lane (Chainage 1550) and east of 'Lower Kit Bank Farm' (Chainage 1850). The depth of cut in this area is already around 2.5m and due to the topography, the likelihood of reaching bedrock at this depth is high with the consequent increase in costs.
- 2.1.18 From there, the route option continues on an embankment over the valley floor, before finally reaching ground level as it ties into the existing Hazlerigg Lane. The river would provide an outlet for the drainage in this area.



2.1.19 Whilst Eastern 2 route option is longer than Eastern 1, this option would produce a significant amount of fill that could be used on large embankments towards the northern part both routes where the route option would pass over the River Condor Valley. From the summit, where the route option falls to connect with northern section common to both routes, there is also potential to drain the road (after attenuation) into the adjacent 'Whitley Beck'.

## 2.2 Central

2.2.1 The Central route options follow the same route until they reach Hazelrigg Lane. Central 2 has an additional spur to A588. There would be two design speeds for these two route options – between 40 and 60mph.

### Central 1

2.2.2 The route option would commence just east of the existing Preston Lancaster Road roundabout with a relatively large (90m inscribed circle diameter) roundabout. The roundabout would sit on the original dual carriageway as the existing carriageway was not designed with a junction in mind, therefore, the large diameter of the proposed roundabout will allow deflection to be made on the approaches.

2.2.3 On leaving the roundabout, the route option travels down the side of a hill to the valley floor at a constant 2% gradient. This would involve making a cutting into the side of the hill at maximum of 4m deep, which could potentially hit bedrock. Excavating bedrock would prove expensive; however, it would produce good quality material for other parts of this route option where the road requires an embankment. Additionally, it also allows all drainage to flow down this slope. If the hill profile was followed closer then drainage would also flow back towards the existing junction and the gradients would be much steeper, as the route option is very straight this could encourage excessive vehicle speeds and force additional measures to reduce this, which is not good practice for new road schemes.

- 2.2.4 370m west from 'Lily Croft' (Chainage 600) is a low point and to the north of this is the start of a small stream, which connects to Whitley Beck and could be used for the attenuated drainage however, it is likely that this would require some improvement works before it could be utilised.
- 2.2.5 The route option rises slightly to provide clearance to cross Stoney Lane by means of a bridge, allowing unimpeded traffic flows. The topography of the land rises after this where the route option would be at or around ground level. Footpath 31 crosses over the adjacent M6 at this point and the feasibility of extending this bridge over the new road will be considered further, should this option be taken forward.
- 2.2.6 The existing ground level peaks 380m east of 'Galgate Mill' (Chainage 1380) and the route option would then cut through this peak to provide more gentle gradients. The existing ground falls away sharply going north before reaching a valley floor of the River Condor. The route option would not reduce in height, as the height would need to be maintained in order to cross Langshaw Lane and then the River Condor. It is likely that in some parts of the route option, the height of the embankments would be over 8m. Considerable fill would be required for this embankment but this will be available from the proposed north facing slip roads for Junction 33.
- 2.2.7 The route option then rises slightly to tie into Hazelrigg Lane. Drainage along this length will be into the River Condor and attenuation ponds will be required to slow the flow into the river.
- 2.2.8 One further point regarding this option, the existing M6 sits alongside this route option and gives evidence that the underlying ground conditions are suitable for a road to be constructed in this area.

## Central 2

- 2.2.9 'Central 2' would follow the same route option as 'Central 1' – however there would be an additional stub known as the 'A588 link'.

- 2.2.10 This stub would be 1000m in length and would connect to the existing A588 of 'Ashton Road'. It would not follow the initial route option corridor as this route passes directly over a small hill, the 10m difference in elevation is not difficult to overcome but the two options are not as promising as the alternative.
- 2.2.11 The route could have two options, where it would either pass over the hill however this would produce a relatively steep slope to the junction on the A588 or the other option would be to cut through the hill, however the depth of bedrock is unknown which could greatly increase the cost of the build.
- 2.2.12 The option chosen is to move the route option north and pass between two adjacent hills of 'Crane Wood' and 'Heronswood'. The route option would be kept off the low point between the hills, and would curve around the slope of the southern hill of 'Heronswood'. This would keep the road out of the potential wetter areas in the valley floor and would provide some additional fill material for embankments elsewhere in the scheme.
- 2.2.13 The route option would be slightly higher on the slope than preferred (as the road needs to be higher to avoid the cutting becoming wider) as to avoid a stone barn to the north of the route option. The low point would be around some 300m from Ashton lane (Chainage 3080) where the route option passes over a small stream. This stream could be used to drain the route option with appropriate attenuation. There is a further low point some 100m from Ashton Lane (Chainage 3650) but the drain could run north from this along the route option to the existing A588.

## **2.3 Western Route Options**

- 2.3.1 For the Western route options of this scheme, there are two potential options that will be considered within this report. These two options are known as, 'Western 1' and 'Western 2'. The two options follow the similar route up to north west of 'Old Park Wood' (Chainage 2880) where a roundabout would allow the route option to branch off in alternative directions, the engineering

reasons for each option will be explored below. There would be three design speeds for the two route options (30, 40 and 60mph).

## Western 1

- 2.3.2 The route option for Western 1 originates at the Preston Lancaster Road/M6 roundabout where Junction 33 and the M6 meet. This route option then continues in a north west direction. The roundabout would require some modification to ensure the correct deflection angles are feasible. The inscribed circle diameter (ICD) at present is sufficient, but as the 'circle' is flat on the A6 side of this route option, it is likely that the roundabout will need to be modified to appear more 'round'.
- 2.3.3 The route option would continue to swing around a low hill – to the east of Lancaster Canal, in order to prevent the need for a 10m deep cutting. At this point, it is unknown how deep the existing bedrock is and any excavation could prove expensive. The route option would still require the cutting through part of the small hill, however the excess excavated material could be used to form the embankments leading up to the proposed Lancaster Canal bridge. This route option would also avoid the nearby 'Quarry Wood' – which is a designated Biological Heritage Site.
- 2.3.4 From just south east of 'Lodge Hill Cottage' (Chainage 480), the route option continues around the hill, at a reasonable distance from the canal to try to minimise any potential impacts. This should also allow for a good slope from the hill and over the canal, which in turn, should allow the drainage system to pass over the proposed Lancaster Canal Bridge. The gradient of the route option here is such that the drainage pipes can follow the necessary gradient and be placed at the minimum cover depth. This allows the drainage pipes to cross the bridge without the need for several drainage attenuation points. The proposed canal bridge is set north of the existing canal spur to Glasson Dock to minimise the potential impact on this area.

- 2.3.5 Just 320m west of 'The Bungalow - Galgate Marina', the route option gradually falls to a low point at the River Condor. Due to this being a natural low topographical point as a result of the River Condors Valley, it would be the most appropriate location for the drainage outlet. However, there is likely to be some significant work to construct drainage attenuation as the River Condor is prone to flooding.
- 2.3.6 300m from Galgate Cricket ground at the River Condor, the route option proceeds along the river valley floor and passes North of 'Sellerley Farm' – from this point until the northern roundabout. The route option is angled to pass between one of 'Sellerley Farms' barns and a pond (just 160m north of 'Sellerley Farm'), which should reduce the gradient as the route option rises from the valley floor travelling up the valley slope at the same angle.
- 2.3.7 The route option also passes over a low point between two hills reducing the height that needs to be achieved before moving northwards. Unfortunately, there does not appear to be any natural drainage in this area and further investigation will be required to determine if a natural ground soakaway can be utilised, otherwise an approximate 10m deep trench to the south along the route option would be required.
- 2.3.8 The route option curves to the north to pass along a further valley, this is to reduce the impact of the route option being on the top of the hill and is more cost effective than building on the valley side. Careful consideration will be required for any streams, which are within the same location.
- 2.3.9 The route option would then curve around 'Old Park Wood' and would run parallel to the high voltage electricity pylons, passing beneath the cables 60m from 'Old Park Wood' (Chainage 2520), and would be slightly below ground level to provide required clearance of the cables.
- 2.3.10 A roundabout is proposed at Chainage 2880. This roundabout would be situated to the north west of Old Park Wood – a Biological Heritage Site. At

this point, the route options split with Western 1 travelling in a northerly direction and Western 2 travelling in an easterly direction.

2.3.11 From the roundabout, the Western 1 route option would travel in a northerly direction before sweeping to the east and connecting to the Bailrigg Garden Village via a roundabout.

2.3.12 The route option passes over Lancaster Canal just west of 'Park Coppice' (Chainage 340) and would be situated on a skewed bridge. The route option would travel between two high points and would be a dominating feature in the landscape, therefore a multi span bridge may be more appropriate than an embankment.

2.3.13 The route option swings slightly west to pass by 'Lower Barrow' farm buildings and then curves east to connect with Bailrigg Garden Village. The road is kept close to grade for much of its length except where crossing Lancaster Canal.

2.3.14 A small track would cross the route option between 'Burrow Farm' and 'Burrow Heights Bungalow (Chainage 820) and therefore it may be of benefit to lower the route option in order to allow this minor road to cross over without the need for a large bridge. There will also be the opportunity for any excess fill to be used on embankments.

## **Western 2**

2.3.15 The route option for Western 2 is an alternative to the first 900m of the west alignments that would commence 60m north of 'Lane House' and meet 'West Common' - 280m south of Galgate Cricket ground (Chainage 900). This would require works to widen the A6 from the J33 roundabout to the start of this option, it also goes across some of the moorings for Galgate Marina.

2.3.16 From just south east of 'Lodge Hill Cottage' (Chainage 480), the route option continues around the hill, at a reasonable distance from the canal to try to minimise any potential impacts. This should also allow for a good slope from

the hill and over the canal, which in turn, should allow the drainage system to pass over the proposed Lancaster Canal Bridge. The gradient of the route option here is such that the drainage pipes can follow the necessary gradient and be placed at the minimum cover depth. This allows the drainage pipes to cross the bridge without the need for several drainage attenuation points. The canal bridge is set north of the existing canal spur to Glasson Dock to minimise the potential impact on this area.

- 2.3.17 Just 320m west of 'The Bungalow - Galgate Marina', the route option gradually falls to a low point at the River Condor. Due to this being a natural low topographical point as a result of the River Condors Valley, it would be the most appropriate location for the drainage outlet. However, there is likely to be some significant work to construct drainage attenuation as the River Condor is prone to flooding.
- 2.3.18 300m from Galgate Cricket ground at the River Condor, the route option proceeds along the river valley floor and passes north of 'Sellerley Farm' – from this point until the northern roundabout. The route option is angled to pass between one of 'Sellerley Farms' barns and a pond (just 160m north of 'Sellerley Farm'), which should reduce the gradient as the route option rises from the valley floor travelling up the valley slope at the same angle.
- 2.3.19 The route option also passes over a low point between two hills reducing the height that needs to be achieved before moving northwards. Unfortunately, there does not appear to be any natural drainage in this area and further investigation will be required to determine if a natural ground soakaway can be utilised, otherwise an approximate 10m deep trench to the south along the route option would be required.
- 2.3.20 The route option curves to the north to pass along a further valley, this is to reduce the impact of the route option being on the top of the hill and is more cost effective than building on the valley side. Careful consideration will be required for any streams, which are within the same location.

- 2.3.21 The route option would then curve around 'Old Park Wood' and would run parallel to the high voltage electricity pylons, passing beneath the cables 60m from 'Old Park Wood' (Chainage 2520), and would be slightly below ground level to provide required clearance of the cables.
- 2.3.22 A roundabout is proposed at Chainage 2880. This roundabout would be situated to the north west of Old Park Wood – a Biological Heritage Site. At this point the route option options split with Western 1 travelling in a northerly direction and Western 2 travelling in easterly direction.
- 2.3.23 Approaching Lancaster Canal, there is an existing stone bridge to the north of the route option, known as 'New Park Bridge (No89)' which is grade 2 listed.
- 2.3.24 Once the route option crosses the canal, it would travel along the southern edge of a hill before a gradient down to the roundabout at the Bailrigg Garden Village. The route option would require extensive earthworks around the hill with a cutting slope approximately 25m wide and at depths up to 5.3m deep. This will generate large volumes of fill and it is proposed that the material could be used as fill elsewhere on the route option. There is a possibility that bedrock will be encountered at this depth but in order to tie into the link under the railway this amount of excavation is unavoidable.



## 2.4 Junction 33 Slip Roads

- 2.4.1 The route option of the Junction 33 slip roads are fixed by the rules in the Design Manual for Roads and Bridges (DMRB)<sup>1</sup> on 'slip road design'.
- 2.4.2 The location of the slip roads on Hazelrigg Lane presents several issues. The M6 motorway rises as it travels north. Motorway slip roads can reach a maximum allowable gradient of 6% which would force the slip road to be quite long (approximately 874m in total) in order to reach the height of the motorway from Hazelrigg Lane. The other concern would be the ground levels moving away from the motorway. The western side/northbound entry slip road is between the motorway and Lancaster University. The University is built on much higher ground than the motorway and extensive excavation will be required for the slip road and the height (11.5m high and 33.7m wide) of the cutting slopes created will likely need engineering to keep them stable. The southbound off slip road to the east of the motorway would cut into the ground quite significantly although not to the same depth (of 11m) as the western side slip road. The material excavated will require testing (ground contamination) but it is hoped this could be used for the large embankments required for the Central route options (refer to section 2.2).

## 2.5 Hazelrigg Lane

- 2.5.1 Hazelrigg Lane is an existing single carriageway, which was upgraded within the last 15 years as part of the extensions to Lancaster University. The existing road currently has a speed limit of 30mph and consequently has been designed to this limit. If the improved road had an increased speed limit it would not be an issue for the horizontal design (and therefore no changes required), however the vertical design would require extensive modifications and be difficult to achieve in this location. For this reason, the speed limit on this length has been reduced to 40mph.

---

<sup>1</sup> DMRB CD122 rev1 Geometric Resign of Grade Separated Junctions  
<https://www.standardsforhighways.co.uk/dmrbs/search/871d6bff-0126-41b7-bf34-a05c7e74a52f>

2.5.2 The route option at this speed essentially follows the existing vertical design of Hazelrigg Lane. There would be one area of cutting as the route option approaches the A6, but excluding that proposed change, there would be very few earthworks required. Drainage would be achieved by making the existing attenuation pond at the junction of Hazelrigg Lane and the A6 larger to accommodate the increased area of runoff.

## 2.6 Underpass at West Coast Main Line

2.6.1 The options for gaining access from the A6 corridor past the West Coast Main Line and through to the garden village area beyond would be relatively limited.

2.6.2 The only option, which would be feasible from an engineering point of view, would be at the end of Hazelrigg Lane, where the rail line is above the level of the existing surrounding land. There is presently an underbridge here for use by the adjacent landowners. This underbridge is not large enough in either width or headroom to use, however it could be used as a cycleway or combined cycleway/footway. This would allow the proposed underbridge for the carriageway to be reduced in width, which will reduce the depth required for the supporting beams for the bridge deck.

2.6.3 To provide a headroom of 5.3m for the underbridge, the route option would be required to pass below the railway in a cutting below the existing ground level. This cutting depth would be approximately 1.5m below ground level and would be subject to some alteration dependent on the requirements of Network Rail. This reduced level will be approximately 4.5m below the existing A6 and 2.4m below the level of the nearby Beck.

2.6.4 Consequently, the drainage of this area would need to be by pump. This area is critical to Bailrigg Garden Village. It is suggested that when the detailed design takes place, a specialist drainage pump manufacturer would need to be used early in the design process in order to advise on the type of pump, size of underground tank and adjacent attenuation pond, the length of

rising main which could be used, maintenance regime of the pump system and whether an emergency power source would be provided for use should the electricity supply to the pumps fail.

## 3 Summary

### 3.1 Preferred Route

- 3.1.1 Changes in speed can cause confusion for drivers, the Central route options uses only two design speeds (40 and 60mph) and the changes in this are at junctions. The Western routes options have three design speeds (30, 40 and 60mp) whilst the Eastern route options has two design speeds (40 and 60pmh) but combined with other factors (topography, landscape and cost for example) this route would not be taken forward.
- 3.1.2 'Central 1' is the shortest route by over 500m which is a considerable saving in length and would translate to a considerable cost saving.
- 3.1.3 This route would have the lowest gradients at 3% and this gradient is only applicable for a short length, in contrast, the Eastern route options gradients reach the maximum permissible under DMRB of 6% and there is the possibility that HGVs would be dissuaded from using the Eastern route options and continue through Galgate.
- 3.1.4 As the geometry of the Central route options is relatively straight, it would make it the most attractive in terms of vehicle use (particularly HGVs), however there is a potential drawback to this in that higher speeds may be encouraged (however, this could be assessed during the detailed design stage).
- 3.1.5 There are fewer large structures with the Central 1 route option in comparison to the Western route options. There would be no canal crossings for Central 1 whereas some canal crossings on Western route options in particular the one on the west is very close to the Glasson Dock spur and would likely require a much higher quality of appearance and consequent expense.

- 3.1.6 Whilst the Eastern route options potentially have fewer larger structures there are numerous farm accesses, which are crossed, which will require small crossing bridges or underpasses, also due the depth of cuttings on this route, it may require retaining walls.
- 3.1.7 The drainage on the Central 1 route option would be superior in contrast to the Eastern and Western route options as there are convenient watercourses along the route, which could be used after drainage flows are attenuated. All other routes have at least one section where the drainage solution could prove problematic. Central 1 route option would cross the River Condor, however much of the route option would be constructed along the flood plain and early engagement with the Environment Agency would be required to prevent any flooding issues.
- 3.1.8 The Central 1 route option would mainly be constructed on embankment, therefore site investigation would be required to determine the bearing capacity of the ground to allow settlement to be established but there would be extensive excavation of material to construct the north facing slip roads for J33. It is intended for this material to be treated and used as fill for the Central route option embankments. This could generate a considerable cost saving as the excavated material is not required in the same quantities on the other options.
- 3.1.9 Table 1 below demonstrates the issues and constraints for the route options. The 'green' options represent an overall beneficial feature, whereas the red represents an overall detrimental feature. The orange represents a neutral or small detrimental feature.

**Table 1: Comparison of Route Options**

	Western 1	Western 2	Central 1	Central 2	Eastern 1	Eastern 2
Design Speed	30, 40, 60mph	30, 40, 60mph	40, 60mph	40, 60mph	40, 60 mph	40, 60mph
Length	Between 4230 and 6521m (to the slip roads)	Between 3487 and 4572m (to the slip roads)	Between 2529m and 3450m (to the slip roads)	Between 2529m and 4410m (to the slip roads)	Between 3193m and 4220m (to the slip roads)	Between 3335m and 4256m (to the slip roads)
Max gradient	4.5%	4.5%	3%	4%	6%	6%
Lancaster Canal Crossing	Yes	Yes	No	Yes	No	No
WCML Crossing	Yes	Yes	Yes	Yes	Yes	Yes
Crossing a river	Yes	Yes	Yes	yes	Yes	Yes
Geometry	Several tight radii bends including 2 on structures, several large cut and fill areas.	Several tight radii bends including 2 on structures, several large cut and fill areas.	Almost straight, short lengths of cut and long lengths of fill	Straight over half the length, several tight radii and an area of cutting over the other half	Several tight radii bends, several large cut and fill areas including two at very large	Several tight radii bends, several large cut and fill areas including two at very large

	Western 1	Western 2	Central 1	Central 2	Eastern 1	Eastern 2
Design Speed	30, 40, 60mph	30, 40, 60mph	40, 60mph	40, 60mph	40, 60 mph	40, 60mph
Number of large structures	5, includes 2 over canal, one over a river and one overbridge for farm access	4, includes 2 over canal and one over a river	4 including one over river, there may be one pedestrian overbridge depending on PROW requirements	5 including one over river, there may be one pedestrian overbridge depending on PROW requirements	2 includes one over river, there are at least 4 farm accesses that may require overbridges	3 includes one over river, there are at least 4 farm accesses that may require overbridges
Drainage Difficulty 1-10	8 There is one area that does not seem to have natural drainage and may require a deep (>10m) pipe to drain.	8 There is one area that does not seem to have natural drainage and may require a deep (>10m) pipe to drain.	4 Several streams and a river all at convenient locations, but most of route on flood plain	6 Several streams and a river all at convenient locations on 50%, more difficult over the other 50%	6 One area near the start of route that may present difficulties	8 Near the start of route will need investigation to determine if Stoney Lane has a system that could be used.

# Appendix 1

## Extract from DMRB CD109 Highway Link Design

### Vertical alignment

#### Gradients

Longitudinal gradients of links shall not exceed the permitted relaxation values given in Table 5.1.

**Table 5.1 Desirable maximum and permitted relaxations to gradients**

	<b>Desirable maximum</b>	<b>Permitted relaxations</b>
Motorways	3%	4%
All-purpose dual carriageways	4%	8%
All-purpose single carriageways	6%	8%

Full document available at: <https://www.standardsforhighways.co.uk/dmr/search/c27c55b7-2dfc-4597-923a-4d1b4bd6c9fa>