

A47/A11 THICKTHORN JUNCTION

Side Road Strategy Options Report

PCF STAGE 3

HE551492-GTY-GEN-000-RP-CH-0001

May 2019

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1. Background

1.1 General

1.1.1 Highways England is the government owned company charged with operating, maintaining and improving England's motorways and major A roads. Formerly the Highways Agency, Highways England became a government owned company in 2015.

1.1.2 The Road Investment Strategy (RIS) sets out Highways England long-term programme for our motorways and major roads with the stable funding needed to plan-ahead effectively.

1.1.3 The RIS comprises:

- a long-term vision for the strategic road network (SRN), outlining how Highways England will create smooth, smart and sustainable roads
- a multi-year investment plan that will be used to improve the network and create better roads for users
- high-level objectives for the first roads period 2015 to 2020

1.1.4 Over the next 5 years the first RIS will:

- see £15.2 billion invested in over 100 major schemes to enhance, renew and improve the network
- help prevent over 2,500 deaths or serious injuries on the network
- build over 1,300 additional lane miles
- improve 200 sections of the network for cyclists
- benefit up to 250,000 people by reducing the noise impact of the SRN

1.1.5 The A47 trunk road forms part of the strategic road network and provides for a variety of local, medium and long-distance trips between the A1 and the east coast. The corridor connects the cities of Norwich and Peterborough, the towns of Wisbech, Kings Lynn, Dereham, Great Yarmouth and Lowestoft and a succession of villages in what is largely a rural area.

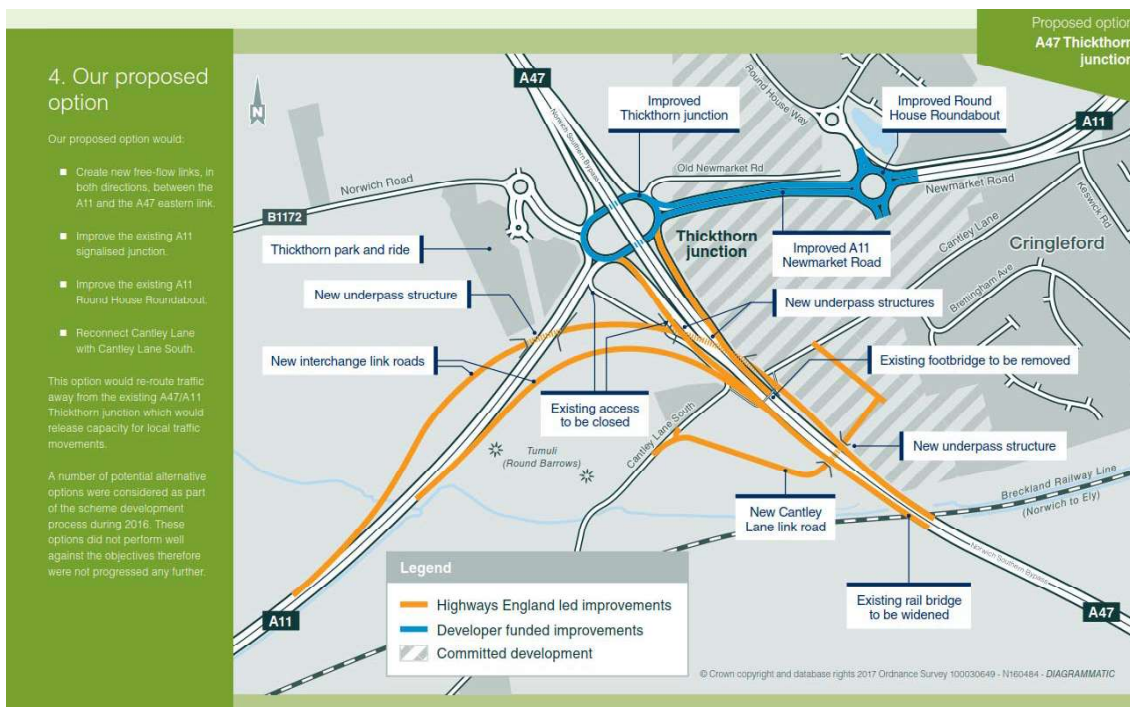
1.1.6 The A47 runs for 115 miles from the A1 west of Peterborough to the east coast ports of Great Yarmouth and Lowestoft.

-
- 1.1.7 Over half of the road is single carriageway.
- 1.1.8 The cities of Peterborough and Norwich attract additional traffic, particularly during the morning and evening peak periods.
- 1.1.9 There has been rapid growth over the past decade, especially in Peterborough where the population increased by 16% between 2001 and 2011.
- 1.1.10 Further planned growth, including the new City Deal for Norwich, will mean that over 50,000 new jobs and 100,000 new homes are planned for the area over the next 15 years.
- 1.1.11 The A47 has several congestion hotspots around Norwich, Peterborough and Great Yarmouth. There is also significant growth predicted in the area which the proposed improvements will help to support.
- 1.1.12 Highways England is proposing 6 locations along the route for improvements. These are:
- A47 Wansford to Sutton
 - A47/A141 Guyhirn Junction
 - A47 North Tuddenham to Easton
 - A47 Blofield to North Burlingham
 - A47/A11 Thickthorn Junction
 - A47/A12 Junction

1.2 March 2017 Public Consultation Comments on Cantley Lane

- 1.1.13 During PCF Stage 1 and 2, Highways England undertook Public Consultation in March 2017 on Thickthorn Interchange Improvements to inform the public of the proposed option and gather feedback prior to the Preferred Route Announcement.
- 1.1.14 As part of the supporting information for the consultation a Public Consultation Report was prepared and made available to the public on Highways England scheme website at www.highwaysengland.co.uk/A47Thickthorn. This report describes the process that was followed for the non-statutory public consultation arrangements; and provides factual information on the responses received.

Figure 1:1 Proposed Option presented at Non-Statutory Consultation



1.1.15 This consultation considered the proposed option to re-connect Cantley Lane to Cantley Lane South by way of a new link road with a new underpass structure and removal of the existing footbridge.

1.1.16 Many respondents at the Public Information Exhibition (PIE), including South Norfolk Council, Cringleford Parish Council, specifically oppose the construction of the Cantley Lane underpass. They feel that such an underpass would not be safe for walkers, cyclists & horse riders (WCHR), would lead to rat-runs on Cantley Lane South and would interrupt traffic flow in the area, leading to congestion. These argue that an underpass would be both expensive and unnecessary. Several of these respondents say they would support the scheme at Thickthorn Junction if this underpass was removed from the proposals.

1.1.17 In summary, the public consultation feedback received raised several main concerns:

- Increased traffic along Cantley Lane, particularly associated with the recycling centre at Station lane;
- Increased traffic and congestion in Cringleford;
- Cantley Lane becoming the main access route from South Norwich to Ketteringham;
- Rat-running to the A11 via. Station Lane;
- Underpass being unsafe for Walking, Cycling & Horse Riders;
- Environmental impact on wildlife and trees;
- Increased noise/air pollution;

- Impacts upon landscape protection zone adjacent to the new development;
- Regular use of the footbridge; and,
- Land severance.

1.1.18 In response to the public consultation feedback, it was necessary to consider further options to compensate for the reduced connectivity of Cantley Lane as a result of the severance.

1.3 Previously assessed options

1.1.19 Seven options have previously been assessed during PCF Stage 2 as fully detailed within the Scheme Assessment Report undertaken in June 2017 which can be found at www.highwaysengland.co.uk/A47Thickthorn

1.1.20 In summary, Options 1, 2, 5, 6 and 7 were not recommended to take forward for varying reasons and Option 4 was recommended for further investigation as summarised below.

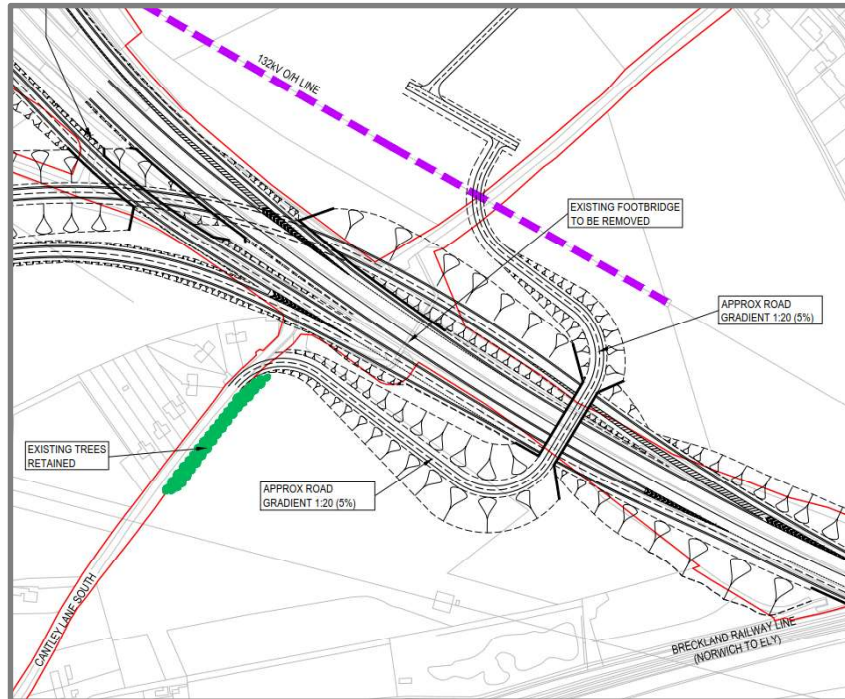
Cantley Lane Option 1

1.1.21 The alignment of Option 1 follows the A47 southern boundary as closely as possible to reduce severance of the land between Cantley Lane South, the A47, and the Breckland Railway Line.

1.1.22 The presence of the overhead high voltage cables is the main constraint to the alignment to the north of the A47.

1.1.23 The local road link is then routed through the Cringleford Extension development, via the development's road network, before connecting to Round House Roundabout which is based on Developer Layout Drawing. No. 350/PL/003, which is subject to change and subject to agreement with the developer.

Figure 1:2: Option 1



1.1.24 Manual for Streets (MfS1 and 2) has been adopted for the design of this link because of the overhead cables constraints and is commensurate with existing Cantley lane South standards and that of the Cringleford Extension development highway standards.

1.1.25 Option 1 was not recommended for the following main reasons:

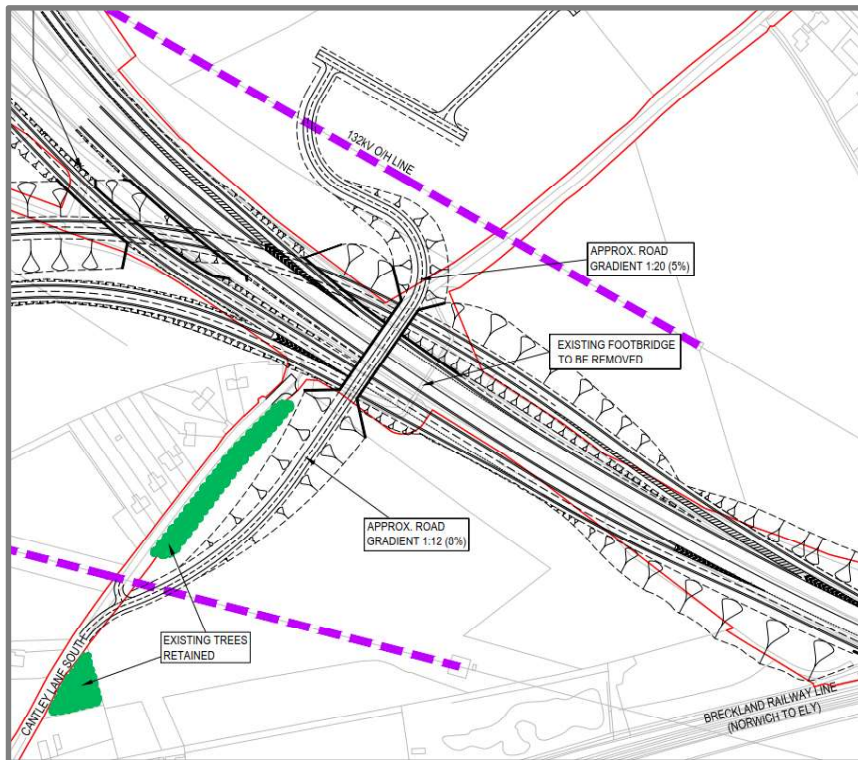
- The overbridge, and its high approach embankments, would be far more visually intrusive to the residents of Cantley Lane South than the originally proposed underbridge
- There is potential for greater propagation of traffic noise from Cantley Lane South due to the overbridge and traffic being much closer to the residential properties than the originally proposed scheme shown at PIE
- The option will result in local trips through the development West of Cringleford by vehicles returning from the Recycling Centre, and a potential increase in through traffic within the development and along Cantley Lane South due to 'rat running' to the A11 via Station Lane

Cantley Lane Option 2

1.1.26 The alignment of Option 2 is a derivative of Option 1 to move the proposed overbridge closer to the existing footbridge, to reduce the desired length of the WCHR route.

- 1.1.27 The presence of the overhead high voltage cables is the main constraint to the alignment to the north of the A47.
- 1.1.28 The horizontal alignment of Option 2 to the south of the A47 passes through existing vegetation adjacent to Cantley Lane South which provides a certain level of screening to the properties along Cantley Lane South and travels beneath the overhead high voltage electricity cables
- 1.1.29 The local road link is then routed through the Cringleford Extension development, via the development's road network, before connecting to Round House Roundabout which is based on Developer Layout Drawing. No. 350/PL/003, which is subject to change and subject to agreement with the developer.

Figure 1:3: Option 2



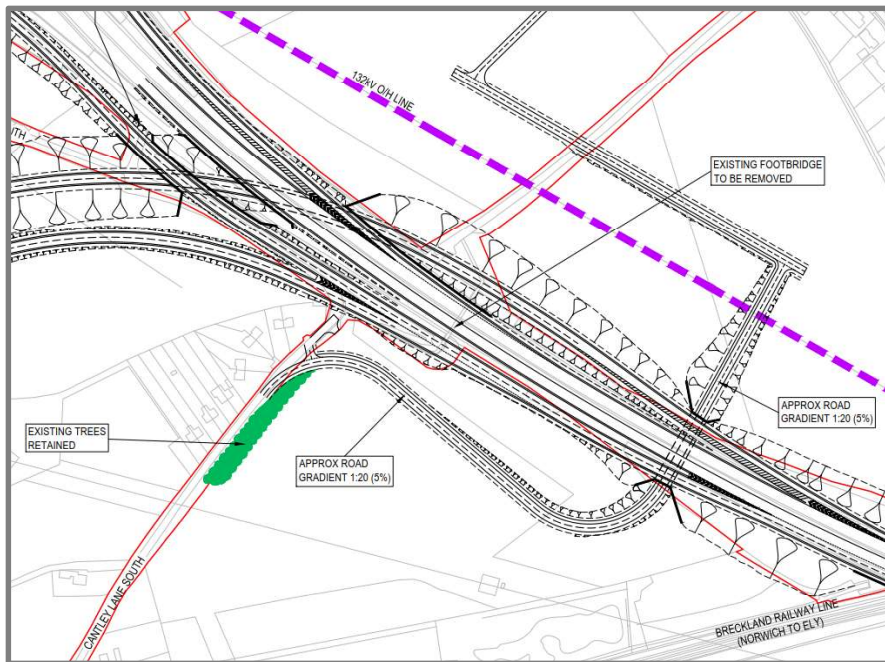
- 1.1.30 Manual for Streets (MfS1 and 2) has also been adopted for the design of this link because of the overhead cables constraints and is commensurate with existing Cantley lane South standards and that of the Cringleford Extension development highway standards.
- 1.1.31 Option 2 was not recommended for the following main reasons:
- The overbridge, and its high approach embankments, would be far more visually intrusive to the residents of Cantley Lane South than the originally proposed underbridge
 - The steep approach gradient on the southern side of the A47 is on the limit of acceptability for mobility users and may cause high traffic speeds

- There is potential for greater propagation of traffic noise from Cantley Lane South due to overbridge and traffic being much closer to the residential properties than the originally proposed scheme shown at PIE
- The option will result in local trips through the development West of Cringleford by vehicles returning from the Recycling Centre, and a potential increase in traffic through the development and along Cantley Lane South caused by rat running to the A11 via Station Lane

Cantley Lane Option 3

- 1.1.32 The alignment of Option 3 was developed in response to concerns that were raised by the owner of the corner of land between Cantley Lane South, the A47, and the Breckland Railway Line (Plot 52A on the originally proposed Single Option land plans with the originally proposed local road link road shown at PIE), that the proposed link caused severe severance to his land.
- 1.1.33 The presence of the overhead high voltage cables is the main constraint to the alignment to the north of the A47.
- 1.1.34 The local road link is then routed through the Cringleford Extension development, via the development's road network, before connecting to Round House Roundabout which is based on Developer Layout Drg. No. 350/PL/003, which is subject to change and subject to agreement with the developer.

Figure 1:4: Option 3



1.1.35 Manual for Streets (MfS1 and 2) has also been adopted for the design of this link because of the overhead cables constraints and is commensurate with existing Cantley Lane South standards and that of the Cringleford Extension development highway standards.

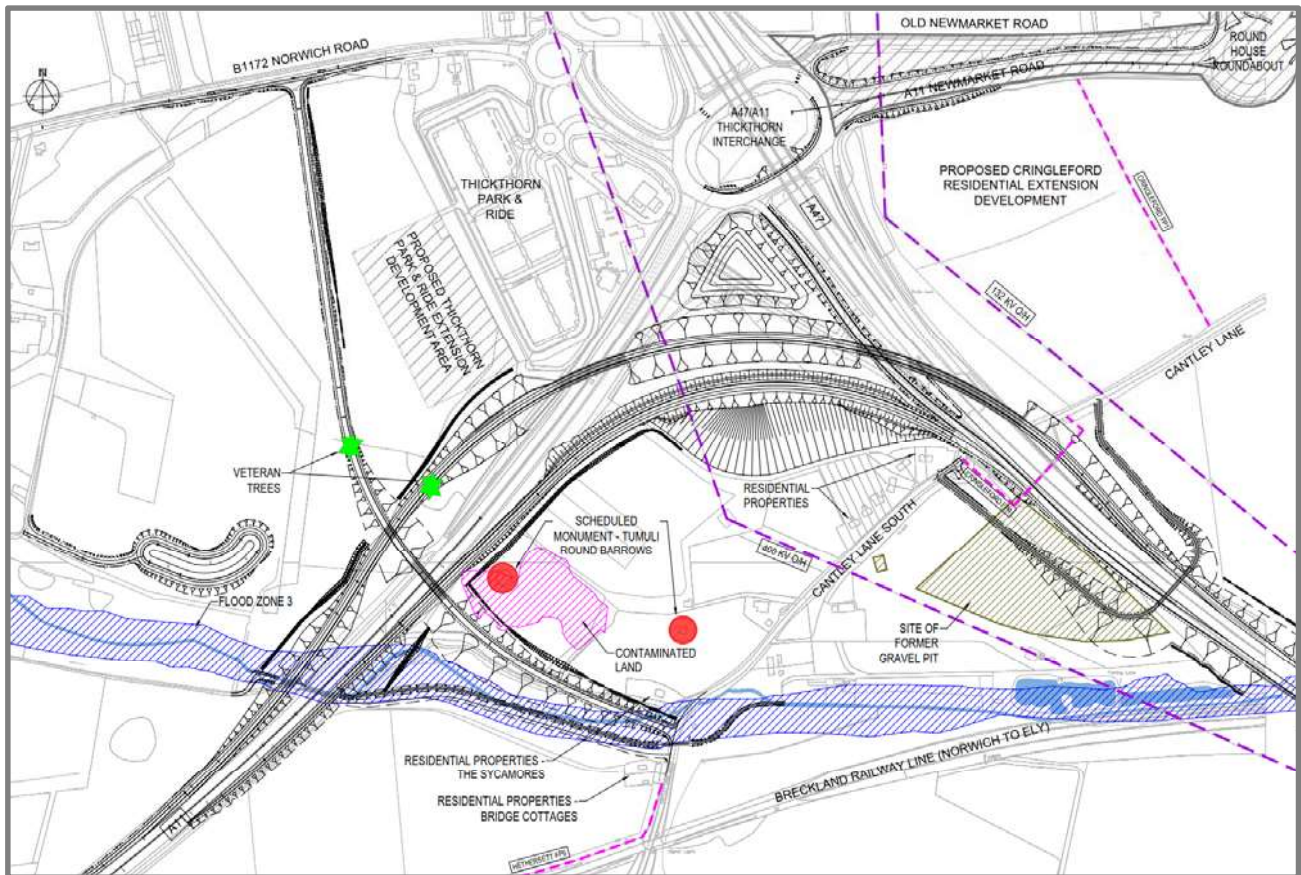
1.1.36 Option 3 has been further assessed as part of this options report.

Cantley Lane Option 4

1.1.37 Owing to the concerns that were raised by the public at, and following, the PIE regarding traffic flows along Cantley Lane (north) following the re-connection of Cantley Lane South to Cantley Lane; the option of connecting Cantley Lane South to the B1172 Norwich Road was investigated.

1.1.38 This option restores access to the main highway network for the properties along Cantley Lane South, who otherwise would have their access restricted by the Breckland railway bridge, when the Cantley Lane (South) links to Thickthorn Roundabout are removed to implement the scheme.

Figure 1:5: Option 4



Note: Works to roundhouse roundabout and A11 Newmarket Road are part of a developer-led scheme and not part of Highways England Scheme.

1.1.39 The main constraints to the proposed alignment are:

- Residential Property adjacent to Cantley Lane South
- Scheduled Monument - 2 “Tumuli” (round barrows) dating back to the bronze age
- 2 No. Veteran trees
- Contaminated land
- Impacts on the existing flood zone No. 3
- Cantley Stream
- Thickthorn Park and Ride – Future Development Plans

1.1.40 This option is located to the north of the existing Breckland Railway Bridge which crosses Cantley Lane South; Breckland Railway Bridge has a restricted headroom of 13’/4.0m and a restricted width of approximately 5.0m.

1.1.41 The existing footbridge across the A47 between Cantley Lane South and Cantley Lane will be replaced to accommodate the proposed A11 south to A47 east bi-directional Interchange link roads.

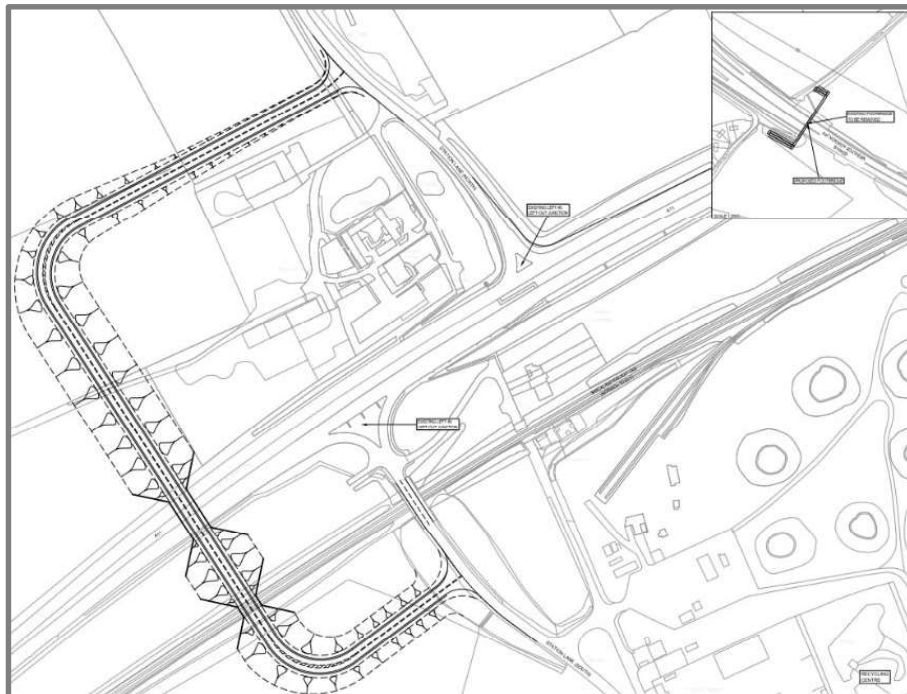
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- 1.1.42 The resulting alignment of the proposed link has been designed in accordance with the Design Manual for Roads and Bridges (DMRB), with bends of 360m radii and 5% super-elevation.
- 1.1.43 However, visibility with an 'X' distance of 2.4m from the give way line at the tie in with Cantley Lane South is 120m, which corresponds to a 70kph (40mph) design speed. This 'X' distance is a 2 Step relaxation used only in exceptionally difficult circumstances.
- 1.1.44 Several structures are required to cross the A47 westbound to A11 southbound interchange link, the A11 mainline and the A11 northbound to A47 westbound interchange link.
- 1.1.45 The new link requires additional construction in the flood plain, which will require flood compensation to be provided.
- 1.1.46 There is also a need to divert Cantley Stream and introduce a new skewed culvert that crosses the proposed link at the junction with Cantley Lane South. Either could result in an increased flood risk to the property on the eastern side of Cantley Lane South in the location of the proposed junction. A robust flood risk assessment and drainage collection system will be required on the upstream side of this property to mitigate this risk.
- 1.1.47 River modelling would therefore be required to determine flood risk to nearby residential properties as well as hydraulic connectivity modelling of the new diversion between the upstream and downstream of the watercourse.
- 1.1.48 The Cantley Lane South Historic Landfill is located to the south of the A11, which is north of the proposed embankment. Detailed investigation is necessary to confirm the extent, ground conditions and provide geotechnical design parameters for the proposed works.
- 1.1.49 Option 4 has been further assessed as part of this options report.

Cantley Lane Option 5, Option 6 and Option 7

- 1.1.50 Options 5, Option 6 and Option 7 were developed based upon improvements at the A11/Station Lane junction to the west of Thickthorn Interchange as shown on drawings HE551492-MMSJV-HGN-000-DR-CH-00007, HE551492-MMSJV-HGN-000-DR-CH-00003 and HE551492-MMSJV-HGN-000-DR-CH-00004 respectively at Appendix A.
- 1.1.51 The A11 Station Lane Junction was originally built as an at-grade, all movements junction, but has subsequently been converted to a left in, left out junction; presumably on the grounds of safety to stop motorists turning right across opposing traffic. This has prevented traffic from Station Lane, north and south of the A11, from turning right onto the A11.

- 1.1.52 Feedback from the PIE indicated that traffic heading southbound on the A11 to the Recycling Centre at Station Lane, returned north via Cantley Lane South.
- 1.1.53 There were several suggestions that a junction at Station Lane/A11, capable of providing a right turn back towards the Thickthorn Junction (from the Recycling Centre) would be more convenient and would cause less disruption to the residents of Cantley Lane and Cantley Lane South.
- 1.1.54 This idea received a unanimous vote at the meeting with East Carleton & Ketteringham Parish Council on 6 April 2017. A proposal from the public was tabled at this meeting for consideration by the design team (Option 7).
- 1.1.55 Options 5, 6 and 7 are detailed below.

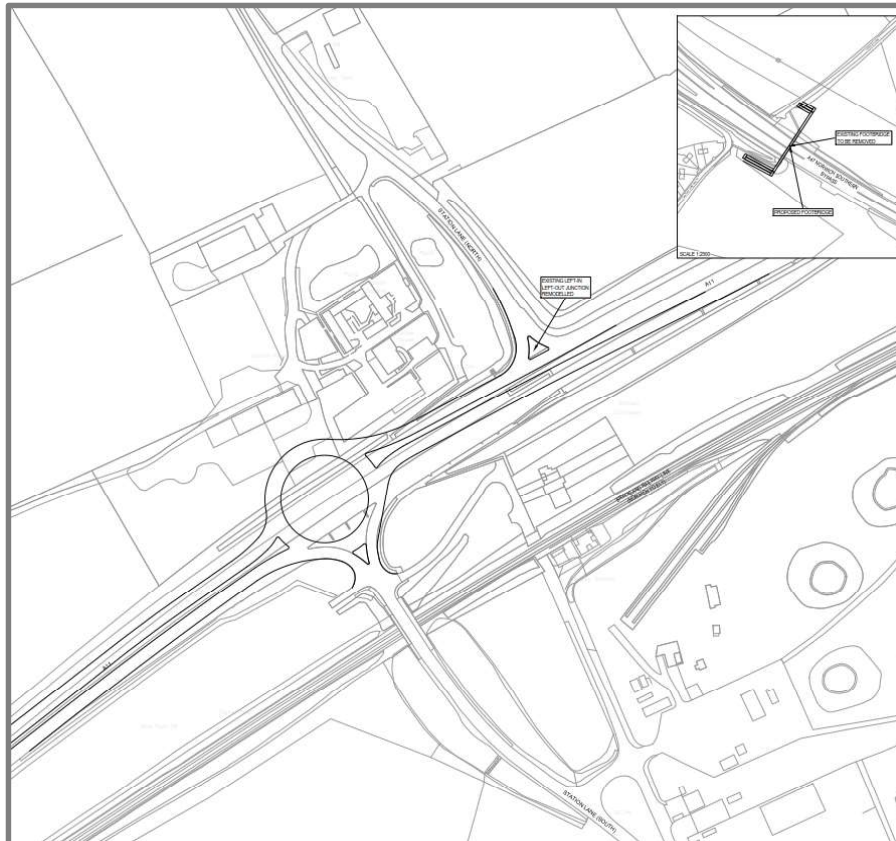
Figure 1:6: Option 5



- 1.1.56 Option 5 as shown on General Arrangement drawing HE551492-MMSJV-HGN-000-DR-CH-00007 at Appendix A and Departure from Standards drawing HE551492-MMSJV-HAC-000-DR-CH-00004 at Appendix D was not recommended for the following main reasons:
- The properties on Cantley Lane South will have to make a large detour of up to an additional 5.6km compared to the existing situation when travelling to Thickthorn Junction
 - The long detour to the main group of properties on Cantley Lane South, which includes approximately 2.4km of rural 2-way single lane carriageway roads with limited passing places, would adversely affect emergency services response times

- Access to the properties on Cantley Lane South will be restricted by the low railway bridge, which has a 13³/₄.0m headroom, which would restrict access not only for residents but also for emergency services, refuse collection, deliveries, farmers and their equipment, movement of products and animals etc
- There is likely to be adverse landscape and visual effects because of the 2 new overbridges and associated embankments within the local landscape
- Due to the number of community facilities and trips made by walkers, cyclists and horse riders, this option also requires the footbridge across the existing A47 to be replaced
- There is a high cost associated with providing bridges over the railway, the A11 main line and an WCHR bridge to reconnect Cantley Lane South to Cantley Lane
- This scheme option is predicted to only attract an Average Annual Daily Traffic (AADT) count of 160 on the bridge in the design year of 2037 according to the highway transport model. This scheme does not form a through route between Hethersett and Ketteringham recycling centre via Station Lane North because the northern part of Station Lane North is closed to traffic as per the base year. In addition, traffic from Station Lane North, has to give way to A11 mainline traffic, which deters rerouted traffic from Ketteringham. A merge to this option for the A11 Eastbound traffic could attract more vehicles to use this link but the substandard weaving length to the proposed A11 Eastbound diverge rules this out on safety grounds
- This option prevents any through traffic on Cantley Lane South because the existing access on Thickthorn junction is now closed. Therefore, the predicted traffic on Cantley Lane South is zero except for local traffic to access Ketteringham Recycle Centre and houses on Cantley Lane South, both of which are not captured in the transport model
- Under this option, the average journey (i.e. inter-peak) to access Thickthorn Junction (A11 Eastbound off slip approach) from Cantley Lane South in 2037 is approximately 7 minutes as compared to approximately 1 minute (A47 Westbound off slip road approach) in 2015
- This option does not deliver on the scheme objectives and results in additional delay to journey time. This may result in the scheme performance not being value for money and result in objections.

Figure 1:7: Option 6

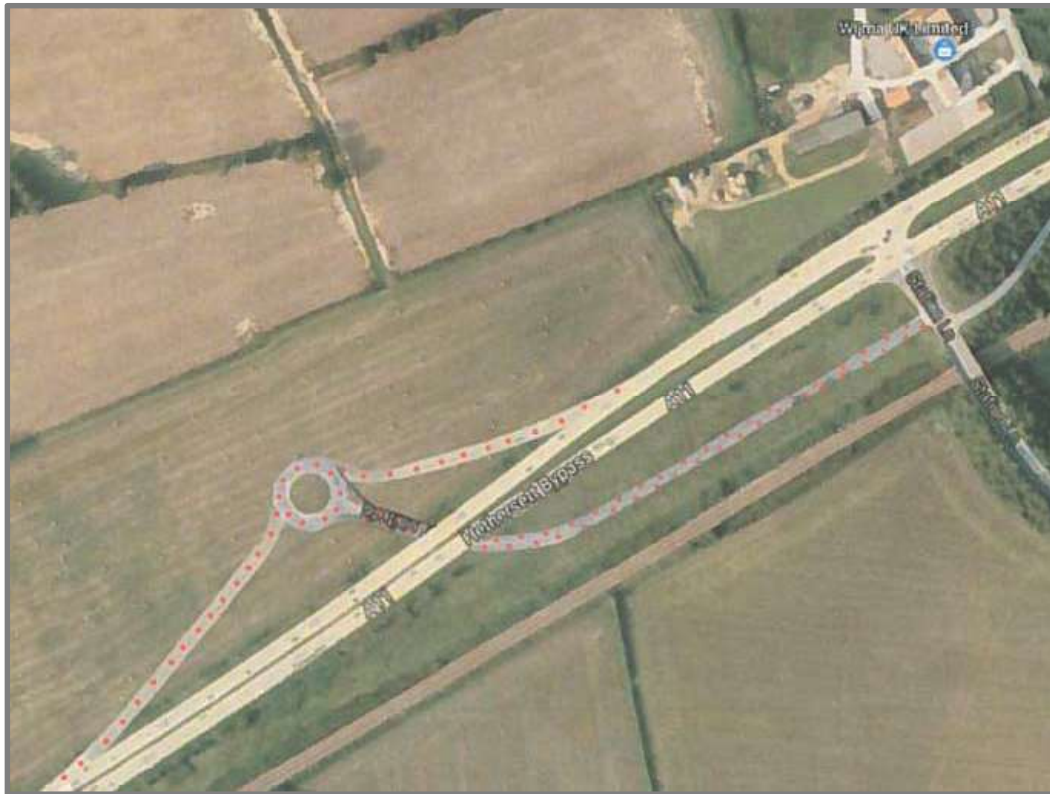


1.1.57 Option 6 as shown on General Arrangement drawing HE551492-MMSJV-HGN-000-DR-CH-00003 at Appendix A and Departure from Standards drawing HE551492-MMSJV-HAC-000-DR-CH-00005 at Appendix D was not recommended for the following main reasons:

- The option does not comply with Highways England Strategic Goals of providing a safer network, supporting the smooth flow of traffic, reducing delays and achieving real efficiencies
- The properties on Cantley Lane South will have to make a large detour of an additional 4.9 kilometre compared to the existing situation when travelling to Thickthorn Junction
- The long detour to the main group of properties on Cantley Lane South, which includes approximately 2.4 kilometre of rural 2 way single lane carriageway roads with limited passing places, would adversely affect emergency services response times
- Access to the properties on Cantley Lane South will be restricted by the low railway bridge, which has a 13³/₄.0m headroom, which would restrict access not only for residents but also for emergency services, refuse collections, deliveries, farmers and their equipment, movement of products and animals etc

- Summary of Departure from Standards for Option 6 given at Appendix D
- Due to the number of community facilities and trips made by walking, cyclists and horse riders, this option also requires the footbridge across the existing A47 to be replaced
- The main problem relating to highway safety is the introduction of a roundabout, in close proximity to A11/Station Lane junction, which would result in a Departure from Standard for reduced distance between junctions and a significant safety issue associated with vehicle conflicts between merging, diverging and free-flowing traffic
- The introduction of a roundabout on a free-flowing section of the A11 is likely to cause delays, and may increase the number of accidents, which could introduce cumulative economic dis-benefits. For instance, the scheme is predicted to cause 177 seconds delay per vehicle for the A11 eastbound traffic and 117 seconds delay for the A11 westbound traffic during the AM peak hour, according to the 2037 highway transport model. In addition, the appearance of agricultural vehicles would make the performance of the roundabout even worse
- This option prevents any through traffic on Cantley Lane South because the existing access on Thickthorn junction is now closed. Therefore, the predicted traffic on Cantley Lane South is zero except for local traffic to access Ketteringham Recycle Centre and houses on Cantley Lane South, both of which are not captured in the transport model
- Under this option, the average journey (i.e. inter-peak) to access Thickthorn Junction (A11 Eastbound off slip approach) from Cantley Lane South in 2037 is approximately 6 minutes as compared to approximately 1 minute (A47 Westbound off slip road approach) in 2015

Figure 1:8: Option 7



1.1.58 Option 7 as shown on General Arrangement drawing HE551492-MMSJV-HGN-000-DR-CH-00004 at Appendix A and Departure from Standards drawing HE551492-MMSJV-HAC-000-DR-CH-00003 at Appendix D was not recommended for the following main reasons:

- The properties on Cantley Lane South will have to make a large detour of an additional 6.3 kilometre compared to the existing situation when travelling to Thickthorn Junction
- The long detour to the main group of properties on Cantley Lane South, which includes approximately 2.4 kilometre of rural 2-way single lane carriageway roads with limited passing places, would adversely affect emergency services response times
- Access to the properties on Cantley Lane South will be restricted by the low railway bridge, which has a 13³/₄.0m headroom. This would restrict access not only for residents but also for emergency services, refuse collection, deliveries, farmers and their equipment, movement of products and animals etc

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- There are several problems relating to the highway safety of the junction for the proposed 2-way link with Station Lane (south):
 - Traffic using the junction will have high speed traffic approaching from the left on the A11 northbound
 - The visibility to the right along Station Lane is severely restricted by the concrete parapets for the existing railway bridge, and furthermore, the access directly opposite for Station Cottages, does not conform to the preferred right/left stagger arrangement
 - Safety concerns relating to the proposed A11 northbound on slip owing to the short weaving length to the Station Lane (south) Junction. Vehicles accelerating on this on slip to join the A11 main line could suddenly encounter vehicles slowing down to turn into Station Lane (north), or slow-moving vehicles emerging from Station Lane (north) – summary of Departure from Standards for Option 7 given at Appendix D
 - The deep cutting to accommodate the underpass (1:3 side slopes up to 11m in height) is directly adjacent to the live Breckland Railway which would require close consultation with Network Rail, and additional slope stabilisation/retaining wall structures to ensure the railway is not compromised
 - The deep cutting also adds to the surplus material already generated by the scheme which will require disposing of
 - Due to the number of community facilities and trips made by walkers, cyclist and horse riders, this option also requires the footbridge across the existing A47 to be replaced
 - The underbridge beneath the A11 would require a greater skew, and would therefore be longer than is indicated in the above marked up image. In order for the alignment of the proposed 2-way link to meet the requirements of the Design Manual for Roads and Bridges as is shown on drawing HE551492-MMSJV-HGN-000-DR-CH-00004 contained within Appendix A
 - The scheme is predicted to attract 1,000 AADT on the underpass in the design year of 2037 according to the transport model. This scheme does not form a through route between Hethersett and Ketteringham recycling centre via Station Lane North because the northern part of Station Lane North is closed to traffic as per the base year. In addition, the design of a single lane merge reduces the difficulty for eastbound traffic to access A11 as compared to Option 5 and therefore attracts more rerouted traffic from Ketteringham

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- This option prevents any through traffic on Cantley Lane South because the existing access on Thickthorn junction is now closed. Therefore, the predicted traffic on Cantley Lane South is zero except for local traffic to access Ketteringham Recycle Centre and houses on Cantley Lane South, both of which are not captured in the transport model
 - Under this option, the average journey (i.e. inter-peak) to access Thickthorn Junction (A11 eastbound off slip approach) from Cantley Lane South in 2037 is approximately 6 minutes as compared to approximately 1 minute (A47 westbound off slip road approach) in 2015

1.1.59 As a result of the above, Option 3 and Option 4 will be compared as part of this report.

2. PCF Stage 3 Cantley Lane Option 3

2.1 Background to Option 3

- 2.1.1 This option provides a continuous link between Cantley Lane and Cantley Lane South but ties into the road network associated with the Cringleford Extension development rather than Cantley Lane.
- 2.1.2 This option has been further developed as shown on General Arrangement drawing HE551492-MMSJV-HGN-000-DR-CH-00001 at Appendix A and Departure from Standards drawing HE551492-MMSJV-HAC-000-DR-CH-00002 at Appendix D.

2.2 Highway alignment

- 2.2.1 Option 3 connects Cantley Lane South to Round House Roundabout which travels beneath the A47 via an underbridge. This option is similar, to the proposed option consulted upon, except that the local road to the South of the A47 has been diverted along the edge of the existing trees in order to reduce the severance of the land between Cantley Lane South, the A47, and the Breckland Railway Line. This also minimises severance to Plot 52A land.
- 2.2.2 This option also ties into the Cringleford Residential extension development road network which will introduce greater flows through the development which could affect the sale or value of properties in the area.
- 2.2.3 This option has been designed in accordance with Manual for Streets (MfS1 and 2) which, following consultation with Norfolk County Council, it was noted that this link road would become a main thoroughfare for vehicles travelling between Cantley Lane South and Round House Roundabout.
- 2.2.4 However, this route becoming the main thoroughfare is restricted by the fact that Cantley Lane South has a 7.5 tonne weight limit from the Cantley Lane/Station Lane/High Street/Hethersett Road junction to avoid the 13'4.0m height restricted railway bridge (Network Rail bridge reference 1630 ETN) along Cantley Lane South.
- 2.2.5 As a result, this would restrict the use to Light Goods vehicles or private vehicles only, which would prevent HGV's travelling to/from the recycling centre along Station Lane. However, its use would increase, as a result of re-connecting Cantley Lane to Cantley Lane South, particularly by those travelling to/from the recycling centre from Cringleford.
- 2.2.6 Potential 'rat-running' to avoid the Thickthorn Interchange is introduced although the current width of Cantley Lane and height/width restriction at the

railway bridge would deter motorists using this as a route to avoid Thickthorn Interchange.

2.2.7 Option 3 has been designed to Manual for Streets standards although this would only be acceptable within the area of the Cringleford Neighbourhood Development Plan which would be urban in nature following the Cringleford Residential Extension development. Cantley Lane South would remain rural in nature and likely to encourage higher speeds than the low speeds covered by Manual for Streets.

2.2.8 A sixty-four metre, horizontal radius has been designed to the west of the alignment in accordance with MfS2 table 8.1 with the approach road of Cantley Lane South being derestricted speed limit.

2.2.9 The vertical alignment at PCF Stage 2 indicated 5% gradients are achievable either side of the A47 underbridge which have been further assessed.

2.2.10 Given the required structure depth, minimum headroom of 5.3m and the length to the junction tie in, to the Cringleford Residential Extension road network, a steeper 8% gradient is required. This exceeds the maximum 5% grade permitted for walking, cycling & horse riding.

2.2.11 This 8% gradient cannot be avoided unless:

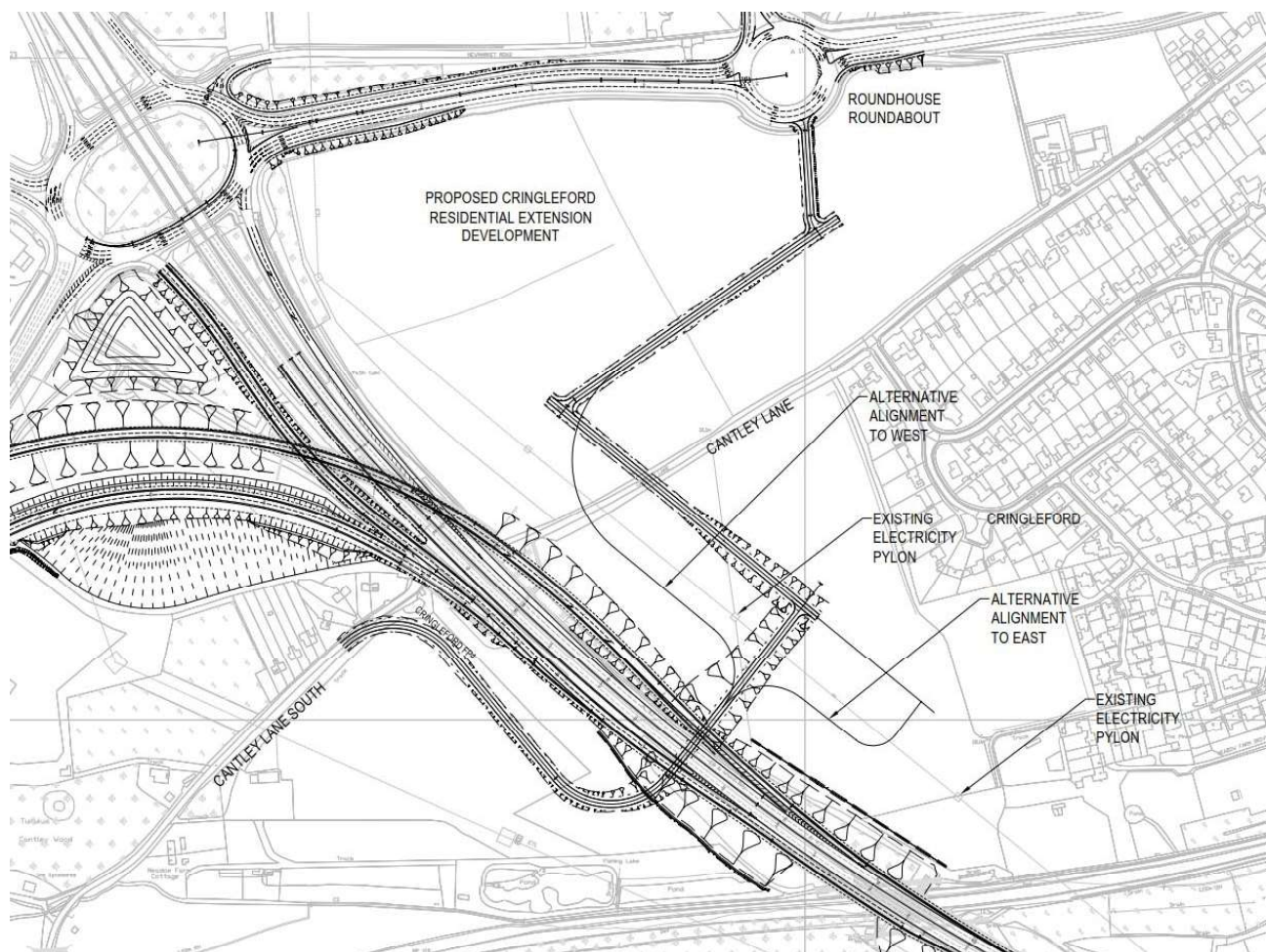
- The road network associated with Cringleford Extension development is moved further north to provide a greater length to reduce the gradient
- The Option 3 alignment is altered to skew the road east or westwards to provide a greater length to reduce the gradient

2.2.12 Neither option is feasible when it is considered that:

- The developer of Cringleford Residential Extension has maximised the space and plots to be built when taking into consideration the green space buffer required between the development and the Highway Boundary
- The 8% gradient cannot be avoided without adversely impacting upon the adjacent pylon and properties of Cringleford as follows and shown below:
- If the alignment was re-routed west, this would impact upon an adjacent electricity pylon, associated cables and would require significant diversionary works incurring additional costs. This was considered during PCF Stage 2 and ruled out because of the impacts on the overhead power lines and pylons.

- If the alignment was re-routed east, this would impact upon the overhead electricity cables and would require significant diversionary works incurring additional costs. To avoid impacting the cables, an alignment standard lower than required by Manual for Streets would be required to tie in to the proposed Cringleford Residential Extension Development highway network

Figure 2:1: Alternative option to avoid 8% gradient



2.2.13 Fixing a minimum DMRB TD9/93 900m sag curve beneath the proposed underbridge crossing the A47 requires an 8% grade to the east of the A47 to get back up to existing ground level with a 1000m crest and 15m 4% dwell area at the T junction. Any lower sag curve will require a Departure from Standard and result in an even greater gradient.

2.2.14 Furthermore, due to the short-distance between the proposed underbridge and the connecting link, this requires the alignment to be approx. 3.5m below existing ground level resulting in additional cut material and increased earthworks footprint (based on the received A47 LiDAR to which the earthworks have been interfaced). This vertical alignment is based on values from the Design Manual for Roads and Bridges (DMRB), TD9/93, Table 3, with a design speed of 50kph rather than the proposed horizontal design speed of 60kph.

The likelihood is that a Departure from Standard would be required for the reduction in values used for the vertical design as outlined below in section 2.3.

2.3 Departure from Standards

- 2.3.1 The proposed link connects the derestricted rural Cantley Lane South with a proposed residential development road approximately 140m north of the A47 D2AP. The proposed section of road is over half a kilometre long and is assumed to be national speed limit up to the junction with the new residential road. The design speed of the link should be based on TD 9/93 and has been assessed as 70A kph taking account of local operational route aspects. Departures presented are based on the assessed design speed. The proposed development roads and junctions from the connection of Cantley Lane to the Round House Roundabout have not been assessed.
- 2.3.2 The proposed section of road possesses numerous relaxations and most of the departures are based on a combination of relaxations although some of the compounded relaxations are departures independently. Where relevant all relaxations and departures have been combined to show their effect over each section of the proposed road.
- 2.3.3 Summary of Departure from Standards for Option 3 are given in Appendix D.
- 2.3.4 From the southern tie-in with the existing Cantley Lane South, the proposed Option 3 geometric alignment bends to the right and exhibits combinations of relaxations for Stopping Site Distance (SSD) (3 Steps), vertical curvature (2 Steps) and horizontal curvature (3 Steps); including transition relaxations. This combination of departures is within the vicinity of several houses with closely spaced vehicular accesses. The geometric layout is based on a low speed urban road 20/30mph speed limits however there are minor improvements to curvature and visibility compared to the existing arrangement in this area which is to be stopped up.
- 2.3.5 Adjacent to the departure combination above, a less onerous combination consists of SSD (2 Steps) and vertical crest curve (2 Steps); this departure combination is on a straight section of road. Full SSD at the higher 1.05m object height should be available to the local accesses however there is no discernible visibility improvements from the existing layout.
- 2.3.6 Continuing northbound and in advance of the left bend that proceeds below the A47 there is an SSD departure (3 Step relaxation as opposed to a 2 Step requirement in this location) for northbound traffic only. A portion of this departure is on a short straight section of road and is between and through part of a low radius horizontal curve. If this arrangement is adopted then this departure is likely to be allowed with the inclusion of appropriate mitigation measures.

- 2.3.7 Towards the proposed underpass the road turns through an angle greater than 90 degrees which results in a departure combination of SSD (3 Steps – more onerous northbound on inside of curve) and horizontal curvature (3 Steps) with transition relaxations.

The geometric layout is based on a low speed urban road with 20/30mph speed limits, however the tight corner is near the bottom of a steep 8% gradient, where it is expected that design speed can be gained with ease. It is unlikely that this departure combination would be granted without traffic calming measures and hazard mitigation.

- 2.3.8 On the approach to the proposed residential road junction, the geometric alignment exhibits combinations of relaxations for SSD (2 Steps), vertical sag (2 Step) and crest curvature (2 Step) and in horizontal curvature (3 steps) including transition relaxations. Approach design speeds are unlikely to be realised on this section of carriageway towards the junction due to the steep 8% gradient. Also, within the vicinity of this combination is a departure at the junction approach where vertical gradient is to be maintained at a maximum of 2.0%; although 4.0% has been provided presumably to alleviate the vertical alignment and gain access below the A47.

- 2.3.9 As previously stated, the alignment has been developed based on the road being restricted with a 40mph speed limit. If agreement cannot be reached with Norfolk County Council and the Police for the implementation of a local 40mph speed limit, or traffic calming on part of Cantley Lane South, then the above Departures from Standards would be required for the geometric aspects and visibility at the junction and the proposed link road Cantley Lane South.

2.4 Traffic

Table 2:1 Daily Traffic Flows

Scenario	Cantley Lane South
2015 Modelled AADT (vehicles)	740
2037 Modelled 24 Hour 2-way AADT (vehicles)	120

- 2.4.1 The table above shows modelled daily traffic flows on Cantley Lane South extracted from the Stage 3 base (2015) and design year (2037) highway transport models. With Option 3 in place, traffic on Cantley Lane South would be rerouted to use the new link road to access Roundhouse Roundabout and the A11.
- 2.4.2 According to the base year model, the majority of traffic on Cantley Lane South belongs to Ketteringham outbound and Mulbarton outbound traffic to access A47. For Ketteringham and Mulbarton inbound traffic, the Thickthorn Junction, A11 then Station Lane South route would be used.

- 2.4.3 This scheme option is predicted to attract an Annual Average Daily Traffic (AADT) of 120 in 2037 with the majority, of the rerouted traffic coming from Ketteringham to access the A11 east of the Roundhouse Roundabout. Also, due to additional travel distance and lower speed along the reconnection link road through the Cringleford residential area, outbound traffic from Ketteringham and Mulbarton would be rerouted to use Ketteringham Lane to access A47 instead.
- 2.4.4 Although this option does provide an alternative through route to the Thickthorn Junction, the transport model predicts that it is unlikely to attract any additional rerouted traffic from a wider area. The reason for this is that the reconnection link road, Cantley Lane South and Station Lane form a longer route for westbound traffic to access the A11, compared to the Thickthorn route and the Thickthorn scheme also reduces the delay at the interchange for A11 Westbound traffic from Norwich. However, in the event of an incident on the A11/A47, there could be a significant increase of traffic utilising this parallel route.
- 2.4.5 This option could also see a small rise in traffic from a wider area utilising Cantley Lane South to travel to and from Ketteringham Recycling Centre. Although this is not captured in the transport model, our professional judgement on this increase would be around 100 AADT based on actual count data for the recycling centre.
- 2.4.6 Under this option, the average journey (i.e. inter-peak) to access Thickthorn Junction (A11 Westbound approach) from Cantley Lane South in 2037 is approximately 3 minutes as compared to approximately 1 minute (A47 Westbound off slip road approach) in 2015.

2.5 Walking, cycling & horse riders

- 2.5.1 Option 3 creates a suitable route for walkers, cyclists and horse riders linking Cantley Lane to Cantley Lane South with residential estate roads subject to 20mph and 30mph speed limits. This would re-connect the existing Cringleford footpaths FP1 and FP4, albeit alongside the proposed highway.
- 2.5.2 The highway alignment introduces an 8% gradient leading to Cantley Lane (North of A47) which is above the 5% maximum permitted gradient for walking, cycling & horse riders. An offline route for walking, cycling & horse riders is therefore required to provide a compliant route which will require additional land, potentially additional structures and will be routed through the 'Green Space' associated with the Cringleford Residential Extension Development.
- 2.5.3 However, roads with a 30mph limit do require separate facilities for people who are cycling (as well as walkers) and the route will provide nothing for horse riders. Due to the potential for multiple parked vehicles and cars emerging from

private driveways it could present a relatively hostile environment for horse-riders.

- 2.5.4 The design of the estate roads with junctions where the mainline becomes a side road will require pedestrians and cyclists to give-way or cross the carriageway junctions; at several locations, going against the design principles of coherence and safety.
- 2.5.5 Since it will provide a direct vehicular link between the east and west it is also likely to attract non-residential through traffic, which may also be less likely to abide by the speed limits.
- 2.5.6 The underpass beneath the A47 will also require careful design, although it is unlikely to provide the light and airy atmosphere required to be an attractive route. It will also require lighting, otherwise it may become unattractive due to fears over personal safety; and create a barrier to east-west movement for walking, cycling & horse riders rather than a valuable link.

2.6 Drainage

- 2.6.1 The A11 Newmarket Road/Round House Roundabout has an existing highway drainage network consisting of gullies and combined kerb drain units which presumably discharge to existing soakaways, existing surface water drains, existing watercourses or even connecting into the existing sewer system. Existing drainage strategy to be confirmed following receipt of survey information.
- 2.6.2 Cantley Lane South has an existing highway drainage network consisting of occasional gullies which presumably discharge to existing soakaways, existing surface water drains, existing watercourses or even connecting into the existing sewer system. Existing drainage strategy to be confirmed following receipt of survey information.
- 2.6.3 It is assumed that any proposed highway drainage within the area of the Cringleford Residential Extension development would connect into the existing drainage system at the A11 Newmarket Road/Round House Roundabout.
- 2.6.4 It is likely that the proposed drainage system would require additional piped attenuation and pollution control devices before discharging.
- 2.6.5 It is further assumed that any proposed highway drainage at the underpass beneath the A47 would discharge into a new soakaway which would be subject to confirmation of suitability through ground investigation and trials. It is highly likely that the existing ground water is encountered within the cutting which could rule out the use of soakaways.

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- 2.6.6 Should the ground investigation/trial holes prove soakaways to be inefficient or unsuitable, a discharge to the existing watercourse that runs parallel to the Breckland Railway may be possible given that the low point of the link road is approximately 18m Above Ordnance Datum (AOD) and the watercourse at approximate 11m AOD. This watercourse eventually discharges into the Intwood Stream and ultimately into the River Yare which may require drainage discharge consents from both the Lead Local Flood Authority and the Environment Agency.
- 2.6.7 It is unlikely that the underpass beneath the A47 could discharge into a new attenuation pond that ultimately discharges to Intwood Stream due to the link being in cutting although the approaches could discharge to the pond.
- 2.6.8 Again, it is likely that the proposed drainage system would require additional piped attenuation and pollution control devices before discharging.
- 2.6.9 If neither of these options are feasible then a pumped drainage system would be required which would also require attenuation and pollution control devices.
- 2.6.10 Any discharge to watercourses will require drainage discharge consents from both the Lead Local Flood Authority and the Environment Agency.

2.7 Geotechnical

- 2.7.1 Geological mapping suggests that superficial deposits comprise glacial sands and gravels of the Sheringham Cliffs Formation and chalky till of the Lowestoft Formation north and south of Cantley Brook. Alluvial soils comprising clay, silt, sand and gravels is present along the line of the Cantley Brook. Bedrock comprises Chalk of the White Sub-Group. Rockhead level varies across the site but is anticipated to occur from circa 18m AOD to 1m AOD (occurring between 17m and 13m below ground level locally). There is potential for some structures to adopt spread foundations, however depending on the magnitude of the foundation loads, the structures may be piled.
- 2.7.2 High groundwater and risk of flooding can be associated with Cantley Brook and the River Yare valley area. The Chalk bedrock is highly permeable and designated a Principal Aquifer. Superficial soils are designated as a Secondary 'A' Aquifer (Sheringham Cliffs Formation) and Secondary (undifferentiated) Aquifer (Lowestoft Formation). While glacial clays and silts of the Lowestoft Formation are typically of low permeability, perched groundwater is anticipated within the granular lenses and the glacial sands and gravels. Groundwater control measures will be required for the proposed extensive cutting sections into these deposits.
- 2.7.3 Cuttings into the glacial soils are likely to be stable at 1 in 3 slopes (with some potential for steeper gradient). However, groundwater control may be crucial to stability of cuttings, with an outside potential for slope strengthening or retention

techniques to be considered. This is likely to be necessary for cuttings through made ground (see section 2.7.1). Likewise considering the flood plain north of Cantley Brook, drainage measures should be incorporated in the design of the Cantley Lane underpass of the A47.

- 2.7.4 The Alluvium deposits coincident with Cantley Brook are expected to be highly compressible and this is coincident with the proposed embankment and overbridge widening either side of the Breckland Railway Line. Consideration should be given to design and construction measures to ensure foundation stability and mitigate differential settlement to earthworks and at the structure interface. It is currently anticipated, subject to further investigation, that excavation and replacement of shallow compressible soils would form the basis for earthworks subgrade and foundation improvement.
- 2.7.5 With the possible exception of made ground (see section 2.7.1) it is anticipated that site won fill will be generated from cuttings for reuse for embankment build (with or without modification), although the earthworks balance suggests surplus fill will be generated on site. Notwithstanding, consideration should be given to the material makeup of the existing A47 earthworks either side of the existing railway overbridge and the properties and internal stability of the proposed fill material for embankment construction in a flood plain.

2.8 Contaminated Land

- 2.8.1 The alignment traverses a field below which an infilled former gravel pit exists. This may be a former 'borrow-pit' for highway construction; the pit backfill material is, however, unknown as no environmental baseline data currently exists.
- 2.8.2 The proposed engineering and construction works are likely to result in disturbance of the made ground infill material, as well as generation of excavation arisings.
- 2.8.3 Depending on the composition of the material present, the potential currently exists for leachate generation and pollution of controlled waters. Chemical testing is necessary to examine potential risks during and post construction to the construction workforce, site users and the wider environment once the material is disturbed.
- 2.8.4 The extant ground and groundwater conditions, and the nature of the existing pit infill materials will therefore require confirmation in order to determine design parameters for the proposed earthworks. These activities will also require prior planning and controls to mitigate potential environmental impacts.
- 2.8.5 Waste Acceptance Criteria (WAC) testing would also be appropriate at this stage to confirm potential abnormal disposal costs for surplus excavation material.

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- 2.8.6 It is envisaged that these work elements may be incorporated into the routine geotechnical ground investigation.

2.9 Pavement

- 2.9.1 The pavement is all new construction. Traffic figures are required to calculate design traffic in accordance with DMRB HD 24/06. Pavement materials and construction shall be in accordance with the relevant DMRB standards (namely HD26/06) and Interim Advice Notes (namely IAN73/06 Rev 1).
- 2.9.2 There are some buildability concerns with Option 3: if the vertical alignment is set with an 8% gradient, there will likely be problems laying this due to level control. In the same location, the asphalt delivery wagons being unable to tip with only 5.3m headroom.
- 2.9.3 Option 3 contains gradients of 8.0%, horizontal curvature <100m, and a design speed of 60kph, operating speed limit of 30mph. These factors will contribute to a higher Polished Stone Value (PSV) potentially being required. West of the proposed underbridge (which carries the A47 and its slip roads), the layout appears to have junctions. There is the potential for heavy braking in these locations and this may cause an increase in PSV.

2.10 Structures

- 2.10.1 Option 3 includes a new underbridge carrying the A47 mainline carriageway and slip roads over the new alignment of Cantley Lane, west of the existing Cringleford Railway Bridge. The Stage 2 development of this bridge identified its structural form as in-situ concrete slab deck integral with concrete faced contiguous piled abutments, and contiguous piled wing walls. There would be efficiencies in both design and construction of this bridge due to similarities with 3 other underbridges on the scheme.
- 2.10.2 The existing Cantley Lane Footbridge would be demolished for this option and the WCHR route diverted to pass underneath the A47 along the northern verge of the new underbridge. A minimum headroom of 5.3m is required to the soffit of the bridge to comply with TD27/05.

2.11 Environmental

Table 2:2 Summary of Environmental Impact

Cantley Lane – PCF Stage 3 Option 3 (link to north via underpass)	
	<p>Assumptions:</p> <ul style="list-style-type: none"> • The appraisal considers the option for the connection of Cantley Lane South in isolation from the main interchange works between the A11 and A47 • The alignment of the Option 3 link to Cantley Lane South from the Round House Roundabout is based on a masterplan for a proposed Cringleford Extension Development in the fields south of the Round House Roundabout. The appraisal therefore assumes an altered baseline within which this development will have taken place • The construction-related issues (abnormal costs/programme delay/regulatory compliance/health and safety) are excluded and this assessment considers the environmental impacts only
Topic	Summary of impact
Air Quality	<p>The reconnection of Cantley Lane South and Cantley Lane in Option 3 is likely to increase traffic along Cantley Lane South and through the Cringleford Extension Development. Although this will have a negative effect on air quality at nearby receptors the effect is not likely to be classed as significant considering existing pollutant concentrations in the area and level of changes in traffic flows expected.</p>
Biodiversity	<p>Nature Conservation designations:- Skirts Meadow Farm Meadow County Wildlife Site - opportunity for new roadside verge habitat to enhance connectivity with the County Wildlife Site (CWS) and wider area.</p> <p>Habitats: The proposed scheme is likely to result in direct and indirect impacts upon Natural Environment and Rural Communities Act (NERC) habitats and other habitats of high biodiversity value, including arable field margins.</p> <p>Protected and notable species: Potential impacts upon badgers, reptiles, breeding birds, otter, polecat, bat foraging and commuting.</p> <p>Mitigation: A number of additional mitigation measures to avoid, reduce, mitigate or compensate are needed in order to manage potential ecological effects and reduce any significance. Potential for enhancement of wildlife corridors.</p>
Heritage	<p>Cantley Lane South Option 3 is situated within 270m of a scheduled monument comprising 2 tumuli, a nationally significant designated asset. The road construction would potentially introduce temporary effects through increased noise and therefore alter the setting of the scheduled monument to a minor extent. This would result in a moderate adverse effect.</p>

<p>Landscape & Visual</p>	<p>Landscape elements Alignment impacts on tree cover within the highway corridor immediately adjacent to the existing A47 which is likely to be of limited landscape value (underpass and cutting). Alignment follows field pattern, causes very limited field severance to south of A47 and would pass through new urban development to the north of the A47.</p> <p>Landscape character Likely negligible effect on the character of the Yare Tributary Farmland with Parkland landscape due to tight association with existing highway corridor, below grade underpass and alignment through new area of urban fringe development.</p> <p>Visual Visual effects on sensitive private properties at northern end of Cantley Lane South but at-grade and within context of existing adjacent A47 highway corridor. Orientation and landscape context suggests the ability to successfully mitigate visual effects on these properties. Visual effects north of the A47 (residential areas and footpaths) would be negligible due to proposed urban development in this location which would change the visual context from open fields to an urban area with which the connection would be integral and visually consistent.</p>
<p>Noise</p>	<p>The re-aligned Cantley Lane would form a new link between Newmarket Road to the east of the interchange and Cantley Lane itself, adjacent to approximately 12 properties. The proposed Cringleford Extension Development is likely to result in an impact at these 12 properties from the re-aligned Cantley Lane section owing to increased traffic flow, although mitigation may be able to partially offset this. Depending on the traffic flow there may be an additional impact at properties to the north-east of the A47 and re-aligned Cantley Lane, although it is likely that traffic noise from the A47 will dominate.</p>
<p>Water Environment</p>	<p>The scheme is underlain by superficial deposits comprising sands and gravels, which are classed by the Environment Agency as a Secondary A aquifer (supports water supplies at a local rather than strategic scale (such as for private supplies) and remain important for rivers, wetlands and lakes).</p> <p>The bedrock comprises Chalk, which is classed as a principal aquifer (provides significant quantities of water and can support water supply and/or baseflow to rivers, lakes and wetlands on a strategic scale).</p> <p>The Chalk has a vulnerability classification of Major Aquifer Intermediate (some protection of groundwater provided by overlying soils and superficial deposits). These aquifers are part of the Broadlands Rivers Chalk and Crag groundwater body, which is a drinking water protected area and protected by the Nitrates Directive. The scheme does not intersect any source protection zones (SPZ), although a SPZ 2 (Outer Zone) is located 200m from the northern extent of the proposed scheme.</p> <p>The cutting may intercept groundwater flow if it extends below the water table, which may affect river baseflow. Dewatering may be required during construction of the cutting or other structures, which may impact on groundwater flow. Structures extending below the water table may act as a barrier to flow, creating a “groundwater dam”.</p> <p>New areas of hardstanding during construction and operation may intercept natural recharge to the underlying aquifer. Excavation of the cutting may generate significant suspended solids/turbidity.</p> <p>Ground Investigations (GI) and subsequent groundwater monitoring will inform the assessment of groundwater risks. Mitigation would be through permanent and temporary works design, including drainage design. Contaminated run-off, contact with construction materials, disturbance of contaminated land and accidental spills pose a risk to groundwater quality of both the superficial and bedrock aquifers. These risks would be mitigated by measures included in the Construction Environmental Management Plan</p>

	<p>(CEMP) and drainage design. Consultation with the Environment Agency is likely to be required with respect to potential groundwater risks and mitigation measures.</p> <p>The alignment between Ch.350 and Ch.500 traverses an infilled former gravel pit which may be a former 'borrow-pit' for highway construction. The pit backfill material is, however, unknown.</p> <p>The potential exists for leachate generation and pollution of groundwater below the infilled pit which is a Secondary 'A' Aquifer. Cantley Brook is in close proximity and may be in hydraulic continuity. If this is the case, then a second potential contaminant linkage may exist. No environmental baseline data currently exists.</p> <p>The proposed earthworks within this area is likely to exacerbate any such existing environmental impacts in these regards in the short-term but status quo would be expected in the longer-term.</p> <p>There is potential for accidental spillages or contaminated run-off from construction areas to enter surface water features namely Thickthorn Stream which passes 90m to the south of the proposed local link road. An appropriate Construction Environmental Management Plan (CEMP) will be required to mitigate this risk and minimise any impacts on surface water quality and ensure flow conditions are not altered or interrupted during construction.</p> <p>During operation, there will be an increased impermeable area which will require additional attenuation via soakaways / Sustainable Drainage System (SuDS) to ensure no increase in run-off peak flow rate or volume into Thickthorn Stream or other watercourses receiving drainage flows. Furthermore, there will be increased potential for routine run-off and spillage of contaminated run-off to enter receiving watercourses. It is assumed that these will be appropriately assessed and mitigated, where necessary.</p>
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3. PCF Stage 3 Cantley Lane Option 4

3.1 Background to Option 4

- 3.1.1 Owing to public concern raised during the PIE, a further option of connecting Cantley Lane South to the B1172 Norwich Road was investigated.
- 3.1.2 This option restores access to the main highway network for the properties along Cantley Lane South, who otherwise would have their access restricted by the Breckland Railway Bridge, when the Cantley Lane (South) links to Thickthorn Roundabout are removed to implement the scheme.
- 3.1.3 This option ties into Cantley Lane South, just north of the existing Breckland Railway Bridge that crosses Cantley Lane South, which has restricted headroom of 13'4.0m and a restricted width of approximately 5.0m.
- 3.1.4 This option has been further developed during Stage 3, as shown on General Arrangement drawing HE551492-MMSJV-HGN-000-DR-CH-00002 at Appendix A and Departure from Standards drawing HE551492-MMSJV-HAC-000-DR-CH-00001 at Appendix D.

3.2 Highway alignment

- 3.2.1 The proposed link for Option 4 connects Cantley Lane South with the B1172 Norwich Road to the west of the Thickthorn Junction. The proposals pass over the A11 mainline and also the A11 south to A47 east bi-directional interchange links.
- 3.2.2 A new footbridge will be constructed as a replacement for the existing footbridge across the A47 between Cantley Lane South and Cantley Lane, which has to be removed to accommodate the proposed A11 south to A47 east bi-directional interchange links.
- 3.2.3 The alignment of the new Option 4 road link takes into consideration the potential to expand the Thickthorn Park & Ride site in the future. Other constraints to the alignment of the proposed link road include the proximity of the houses adjacent to Cantley Lane South and the proximity of the Cantley Stream.
- 3.2.4 There are also Scheduled Monuments, consisting of 2 No. Tumuli (round barrows) dating back to the Bronze Age, located within the study area which represents a further constraint to the alignment.
- 3.2.5 The resulting alignment of the proposed link has been designed in accordance with Design Manual for Roads and Bridges (DMRB). In order for the geometrical alignment to fit within the existing constraints, a 70kph design

speed is required, although a derestricted speed limit is proposed since policing a 40mph limit would be difficult. An agreement with Norfolk County Council and the Police would be required for the employment of this speed limit.

- 3.2.6 The alignment design meets the requirements set out in Table 3 in TD9/93 of DMRB with bends of 360m radii, and 5% super-elevation (for a design speed of 70kph).
- 3.2.7 A design speed assessment that was undertaken in accordance with TD9/93, Section 1, indicated that Cantley Lane South, has a design speed of 85kph (50mph) within the vicinity of the junction with the proposed link. However, assessing the available visibility from the junction along Cantley Lane South in accordance with TD42/95 of DMRB, it was found that the requirements for a design speed of 85kph could not be met.
- 3.2.8 Visibility along the existing Cantley Lane South is approximately 70m because of existing hedgerows/trees and the current width of Cantley Lane.
- 3.2.9 At the proposed junction with Cantley Lane South, 70m visibility can be achieved from 2.4m setback from the give way line (which is a 2 Step relaxation from DMRB standard used in exceptionally difficult circumstances) which corresponds to a 70kph (40mph) design speed. Agreement would therefore be needed with Norfolk County Council and the Police as to whether a local 40mph speed limit, or traffic calming would be required for that part of Cantley Lane South, or whether a Departure from Standards would be needed.
- 3.2.10 However, at this southern tie-in to Cantley Lane South, it is suggested that the priority for traffic is altered such that through traffic do not travel to the dead-end of Cantley Lane South which should only be access for the private dwellings. It is suggested that the link to the houses is made the minor arm of the T-junction with the western section of Cantley Road South joining directly to the B1172 link and becoming the major arm.
- 3.2.11 This would reduce the possibility of drivers mistakenly continuing along Cantley Lane South when they should turn left to access the B1172 Norwich Road and thereby the risk of conflict with walking, cycling & horse riders.

3.3 Departure from Standards

- 3.3.1 This proposed link connects 2 rural roads both with national speed limits. The link is nearly a kilometre long and is assumed to be derestricted national speed limit therefore based on TD 9/93 the design speed of the link has been assessed as 85A kph taking account of local operational route aspects. Departures presented are based on the assessed design speed.
- 3.3.2 The link possesses numerous relaxations and most of the departures are based on a combination of relaxations although some of the compounded relaxations

-
- are departures independently. Where relevant all relaxations and departures have been combined to show their effect over each section of the proposed road.
- 3.3.3 Summary of Departure from Standards for Option 4 are given at Appendix D.
- 3.3.4 On the approach to Cantley Lane South, the proposed Option 4 geometric alignment exhibits combinations of relaxations for SSD (2 steps) and vertical crest (2 step). Even if design speed is realised on this section of carriageway, which may be likely as a significant section of this road is downhill, then this departure combination should be accepted with suitable mitigation as the departure combination exists only within the farthest point from the (immediate approach to the) junction and should not have a detrimental effect on road safety. There is a departure at the junction approach where vertical gradient should be maintained at a maximum of 2.0%. >3.0% has been provided presumably to alleviate the vertical alignment over the existing A11. Mitigation for this departure could be high friction surfacing on the approach to the give way line.
- 3.3.5 The link road approach to B1172 Norwich Road has a similar assemblage of relaxations. The combinations of relaxations are; SSD (1 steps) and a vertical crest (1 step). If design speeds are realised on this section of carriageway, which may be likely as part of this road is downhill with a significant length of straight road, then this departure combination could have a detrimental effect on road safety however full SSD is provided to the give way line.
- 3.3.6 Between the junction approaches there are 2 separate sections of road that have combination departures and run concurrently with minor varying levels of relaxations. One of the departure combinations consists of SSD (2 steps) and a vertical crest curve (2 steps) including horizontal transitions. The final departure combination is made up of SSD (1 steps) and a vertical crest curve (1 step). These departure combinations are out with the immediate approach to a junction, offering a better likelihood of acceptance from the Local Authorities, subject to appropriate mitigation measures being in place.
- 3.3.7 The final 2 departures relate to junction approach visibility at the B1172 Norwich Road eastbound direction from the new link, and to Cantley Lane westbound direction from the new link. Full 'y' visibility to B1171 Norwich Road cannot be gained even using the 'x' distance = 2.4m for exceptionally difficult circumstances because of building and property boundaries. A departure for reduced visibility may be accepted because the approach traffic to the junction has just left a roundabout so speeds should be lower than normal link speeds. The 'y' visibility to Cantley Lane also cannot be gained using the 'x' distance = 2.4m for exceptionally difficult circumstances because of the rail bridge abutment. However, the local alignment at this location on Cantley Lane would

reduce speed significantly, offering the potential of acceptance by the Local Authority.

- 3.3.8 It has been mentioned previously within the report that the alignment has been developed based on the road being restricted with a 40mph speed limit. If agreement cannot be reached with Norfolk County Council and the Police for the implementation of a local 40mph speed limit, or traffic calming on part of Cantley Lane South, then the above Departure from Standards would be required for the geometric aspects and visibility at the junction of the proposed link road and Cantley Lane South.

3.4 Traffic

Table 3:1: Daily Traffic Flows

Scenario	Cantley Lane South
2015 Modelled AADT (vehicles)	740
2037 Modelled 24 Hour 2-way AADT (vehicles)	1,000 (Cantley Lane South to the west of new overpass)

- 3.4.1 The table above shows modelled daily traffic flows on Cantley Lane South extracted from the base (2015) Stage 3 design year (2037) highway transport model. With Option 4 in place, existing traffic on Cantley Lane South would now access the A47 via the new overpass, B1172 and Thickthorn interchange. The scheme option is unlikely to affect local traffic from Cringleford on Cantley Lane.
- 3.4.2 According to the base year model, the majority of the traffic appearing on Cantley Lane South belongs to Ketteringham outbound and Mulbarton outbound traffic to access A47. For Ketteringham and Mulbarton inbound traffic, the Thickthorn Junction, A11 then Station Lane South route would be used.
- 3.4.3 This scheme option is predicted to attract 1,000 AADT on Cantley Lane South to the west of the new overpass in 2037 with majority of the traffic belonging to Ketteringham outbound and Mulbarton outbound traffic to access the A47 as per the base year. This option could also see a small rise in traffic from a wider area utilising the new overpass to travel to Ketteringham Recycling Centre but this is not captured in the transport model.
- 3.4.4 Under this option, the average journey (i.e. inter-peak) to access Thickthorn Junction (B1172 approach) from Cantley Lane South in 2037 is approximately 2 minutes as compared to approximately 1 minute (A47 Westbound off slip road approach) in 2015.

3.5 Walking, cycling & horse riders

- 3.5.1 Option 4 is likely to provide a more attractive route for walkers, cyclists and horse riders when compared to Option 3, with the main caveat being that what is currently proposed to be a footbridge over the A11 and its new connector

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- roads is re-designed to accommodate all walkers, cyclists and horse riders, including mobility-impaired pedestrians and wheelchair users. This would re-connect the existing Cringleford footpaths FP1 and FP4.
- 3.5.2 Assuming, that the existing fencing/gate at the junction of Brettingham Avenue/Cantley Lane is retained (or similar, allowing full access by cyclists and horse riders), then between Brettingham Avenue and the WCHR bridge east of the A11 Cantley Lane essentially becomes a paved bridleway to tie into Cringleford BR5 Bridleway, albeit with occasional access by farm vehicles. This should be an attractive route, without requiring major engineering interventions aside from lighting, to delineate the route and improve the feeling of personal safety.
- 3.5.3 West of the A11 and the egress point from the WCHR bridge, Cantley Lane South provides access to around a dozen houses. Again, this will create a relatively quiet environment for walkers, cyclists and horse riders with little or no additional engineering measures required (with the exception, again, of lighting to define the route and increase personal safety).
- 3.5.4 However, the speed limit of Cantley Lane South is currently 60mph which could be reduced to 30mph since this will be a dead-end and those speeds are unlikely to be met.
- 3.5.5 To maintain the resident's connectivity to the east it is proposed to provide a link to the B1172 Norwich Road from a point approximately 400m west of the WCHR bridge. This will inevitably result in the rest of Cantley Lane South being subject to an increase in traffic volume and speeds. To make this safe for walkers, cyclists and horse riders will require segregated facilities alongside the carriageway. The link to the B1172 would also require similar WCHR facilities in order to create a joined-up network, ideally with a crossing to allow walkers and cyclists to access the 3m wide shared route running along the northern side of Norwich Road.
- 3.5.6 As detailed above under alignment, at the southern tie-in to Cantley Lane South, it is suggested that the priority for traffic is altered such that through traffic do not travel to the dead-end of Cantley Lane South which should only be access for the private dwellings. It is suggested that the link to the houses is made the minor arm of the T-junction with the western section of Cantley Road South joining directly to the B1172 link and becoming the major arm.
- 3.5.7 This would reduce the possibility of drivers mistakenly continuing along Cantley Road South when they should turn left to access the B1172 Norwich Road and thereby the risk of conflict with walkers, cyclists and horse riders. This layout would also allow those WCHR facilities suggested to be included on the link to continue seamlessly into those suggested for the western section of Cantley Road South, satisfying the need for such facilities to be coherent and direct.

3.6 Drainage

- 3.6.1 Any drainage proposal must be confirmed by way of a drainage survey which is currently being procured.
- 3.6.2 The B1172 Norwich Road appears not to have any gullies but seems to be super elevated to the southernmost channel where surface water appears to flow over the edge and into either an existing filter drain or an existing drainage ditch.
- 3.6.3 Cantley Lane South has an existing positive highway drainage network consisting of occasional gullies which presumably discharge to existing soakaways, existing surface water drains, existing watercourses or even connecting into the existing sewer system.
- 3.6.4 It is likely that the proposed drainage system would require additional piped attenuation and pollution control devices before discharging.
- 3.6.5 Given the lack of drainage on B1172 Norwich Road, the natural lie of the land falling southwards along Option 4 lends itself to a gravity drainage system draining southwards towards a proposed attenuation pond where it can discharge just north of the A11 and connector roads and ultimately discharge to Intwood Stream.
- 3.6.6 The proposed highway drainage at the southern tie-in to Cantley Lane South would discharge into a new soakaway which would be subject to confirmation of suitability through ground investigation and trials.
- 3.6.7 Should the ground investigation or trials prove soakaways to be inefficient or unsuitable, surface water could discharge to the existing Intwood Stream which would also require attenuation and pollution control devices.
- 3.6.8 Any discharge to watercourses will require drainage discharge consents from both the Lead Local Flood Authority and the Environment Agency.
- 3.6.9 The bridge deck across the A11 is likely to be approximately 115m in length to enable the link road to cross the A11 and connector roads consisting of a bridge deck, a trough structure and a box structure.
- 3.6.10 Draining such a length of structure will almost certainly require intermediate outfalls to avoid flooding of the highway which will require a carrier pipe across the structures.
- 3.6.11 It is assumed that the northern half of the structure could also discharge to the pond just north of the A11 and connector roads whilst the southern half could discharge to the soakaway or Intwood Stream since the structure is the high point of the link road.

- 3.6.12 A detailed drainage model needs to be created in conjunction with discussions with the Lead Local Flood Authority and Environment Agency to ascertain discharge rates into Cantley Stream and whether further attenuation will be required.
- 3.6.13 Furthermore, the proposals for the new link as part of Option 4 require construction of earthworks within the existing flood plain of Cantley Stream which will necessitate additional flood compensation to be provided.
- 3.6.14 The close-proximity of Cantley Stream is a constraint on the scheme and may lead to the need to divert the stream and introduce a new skewed culvert that crosses the proposed link at the junction with Cantley Lane South. These options could result in an increased flood risk to the property on the eastern side of Cantley Lane South in the location of the proposed junction. A robust flood risk assessment and drainage collection system will be required on the upstream side of this property to mitigate this risk.
- 3.6.15 Detailed river modelling is therefore required to determine flood risk and the compensatory flood areas required to safeguard nearby residential properties as well as hydraulic connectivity modelling of the new diversion between the upstream and downstream of the watercourse. Any necessary compensatory flood storage and other measures can be provided following the outcome of the flood risk study.

3.7 Geotechnical

- 3.7.1 Geological mapping indicates that natural superficial deposits comprise glacial sands and gravels of the Sheringham Cliffs Formation and chalky till of the Lowestoft Formation north and south of Cantley Brook. Alluvial soils comprising clay, silt, sand and gravels is present along the line of the Cantley Brook.
- 3.7.2 The former Cantley Lane landfill site is situated at Cantley Wood, immediately north of the alignment. This is considered in more detail in section 3.8.1.
- 3.7.3 Bedrock comprises Chalk of the White Sub-Group. Rockhead level varies across the site but is anticipated to occur from circa 18m AOD to 1m AOD (occurring between 17m and 13m below ground level locally). There is potential for some structures to adopt spread foundations, however depending on the magnitude of the foundation loads, majority of the structures may be piled.
- 3.7.4 High groundwater and risk of flooding can be associated with Cantley Brook and the River Yare valley area. The Chalk bedrock is highly permeable and designated a Principal Aquifer. Superficial soils are designated as a Secondary 'A' Aquifer (Sheringham Cliffs Formation) and Secondary (undifferentiated) Aquifer (Lowestoft Formation). While glacial clays and silts of the Lowestoft Formation are typically of low permeability, perched groundwater is anticipated within the granular lenses and the glacial sands and gravels. Groundwater

control measures will be required for the proposed extensive cutting sections into these deposits.

- 3.7.5 Cuttings into the glacial soils are likely to be stable at 1 in 3 slopes (with some potential for steeper gradient). However, groundwater control may be crucial to stability of cuttings, with an outside potential for slope strengthening or retention techniques to be considered.
- 3.7.6 The Alluvium deposits coincident with Cantley Brook are expected to be highly compressible. This is coincident with the proposed embankment and overbridge widening either side of the Breckland Railway Line, and the proposed embankment section south of A11 linking Cantley Lane South with the B1172.
- 3.7.7 Consideration should be given to design and construction measures to ensure foundation stability and mitigate differential settlement to earthworks and at structure interfaces. It is currently anticipated, subject to further investigation, that excavation and replacement of shallow compressible soils would form the basis for earthworks subgrade and foundation improvement. However, there are potential restrictions associated with Schedule Monuments (tumuli) present in the adjacent field to the proposed embankment section south of A11 linking Cantley Lane South with the B1172. The former Cantley Lane landfill is also located in this area which presents the risk of abnormal construction costs (see section 3.7.1).
- 3.7.8 It is anticipated that site won fill will be generated from cuttings in natural superficial deposits for reuse for embankment build (with or without modification), with reduced surplus fill due to the proposed Canley Lane South/B1172 Norwich Road link road embankment build. Notwithstanding, consideration should be given to the material makeup, properties and internal stability of the fill material adopted for embankment construction in a flood plain.

3.8 Contaminated land

- 3.8.1 The alignment traverses undeveloped land which is an historical landfill site (Cantley Lane Landfill) located within a former gravel pit. The landfill contains domestic, industrial, commercial and inert waste streams deposited during the 1960's.
- 3.8.2 Ground investigation fieldwork was undertaken in this section of the site in July 2018. Scheduled laboratory chemical and contaminated land test results are currently awaited and laboratory test results, as-built survey locations and the factual report for the recent ground investigation are yet to be received. Initial data from the recent ground investigation suggests that a section of the proposed Cantley Lane earthworks coincides with the footprint of the historical landfill.

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- 3.8.3 Exploratory hole preliminary log descriptions from two trial pits targeting the historical landfill footprint area indicate made ground comprising clayey sands and gravelly sandy clays to depths of 3.7m and 4.1m below ground level (bgl), underlain by a layer of possible domestic waste. The possible domestic waste layer is described as gravelly sand containing bricks, ceramics, plastic bags, plastic bottles, cups, crisp packets, crushed tins, foil material, glass and paper. The base of this waste layer was not determined; but it is expected to extend greater than 4.5m bgl where both trial pits were terminated. Nearby boreholes that do not encounter a similar waste layer suggest chalk bedrock is encountered around 6.3m bgl.
- 3.8.4 There remains significant uncertainty concerning the precise extent of the landfill waste, the depth of waste and its condition, as well as the interface with the undisturbed natural ground.
- 3.8.5 It is also unknown as to whether any pollution control measures were emplaced, such as an impermeable basal liner, in-ground cut-off walls or landfill gas vents, which could be required to remain functional. However, these are considered unlikely, as such engineered controls are not normally associated with landfills of this age.
- 3.8.6 Consultation with the local authority contaminated land officer and the Environment Agency will be necessary to further examine these issues. In addition, these regulatory bodies should confirm whether any action has previously taken place, or is planned, in connection with extant environmental risks.
- 3.8.7 The proposed engineering and construction works are likely to result in disturbance of the current status quo. This is in addition to practical engineering considerations of potentially working made ground and waste material, and management of contaminated excavation arisings.
- 3.8.8 In view of the current uncertainty, it is recommended that detailed investigation is completed of the route and the interface with the landfill site. These activities will also require prior planning and controls to mitigate potential environmental impacts during ground investigation.
- 3.8.9 The extant ground conditions and the nature of the waste materials, including landfill gas and leachate concentrations, will therefore require confirmation.
- 3.8.10 Chemical test data and monitoring of landfill gas levels is necessary to examine potential risks to the construction workforce, site users and the wider environment. WAC testing would also be appropriate at this stage to confirm potential abnormal disposal costs for surplus excavation material.

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- 3.8.11 The data is necessary to determine design parameters for the proposed road construction works, as well as any necessary engineered pollution control measures to manage the long-term environmental risks.
- 3.8.12 The remediation strategy should examine feasible and sustainable options to manage, remove/dispose or treat identified contaminated material where it is cost effective and practicable to do so. These techniques could include a range of biological, chemical and physical treatments such as biopiles, air sparging or soil washing. Engineered remediation works to mitigate unacceptable risks, which may include a cover layer over residual waste with drainage to minimise infiltration, and in-ground cut-off/vent trenches may also be appropriate.
- 3.8.13 The strategy should also address any regulatory requirements under development control or environmental permitting and include proposals for managing any previously unknown contamination encountered during the works.
- 3.8.14 Where practicable, material should be re-used on site provided performance criteria are met with respect to chemical composition and geotechnical parameters. This may be managed under a Materials Management Plan prepared in accordance with the Contaminated Land: Applications in Real Environments Code of Practice (CL:AIRE).

3.9 Pavement

- 3.9.1 The pavement is all new construction. Traffic figures are required to calculate design traffic in accordance with DMRB HD 24/06. Pavement materials and construction shall be in accordance with the relevant DMRB standards (namely HD26/06) and IANs (namely IAN73/06 Rev 1).

3.10 Structures

- 3.10.1 Option 4 includes 2 linked overbridges carrying the Cantley Lane link road over the existing A11 carriageway and new A11/A47 slip road. A new footbridge is required linking the footpath from Cantley Lane to Cantley Lane South. A new culvert is also required, to provide crossing of Cantley Stream under the new proposed link road.
- 3.10.2 The Stage 3 development of the 2 overbridges, the footbridge and the culvert is as follows:
- Overbridge over the A11 mainline carriageway – 44m long 2 span with steel composite deck. The deck will be integral with spread footing foundations constructed on reinforced soil abutments. A minimum headroom of 5.3m is required to the soffit of the bridge to comply with TD27/05

- Overbridge over the A11 to A47 link road – 15.9m skew span (14.9 square span) with prestressed precast concrete beams. The beams will be made integral with spread footing foundations constructed on reinforced soil abutments. A minimum headroom of 5.3m is required to the soffit of the bridge to comply with TD27/05
- For this option the existing Cantley Lane Footbridge would be demolished, and a new bridge constructed to span the widened A47 carriageway and slip roads. It is envisaged that the new footbridge will consist of a steel truss superstructure on reinforced concrete abutment wall founded on piles. The total bridge length would be approximately 49m and will allow for a minimum headroom of 5.7m to the soffit of the bridge to comply with TD27/05.
- At the junction of the new link road with Cantley Lane South, where the Cantley Stream crosses underneath the existing road, a new culvert will be required. The stream currently crosses beneath Cantley Lane South in a highly skewed culvert of unknown construction.

3.11 Environmental

Table 3:2: Summary of Environmental Impact

Cantley Lane – Option 4 (link to west via embankment and two new overbridges)	
	<p>Assumptions:</p> <ul style="list-style-type: none"> • The appraisal considers the options for the connection of Cantley Lane South in isolation from the main interchange works between the A11 and A47. • The appraisal assumes an altered baseline with the Cringleford Extension Development in the fields south of the Round House Roundabout being in place. • The construction-related issues (abnormal costs/programme delay/regulatory compliance/health and safety) are excluded and this assessment considers the environmental impacts only.
Topic	Summary of impact
Air Quality	It is not expected that the design would lead to increases in traffic flows along Cantley Lane South where there are sensitive receptors.

<p>Biodiversity</p>	<p>Nature Conservation designations:- None.</p> <p>Habitats: The proposed scheme is likely to result in direct and indirect impacts upon Natural Environmental and Rural Communities (NERC) Act habitats and other habitats of high biodiversity value, including arable field margins, broadleaved semi-natural woodland, streams, veteran trees (trees of significant age, size, condition or biodiversity value).</p> <p>Protected and notable species: Potential impacts upon badgers, reptiles, breeding birds, otter, water vole, polecat, roosting bats (trees with high bat roost potential identified), bat foraging and commuting.</p> <p>Mitigation: Mitigation would not be possible for the loss of a veteran tree. Loss of bat roosts would require licensing. A number of additional mitigation measures to avoid, reduce, mitigate or compensate are needed in order to manage potential ecological effects and reduce any significance.</p>
<p>Heritage</p>	<p>Cantley Lane South Option 4 is situated within 20m of a scheduled monument comprising 2 tumuli, a nationally significant designated asset. The road construction would introduce a large embankment in close proximity to the northernmost tumulus, thereby significantly altering the legibility of the context of the asset. Any buried archaeological remains associated with the asset, outside the scheduled monument boundary, would potentially be impacted through construction activities resulting in their loss, and further loss of the scheduled monument's contextual setting.</p> <p>Increased noise would introduce temporary effects through construction and permanent effects throughout operation of the scheme. This would result in a large adverse effect.</p>
<p>Landscape & Visual</p>	<p>Landscape elements Alignment impacts on tree cover at Cantley Wood which is likely to be of landscape value. Alignment passes through the centre of an open field to the west of the A11 causing fragmentation of the existing field pattern.</p> <p>Landscape character Likely moderate effect on Yare Tributary Farmland with Parkland landscape due to tree removal along southern edge of Cantley Wood, new sections of highway on embankment, incorporation of 2 new overbridges at the A11 crossing and fragmentation of field pattern between A11 and B1172.</p> <p>Visual Visual effect on visually sensitive private property at the eastern end of the link (where it meets Cantley Lane South) but otherwise few visual receptors other than low sensitivity travellers on the A11. Limited visual effects on footpath network but likely glimpsed views of raised embankment and overbridges from footpath (Heathersett FP6).</p>
<p>Noise</p>	<p>There are relatively few properties in the area immediately adjacent to the new link road between Norwich Road and Cantley Lane, however there are properties further to the west at which there is the potential for small increases in noise due to traffic noise from the new road. On Cantley Lane itself there is unlikely to be traffic increases therefore noise will not increase at the 12 properties adjacent to Cantley Lane.</p>
<p>Water Environment</p>	<p>The scheme is underlain by superficial deposits comprising sands and gravels and low permeability zones. These are classed by the Environment Agency as Secondary A (supports water supplies at a local rather than strategic scale (such as for private supplies) and remain important for rivers, wetlands and lakes) and secondary (undifferentiated) (where it has not been possible to attribute either category A or B to a rock type).</p>

In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type) aquifers respectively.

The bedrock comprises Chalk, which is classed as a principal aquifer (provides significant quantities of water and can support water supply and/or baseflow to rivers, lakes and wetlands on a strategic scale).

The Chalk has a vulnerability classification of Major Aquifer Intermediate (some protection of groundwater provided by overlying soils and superficial deposits).

These aquifers are part of the Broadlands Rivers Chalk and Crag groundwater body, which is a drinking water protected area and protected by the Nitrates Directive.

The scheme crosses a source protection zone (SPZ) 2 (Outer Zone), located at Ch. 6250 to the northern extent of the proposed scheme.

Dewatering may be required during construction of structures below the surface, which may impact on groundwater flow. Structures extending below the water table may act as a barrier to flow, creating a "groundwater dam".

New areas of hardstanding during construction and operation may intercept natural recharge to the underlying aquifer.

GI and subsequent groundwater monitoring will inform the assessment of groundwater risks. Mitigation would be through permanent and temporary works design, including drainage design.

Contaminated run-off, contact with construction materials, disturbance of contaminated land and accidental spills pose a risk to groundwater quality of both the superficial and bedrock aquifers. These risks would be mitigated by measures included in the Construction Environmental Management Plan (CEMP) and drainage design.

Consultation with the Environment Agency is likely to be required with respect to potential groundwater risks and mitigation measures.

The alignment between Ch.150 and Ch.300 closely approaches an historical landfill site (Cantley Lane Landfill) located within a former gravel pit. The landfill contains domestic, industrial, commercial and inert waste streams.

It is likely that the landfill remains a significant source of gas and leachate given its age and waste composition. No environmental baseline data currently exists. The potential exists for pollution of groundwater below the infilled pit which is a Secondary 'A' Aquifer. Cantley Brook is in close-proximity and may be in hydraulic continuity. If this is the case, then a second potential contaminant linkage may exist.

The proposed earthworks and road drainage within this area are likely to exacerbate any such existing environmental impacts in these regards both in the short-term and in the longer-term.

There is potential for accidental spillages or contaminated run-off from construction areas to enter surface water features namely Thickthorn Stream which is crossed directly by the proposed local link road. There is a requirement for direct works within Thickthorn Stream for the proposed diversion and culverting. An appropriate CEMP will be required to mitigate this risk and minimise any impacts on surface water quality and ensure flow conditions are not altered or interrupted during construction.

	<p>During operation, there will be an increased impermeable area which will require additional attenuation via soakaways/SuDS to ensure no increase in run-off peak flow rate or volume into Thickthorn Stream or other watercourses receiving drainage flows. Furthermore, there will be increased potential for routine runoff and spillage of contaminated run-off to enter receiving watercourses. It is assumed that these will be appropriately assessed and mitigated, where necessary.</p> <p>Floodplain storage compensation will be required on a level-by-level and volume-by-volume basis due to the construction of a new local link road embankment in the immediate vicinity of Thickthorn Stream and its functional floodplain. This represents a potential opportunity for betterment and beneficial effects.</p> <p>There are potential impacts on the Water Framework Directive (WFD) waterbody due to proposed diversion and culverting. A WFD Assessment will be required. Any diversion or culvert design should aim to maintain or improve existing flow conditions, geomorphology and quality of in-stream and riparian habitat. This represents a potential opportunity for betterment and beneficial effects.</p>
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4. Side Road Strategy Appraisal and Risk Assessment

- 4.1.1 A detailed assessment and risk assessment on each of the options have been undertaken in order to rank each option so as to identify the preferred side road strategy which are detailed in the following documents given at Appendix E and F:
- Side Road Strategy Options Appraisal ref. HE551492-MMSJV-GEN-000-SH-ZZ-00003 at Appendix E; and,
 - Side Road Strategy Options Designers Risk Assessment HE551492-MMSJV-GEN-000-SH-CX-00011 at Appendix F.
- 4.1.2 Two collaborative workshops were held to assess the above documents as well as the options benefits, impacts and risks. The first of which was held on 27/02/2018 and the second held on 27/04/2018 which were instrumental into the decision for the preferred Side Road Strategy.
- 4.1.3 Options 1 and 2 were assessed within the Scheme Assessment Report undertaken in June 2017. These options were not favourable and have not been assessed as part of this Side Road Strategy Assessment. This is because of the low-standard alignments, the proximity of the overhead power lines, visual intrusion of the embankments, increase in traffic noise and a potential increase in traffic travelling through the Cringleford Residential Extension Development.
- 4.1.4 The Side Road Strategy Options Appraisal ref. HE551492-MMSJV-GEN-000-SH-ZZ-00003 collects various information for each option assessed which are individually scored against the matrix within the appraisal to give a quantitative assessment of each option.
- 4.1.5 This provides evidence of the key considerations that have led to the decision of the preferred option including engineering, environmental, economic, operational, safety and other matters.
- 4.1.6 Safety is a legal requirement under the CDM Regulations and is a crucial element of the design, therefore, a Designers Risk Assessments has also been undertaken as detailed below.
- 4.1.7 The appraisal confirmed that Option 4 has the best score of 50 when compared to option 3 (score of 38), Option 5 (score of 29) Option 6 (score of 30) and Option 7 (score of 41).
- 4.1.8 This is primarily because Option 4:

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- i. Reduces the risk of objection or any potential compensation as a consequence of the proposed route through the Cringleford Residential Extension Development.
 - ii. Reduces the risk of objection by local Cringleford residents, particularly those along Cantley Lane who were concerned at the route being used as a 'rat run'.
 - iii. Avoids lengthy diversions for residents along Cantley lane.
 - iv. Provides a continuous route for non-motorised users between Cantley lane and Cantley lane South via the new non-motorised user bridge across the A47.
 - v. Generates less excavated materials and reduces the schemes export of surplus excavated material.
 - vi. Norfolk County Council preferred option.

4.1.9 Side Road Strategy Options Designers Risk Assessment HE551492-MMSJV-GEN-000-SH-CX-00011 was undertaken to rate each of the options.

4.1.10 The Designers Risk Assessment for each option is divided into different hazard groups where the risk, the hazard and mitigation measures are described and given a Red/Amber/Green rating (post mitigation).

4.1.11 The risk matrix within the Side Road Strategy Options Appraisal above is used to assist in the assessment of the risk ranking.

4.1.12 An overall risk rating for each option is then given at the bottom of the Designers Risk Assessment.

4.1.13 The Designers Risk Assessment confirmed that all options assessed had a high-risk rating post mitigation except Option 4 which was assessed as medium.

4.1.14 Despite the construction of a structure across the existing A11, works required to divert Cantley Stream, potential impacts upon the contaminated land and archaeology, Option 4 scored a medium primarily because:

- i. Option 4 removes impacts upon Cringleford Residential Extension Development.
- ii. Option 4 reduces the risk of the route being used as a 'rat run'.
- iii. Option 4 avoids lengthy diversions for residents along Cantley lane.

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- iv. Option 4 reduces the amount of works directly adjacent to overhead cables, particularly in relation to structures.
 - v. Option 4 reduces the effects from noise/air pollution and vibration as the option is further from Cringleford properties and impacts fewer properties.
 - vi. Option 4 generates less excavated materials and reduces the schemes export of surplus excavated material.

5. PCF Stage 3 Option 3 v. Option 4 Summary

5.1 Alignment

- 5.1.1 Option 3 connects Cantley Lane South to Round House Roundabout, with the route then travelling below the A47 via an underbridge. This is similar to the proposed option consulted upon within the Public Information Exhibition (PIE), except this option minimises severance to Plot 52A land and avoids the tie-in with Cantley Lane South, instead it ties into the Cringleford Residential extension development road network.
- 5.1.2 To achieve this tie-in, an 8% gradient is required which is above the maximum 5% grade to accommodate walkers, cyclists and horse riders, and also the maximum gradient for highways.
- 5.1.3 Furthermore, the short distance between the proposed underbridge and the connecting link within the development requires the alignment to be approx. 3.5m below existing ground level.
- 5.1.4 However, there is a risk associated with Option 3 whereby the developer could object to the layout if further traffic is routed through the development which could affect the sale or value of properties in the area.
- 5.1.5 Option 4 connects Cantley Lane South with the B1172 Norwich Road to the west of the Thickthorn Junction. The proposals pass over the A11 mainline and the A11 south to A47 east bi-directional interchange links with a new footbridge to replace the existing across the A47.
- 5.1.6 The alignment of the new Option 4 road link takes into consideration the potential to expand the Thickthorn Park and Ride site in the future, proximity of houses adjacent to Cantley Lane South, Cantley Stream and the Scheduled Monuments, consisting of 2 tumuli (round barrows) dating back to the bronze age.
- 5.1.7 The resulting alignment of the proposed link has been designed in accordance with Design Manual for Roads and Bridges (DMRB) it is suggested that the priority for traffic is altered at the southern tie-in to Cantley Lane South, such that through traffic does not travel to the dead-end of Cantley Lane. It is suggested that the link to the houses is made the minor arm of the T-junction with the western section of Cantley Road South joining directly to the B1172 link and becoming the major arm.

5.2 Walking, cycling & horse riders

- 5.2.1 Option 3 creates a suitable route for walkers, cyclists and horse riders linking Cantley Lane to Cantley Lane South and re-connects the existing Cringleford

footpaths FP1 and FP4, albeit via an underpass that will have to be lit and alongside the proposed highway although with the potential for multiple parked vehicles and cars emerging from private drives it could present a relatively hostile environment for horse riders.

- 5.2.2 The route of Option 3 will require pedestrians and cyclists to give-way or cross the carriageway junctions a number of times, going against the design principles of coherence and safety and will only get worse following the Cringleford Extension development as this is likely to attract additional non-residential through traffic.
- 5.2.3 Option 4 is likely to provide a more attractive route for walkers, cyclists and horse riders when compared to Option 3 because the proposed link road and the new footbridge will accommodate all walkers, cyclists and horse riders and re-connect the existing Cringleford footpaths FP1 and FP4.
- 5.2.4 Furthermore, the proposed link road will require segregated facilities alongside the carriageway and a pedestrian island will be required at B1172 Norwich Road to enable a crossing place for walkers, cyclists and horse riders to the footway on the north side of B1172 Norwich Road.

5.3 Environmental

Table 5:1: Summary of Options 3 and 4 Environmental Impact

Topic	Option 3	Option 4
Air Quality	Option 3 air quality impact not likely to be significant.	Option 4 air quality impact not likely to be significant.
Biodiversity	Option 3 adversely impacts upon NERC Act habitats and other habitats of high biodiversity value. Mitigation measures can be provided.	Option 4 adversely impacts upon NERC Act habitats and other habitats of high biodiversity value, including veteran trees. Mitigation measures can be implemented except for veteran trees where mitigation measures would take decades to provide the same quality of biodiversity value as would be lost.
Heritage	Option 3 situated within 270m of a scheduled monument potentially introducing temporary effects.	Option 4 situated within 20m of a scheduled monument significantly impacting legibility of the context of the asset and loss of archaeology remains.
Landscape & Visual	Option 3 at-grade or below grade avoids loss of Cantley Wood, severance of fields and favourable visual impacts.	Option 4 results in partial loss of Cantley Wood, severance of fields and adverse visual impacts as a result of elevated highway.
Noise	Option 3 slightly greater impact due to the Cringleford Development.	Option 4 results in no noise increase to Cantley Lane residents.

Water Environment	Option 3 slightly adverse impact due to the highway cutting intercepting groundwater.	Option 4 adversely impacts a source protection zone, landfill and flood plain. There would also be works to divert the watercourse which would negatively impact the water environment.
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5.4 Quantities

Table 5.2: Option 3 & 4 Quantities

	Units	Option 3	Option 4
Land	m2	60,000	130,000
Earthworks Cut*	m3	40,200	5,000
Earthworks Fill*	m3	1,400	61,000
Drainage carrier pipes	m	1100	1300
Drainage manholes	No.	17	20
Drainage pump station	No.	1	0
Pavement (S/C, B/C, Base)	m2	5500	5500
Kerbs	m	2200	2600
Street Lighting	No.	6	0
Structure – Footbridge	No.	0	1
Structure – RC Bridge	No.	1	1
Structure – Trough	No.	0	2
Structure – Box structure	No.	0	1
Cantley Stream Culvert	No.	0	1

* The earthworks cut/fill do not consider the material that could be re-used on site subject to suitability and testing for use in embankment areas.

5.5 Buildability

5.5.1 A buildability assessment was undertaken on programme and construction sequencing on the Thickthorn Junction Improvements although survey information was identified as being critical to develop the designs, identify early enabling works and could influence construction methodology as follows:

- Ground investigation
- Ecology surveys
- Topographical surveys
- Structural surveys
- Utility surveys
- Drainage surveys
- Condition surveys
- Archaeological surveys

5.5.2 The key buildability issues identified for Options 3 and 4 are as summarised below:

- Both options utilise similar temporary haul roads along the routes of Cantley Lane options
- Both options utilise the same site compound areas
- Both options consider the proposed future local developments of the Park & Ride and the Cringleford Residential Development
- Option 3 would require agreement with the Cringleford Extension Developer
- Option 3 would utilise a top-down construction for structures whilst option 4 would be bottom-up
- Option 4 would generate less excavated materials due to Cantley Lane being on embankment (subject to the re-use of site won material)
- Option 4 programme duration longer than Option 3

5.5.3 Furthermore, it has been identified that there is excess excavated material that could be used as landscape bund(s) within the site to suit local receptors to the scheme although precise location/extent/height of these are to be confirmed.

5.6 Risk assessment

5.6.1 Risk Assessments have been undertaken for Option 3 and Option 4 as given at Appendix B and C respectively.

5.7 Recommendations

- 5.7.1 It is recommended that Option 4 is taken forward into preliminary design since this option:
1. Removes the risk of any objection by the Cringleford Extension Developer or any potential compensation due
 2. Reduces the risk of objection by the Local Authority and local Cringleford residents, particularly those along Cantley Lane who were concerned at the route being used as a 'rat-run'.
 3. Removes the risk of objection by a local landowner as severance to Plot 52A land is avoided
 4. Provides a continuous route for walkers, cyclists and horse riders between Cantley Lane and Cantley Lane South via the footbridge
 5. Option 4 generates less excavated materials and can reduce the schemes surplus of excavated material

6. The detour to the main group of properties on Cantley Lane South (approx. 1.5km) avoids the restricted height/width along Cantley Lane which is rural 2-way single lane carriageway road with limited passing places and would minimise emergency services response times. Norfolk Fire Service indicated their preference towards this option
 7. This option minimises disruption to road users as the majority of this option is offline which reduces the traffic management required to existing highways
- 5.7.2 However, Option 4 does adversely impact on other items which will require mitigation as follows:
8. Creates a 1.5kilometre diversion for the residents along Cantley Lane South
 9. A number of departures from standard as detailed in Appendix D. Most of the relaxations and departures would be negated if agreement of a 40mph speed limit were agreed with Norfolk County Council and the Police
 10. Additional structures (6 No. compared to 1 No. for Option 3). There is however, the potential that the construction of these structures can run together to reduce the duration of the construction programme due to their offline nature as opposed to the online structure for Option 3
 11. Scheduled Monuments – geophysical survey required to confirm extents and whether the proposed link road adversely impacts upon buried archaeology
 12. Contaminated land remedials required
 13. Requires existing Cantley Stream and access track to be realigned/diverted as a result of this option. Flood Protection Zone - compensation required

Appendix A Drawings

Drawing Number:	Drawing Title:
HE551492-MMSJV-HGN-000-DR-CH-00001	Cantley Lane Option 3 - General Arrangement
HE551492-MMSJV-HGN-000-DR-CH-00002	Cantley Lane Option 4 - General Arrangement
HE551492-MMSJV-HGN-000-DR-CH-00007	Cantley Lane Option 5 - General Arrangement
HE551492-MMSJV-HGN-000-DR-CH-00003	Cantley Lane Option 6 - General Arrangement
HE551492-MMSJV-HGN-000-DR-CH-00004	Cantley Lane Option 7 - General Arrangement