
The Norfolk County Council (Norwich Northern Distributor Road (A1067 to A47(T))) Order

10.2 Design and Departures Report

Planning Act 2008

Infrastructure Planning

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1 Key Summary

- 1.1.1 Norfolk County Council adopted a preferred route for the Norwich Northern Distributor Road (known as the NDR) from the A1067 Fakenham Road at Attlebridge to the A47 at Postwick in September 2005. The highway alignment and geometry of the junctions were then developed in accordance with the highway standards, as far as reasonably practicable.
- 1.1.2 The purpose of this report is to outline the design approach adopted and departures from standards relating to the Design Manual for Roads and Bridges (DMRB) used by Norfolk County Council in the design of the mainline alignment of the NDR.
- 1.1.3 Compliance with the Design Manual for Roads and Bridges (DMRB) is mandatory for all Trunk Road works. Where it has not been possible to comply with the DMRB on the Trunk Road elements of the NDR scheme a departure from standard has been applied for. The details of these departures could be found in section 3 of this report. Four departure applications have been submitted and approved by the Highways Agency.
- 1.1.4 Where it has not been possible to comply with the DMRB on the local highway network sections of the NDR scheme the departures have been considered through the road safety audit process. The details of these departures could be found in section 4 of this report.

2 Introduction

2.1 The Scheme

- 2.1.1 This document is submitted in relation to the application for a Development Consent Order by Norfolk County Council to the Secretary of State, under the Planning Act 2008.
- 2.1.2 The Application is for the Norfolk County Council (Norwich Northern Distributor Road (A1067 to A47(T))) Order, to grant development consent for the construction of a new highway between the A1067 Fakenham Road and the A47 Trunk Road at Postwick and associated improvements to the existing highway network to the north and north east of Norwich
- 2.1.3 The majority of the junctions along the NDR are designed as at-grade roundabouts. Two grade-separated junctions are to be provided, one at the junction with the A140 and one where the NDR joins the A47(T). A signalised junction will be provided at the Postwick Park and Ride Junction.
- 2.1.4 Where the NDR joins the A47 Trunk Road at Postwick Junction, the new eastbound slip roads would become part of the trunk road network, with the remainder of the NDR incorporated into the local highway network.
- 2.1.5 The schematic layout of the NDR and the naming conventions for its component elements are illustrated in Appendix A.
- 2.1.6 Regulations 5 and 6 of the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 provide the statutory requirements for what must accompany a development consent application.
- 2.1.7 This document comprises part of the application documents and relates to Regulation 5(2)(q) of the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009.
- 2.1.8 Norfolk County Council (NCC) has included this document to outline the design approach adopted and the departures from standards relating to the Design Manual for Roads and Bridges (DMRB) used by Norfolk County Council in the design of the mainline alignment of the NDR.

2.2 Design Development

- 2.2.1 The requirement for an NDR was first formally identified in 1992 following a review of transportation strategies for the Greater Norwich area. Extensive public consultation and stakeholder engagement has helped to inform the development of the scheme since then. The various consultations carried out are explained in sections 3 and 4 of the Pre-application Consultation Report (document reference 5.1) which forms part of the application.
- 2.2.2 The County Council adopted a preferred route for the NDR from the A1067 Fakenham Road at Attlebridge to the A47 at Postwick in September 2005. Since then the highway alignment and geometry of the junctions have been developed in accordance with the highway standards as far as reasonably practicable. This report explains the route alignment and outlines departures from standards relating to the Design Manual for Roads and Bridges (DMRB) used in the design of the mainline alignment of the NDR.
- 2.2.3 The Transport Assessment (document reference 5.5) explains the shortcomings of the existing road network on the northern side of Norwich and the need for improved strategic connections between the radial routes, the A47(T), and the existing and proposed development areas served by these roads (including Norwich International Airport and the employment clusters at Postwick and Rackheath). Chapter 3 of the Environmental Statement (document reference 6.1) explains the need for a new strategic route and the alternatives that have been considered. Any new strategic route serving the northern parts of Norwich and its rural hinterland needs to have a connection with the A47(T), which is the closest part of the national Strategic Road Network. Given the significance of existing and proposed employment and housing growth to the north east of the city, a location on the A47(T) to the east of Norwich is the most appropriate starting point for any such new route. Such a location would also be of most benefit for improving accessibility and connectivity between the employment opportunities within Norwich and the Great Yarmouth Enterprise Zone. The existing Postwick junction (which already serves the Park and Ride site and the employment cluster at Broadland Business Park and related business parks) is the optimum location on the A47(T).
- 2.2.4 The aim was to provide a strategic connection between the A47(T) at Postwick and as many of the radial routes as possible, addressing current transport problems and also serving planned growth to the north east of Norwich. As Chapter 3 of the Environmental Statement explains, substantial

environmental constraints have been identified to any route lying to the west of the A1067 Fakenham Road because of the presence of the ecologically sensitive Wensum Valley. However, assessment has shown that a route from Postwick as far as the A1067 would be achievable without undue environmental impact. Norwich International Airport lies adjacent to the A140 Cromer Road, and any route would need to avoid prejudicing the operational requirements of the Airport. These constraints essentially define the route corridor within which the road has to be aligned. The corridor chosen for the NDR connects the A47(T) at Postwick with the A1067 Fakenham Road and respects these constraints. Within the identified corridor, the alignment selected for the road as far as is practicable minimises its impact on existing communities, sensitive environmental areas, and heritage assets.

- 2.2.5 Changes were made to the emerging scheme proposals as a result of responses received to the various consultations. The more recent changes to the scheme resulting from consultation in 2012 and 2013 are explained in the Pre-application Consultation Report.
- 2.2.6 Environmental assessment has been undertaken in parallel with all stages of scheme development, in accordance with the DMRB. An Environmental Impact Assessment has been undertaken of the final scheme and the results recorded in an Environmental Statement (document reference 6.1 and 6.2) which forms part of the application.
- 2.2.7 The aim of the design process has been to avoid impacts where possible. Where that proved impractical, environmental mitigation measures were incorporated into the Scheme design via an iterative design process. The environment team was represented at design meetings and Scheme design thus evolved with regard to environmental and social considerations. The effectiveness of the process was supported and informed by parallel assessment activities and consultation.

2.3 Design Concept

- 2.3.1 The NDR has been designed using current design standards contained in the DMRB. The DMRB sets a standard of good practice that has been developed principally for Trunk Roads and motorways. It is for the local highway authority to decide on the extent to which the documents in the manual are appropriate when used for local road schemes.
- 2.3.2 Compliance with the DMRB is mandatory for all Trunk Road works. Where it has not been possible to comply with the DMRB on the Trunk Road elements

of the NDR scheme a departure from standard has been applied for. Four departure applications have been submitted to the Highways Agency. The departure submissions are explained in section 3.

- 2.3.3 Where it has not been possible to comply with the DMRB on the local highway network sections of the NDR the departures have been considered through the road safety audit process. The departures from standards are explained in section 4.

2.4 Road Design Standards and Design Speeds

- 2.4.1 All main line links will be designed to the Design manual for Roads and Bridges (DMRB):
- 2.4.2 TD 9/93: Highway Link Design
- 2.4.3 TD 27/05: Cross-Sections and Headrooms
- 2.4.4 TD 22/06: Layout of Grade Separated Junctions
- 2.4.5 TD 51/03: Segregated Left Turn Lanes and Subsidiary Deflection Islands at Roundabouts
- 2.4.6 Roundabouts are designed in accordance with the DMRB:
- 2.4.7 TD 16/07: Geometric design of roundabouts
- 2.4.8 The NDR mainline alignment has been designed using the design speeds shown in Appendix A. Based on these design speeds sections 3 and 4 set out any departures from standards required.
- 2.4.9 Postwick Junction will be subject to a 40mph speed limit other than on slip roads. A design speed of 70kph has been adopted in accordance with DMRB TD 9/93: Highway Link Design except on the existing and proposed bridge crossings where a lower design speed of 60kph has been adopted. The lower speed is appropriate due to the short length of the links between junctions.
- 2.4.10 The slip road design speed for both the A47 and A140 grade separated junctions is determined from the mainline design speed. Both the mainline carriageways are subject to design speed of 120kph. Therefore the appropriate design speed for the slip roads is 70kph in accordance with DMRB TD 22/06: Layout of Grade Separated Junctions paragraph 4.5, Table 4/1. The slip road design speed is 70kph when the slip road is less than 0.75km in length and provides a connection to the local highway at-grade, the

lower speed is appropriate as vehicles will be slowing down or accelerating away from the local highway junction.

- 2.4.11 The NDR mainline carriageway north of the Business Park Roundabout will be subject to the relevant national speed limit (70mph). Therefore a design speed of 120kph has been adopted for the majority of the NDR mainline carriageway, in accordance with DMRB TD 9/93: Highway Link Design.
- 2.4.12 A design speed of 100kph has been adopted on the link road between Salhouse Road and Plumstead Road Roundabouts. The section between the roundabouts, which crosses the railway line, is 1200m long. It is considered that the 85% speed would not exceed 100kph on this section and that this would consequently be an appropriate design speed to apply for this section only.
- 2.4.13 The NDR mainline carriageway joins the existing A1067 Fakenham Road at its western end, the section of new carriageway between the proposed Fakenham Road Roundabout and the tie-in is a single carriageway road and therefore a design speed of 100kph is appropriate.

3 A47 Trunk Road Design

3.1 Eastbound Diverge Slip Road

- 3.1.1 Due to the low downstream flow predicted for the A47 mainline, the diverge type is not specified in Figure 2/5 of TD22/06. The traffic flows (vph) from the latest traffic modelling and corresponding design requirements are summarised in Tables F1 and F2 of Appendix B. The tables show that in both AM and PM peaks the traffic flows are above the threshold of 1200 vph for a Type A layout in both scenarios, suggesting that a Type A layout would not be suitable and a Type B or Type D layout should be adopted.
- 3.1.2 Working within the existing physical constraints of the River Yare/Railway Bridge and the Existing Postwick Bridge, a Layout D for a diverge slip road would require the widening of the River Yare/Railway Bridge which was estimated to cost £42 million in 2008. The nearest compliant layout that could be provided within the constraints for the new diverge slip road is a Layout B Parallel Diverge. This layout allows a taper diverge, where diverging traffic leaves the mainline A47 over a specified flare distance. The flare is followed by an auxiliary lane which is an additional lane at the side of the mainline and would provide a greater weaving length along the slip road in advance of the segregated left turn proposed at the North East Roundabout than a preferred ghost island diverge Layout B. This layout was submitted and approved as a departure from standards.

3.2 Eastbound Merge Slip Road

- 3.2.1 Due to the low upstream flows predicted for the A47 mainline, the merge type is not specified in Figure 2/3 of TD22/06. A Type E or Type F merge layout would require an additional lane on the A47 mainline carriageway. The nearest compliant layout that could be provided within the constraints for the new merge slip road is Layout B. A Layout B comprises an auxiliary lane followed by a taper merge over a specified flare distance. A Layout B was submitted and approved as a departure from standards.
- 3.2.2 The traffic flows (vph) from the latest traffic modelling and corresponding design requirements are summarised in Tables F3 and F4 of Appendix B.
- 3.2.3 The departure from standards is justified as a fully compliant design would require an additional lane on the A47 extending 2.6km to the following junction with an estimated cost at the time of the departure submission of £30m.

3.3 Westbound Diverge Slip Road

- 3.3.1 No design changes are proposed on the existing westbound diverge from the A47. The existing diverge slip road is a Type A taper diverge.
- 3.3.2 The traffic flows (vph) from the latest traffic modelling and corresponding design requirements are summarised in Tables F5 and F6 of Appendix B. The capacity assessment shows that in the 2017 AM and PM peak and the 2032 AM peak a two lane slip road with hard strip should be provided in accordance with TD 22/06 table 3/1b. However when the vph flows are inserted into Figure 2/5 the flows for all scenarios fall within the threshold of 1,200 vph for a single lane slip road other than the 2032 AM peak where the vph flow is 1,222. The design team therefore feel that a Layout A comprising a single lane slip road with two lanes on the A47 main line would still be appropriate.

3.4 Westbound Merge Slip Road

- 3.4.1 The proposed Scheme ties into the existing westbound merge slip road after the Park and Ride signalised junction. It is proposed to retain the existing two-lane taper merge layout onto the A47. The existing layout is not a standard layout as per TD 22/06.
- 3.4.2 The traffic flows (vph) from the latest traffic modelling and corresponding design requirements are summarised in Tables F7 and F8 of Appendix B. The slip road flows require the provision of a two lane slip road however due to the low upstream mainline flow the merge type is not specified in TD 22/06 Figure 2/3.
- 3.4.3 The nearest compliant TD 22/06 layout F could not be provided, as a type F layout would require an additional lane on the A47 mainline carriageway.
- 3.4.4 No works are proposed to the westbound merge taper layout as part of the proposed Scheme but in view of paragraph 2.28 of TD 22/06 a departure from standards to retain the existing two-lane taper merge was submitted and approved. The departure approval requires the provision of a two lane taper Layout D which can be accommodated within the existing carriageway footprint with minor modification to the road markings.
- 3.4.5 The departure is justified as a fully TD 22/06 compliant design would require an additional lane on the A47 with widening of the River Yare bridge. Based on the 2008 departure submission for the eastbound diverge the additional cost of providing this third lane would be in the order of £42m.

3.5 Structures

- 3.5.1 The proposed bridge design is for a three span steel and concrete composite bridge, crossing the A47 Norwich Southern Bypass with a skew angle of 54 degrees. One departure from standard has been identified which relates to the omission of abutment galleries from the design. Abutment galleries are provided below expansion and rotational joints to facilitate inspection and maintenance. The departure from standards was submitted and approved.

4 Local Highway Network

4.1 Carriageway Design

4.1.1 The predicted flows for an opening year of 2017 base on the latest traffic modelling are shown in Table 1 below.

Section of NDR	2017 Annual Average Daily Traffic (AADT)
A1067 to Fir Covert Road	12,300
Fir Covert Road to Reepham Road	14,200
Reepham Road to Drayton Lane	19,000
Drayton Lane to A140	22,300
A140 to B1150	19,500
B1150 to A1151	27,100
A1151 to Salhouse Road	33,000
Salhouse Road to Plumstead Road	35,200
Plumstead Road to A47	32,900

Table 1 – Predicted NDR Annual Average Daily Traffic (AADT) flows at year of opening (2017)

4.1.2 TA 46/97 and TD 70/08 give recommendations for the opening year AADT flows for carriageway standards as follows:

- Single 7.3m with hard strips (S2) – up to 13,000 vehicles per day;
- Wide Single 10m with hard strips (WS2) – between 6,000 and 21,000 vehicles per day;
- Wide Single 2+1 carriageway with hard strips (WS2+1) – up to 25,000 vehicles per day;
- Dual 2 lane all purpose with hard strips (D2AP) – between 11,000 and 39,000 vehicles per day.

4.1.3 The predicted flows for the NDR are in excess of the recommended economic flow range for S2 with the exception of the section between the A1067 and Fir Covert Road.

4.1.4 The predicted flows for the NDR are in excess of the recommended economic flow range for WS2 and WS2+1 for the section between the B1150 and the A47. Whilst WS2 could be provided between the A1067 and Drayton Lane lengths of WS2 in excess of 2km require departure from standard approval (TD 9/93 section 1.28).

- 4.1.5 Although the safety performance of WS2 roads is better than standard S2, it is significantly poorer than for dual carriageways. TRL research indicates that WS2 roads have accident rates over 30% higher than D2AP. For accidents causing deaths and serious injury the rate is 100% higher. In addition, WS2 roads have a higher than expected percentage of accidents involving overtaking than S2. This collision type has a high risk of death or serious injury as the outcome.
- 4.1.6 The basic design principle of WS2+1 is to promote journey time reliability on long distance single carriageway roads. The NDR's primary purpose is a distributor road. It would be difficult to decide what direction you would provide the additional lane between the individual roundabout junctions. Also, WS2+1 would introduce route inconsistency and the safety performance would be worse than D2AP due to the lack of median barrier.
- 4.1.7 A D2AP would provide a consistent standard for the NDR, it would provide continuity of road type with the A47 Norwich Southern Bypass and would provide a superior performance in terms of link accidents and user costs.

4.2 Mainline Horizontal Design

- 4.2.1 Table 3 TD9/93 gives standards for horizontal curvature for the relevant design speeds.
- 4.2.2 Paragraph 3.4 TD9/93 states relaxations in standard may be made at the discretion of the designer of up to 4 steps below desirable minimum standard for all-purpose band B roads.
- 4.2.3 Paragraph 3.15 TD9/93 states transition curves shall be provided on curves the radius of which are less than that shown in table 3, Minimum R without elimination of Adverse Camber & Transitions.
- 4.2.4 Paragraph 3.16 TD9/93 states 'q' values for transition curves should not normally exceed the value of 0.3 m/sec³.
- 4.2.5 The horizontal alignment for the proposed mainline link roads are shown in Appendix C, based on the design speeds specified in section 2.4 there are no departures from standards required for the mainline horizontal alignment.

4.3 Mainline Vertical Design

- 4.3.1 Table 3 TD9/93 gives standards for vertical curvature for the relevant design speeds.

- 4.3.2 Paragraph 4.9 TD9/93 states relaxations in standard for crest curves may be made at the discretion of the designer of up to 3 steps below desirable minimum standard for all-purpose band B roads.
- 4.3.3 Paragraph 4.14 TD9/93 states relaxations in standard for sag curves may be made at the discretion of the designer of up to 1 step below the absolute minimum standard for all-purpose roads.
- 4.3.4 Paragraph 1.26 TD9/93 states relaxations below Desirable Minimum in vertical curvature for crest curves and Absolute Minimum for sag curves are not permitted on the immediate approaches to a junction as defined in paragraph 1.26.
- 4.3.5 Paragraph 4.2 TD 9/93 states that only gradients greater than 8% are considered as a departure from standards.
- 4.3.6 The vertical alignment for the proposed mainline link roads are shown in Appendix D, based on the design speeds specified in section 2.4 there are no departures from standards required for the mainline vertical alignment.

4.4 Mainline Cross Section

- 4.4.1 Paragraph 4.2 in TD27/05 states the standards for new carriageway paved widths.
- 4.4.2 The cross sections for the proposed mainline link roads are shown in Appendix E.
- 4.4.3 The proposed cross section along the length of the mainline design is in accordance with TD27/05 for carriageway, hardstrip and central reserve widths, in some cases verge width provision is 1.5m rather than the required 2.5m. In these situations the verge is reduced due to the need to accommodate a shallow drainage swale. The swales are generally 3.0m wide with 1 in 5 side slopes and a depth of 200mm.

4.5 Mainline Stopping Sight Distance

- 4.5.1 Table 3 TD9/93 gives standards for stopping sight distance (SSD) for the relevant design speeds.
- 4.5.2 Paragraph 2.8 TD9/93 states relaxations in standard may be made at the discretion of the designer of up to 3 steps below desirable minimum standard for all-purpose band B roads.

- 4.5.3 Paragraph 2.2 TD 9/93 states that the SSD shall be measured from a minimum driver's eye height of between 1.05m and 2m to an object height of between 0.26m and 2.0m both above the road surface. It shall be checked in both the horizontal and vertical plane, in the case of dual carriageways between any two points in the centre of each lane for both carriageways on the inside of the curve.
- 4.5.4 Paragraph 1.26 in TD9/93 states relaxations below desirable minimum are not permitted on the immediate approaches to junction as defined in paragraph 1.26.
- 4.5.5 The SSD for the proposed link roads are shown in Appendix F based on the design speeds specified in section 2.4 there is one departure from standards required for the mainline SSD.
- 4.5.6 The NDR passes under Middle Road bridge between Plumstead Road Roundabout (South) and the Business Park Roundabout. At this location the Stopping Sight Distance (SSD) is restricted to 2 steps below standard for westbound lane 2 vehicles due to the presence of the required Vehicle Restraint System (VRS) and the bridge pier within the central reservation. Two steps below desirable minimum would normally be considered a relaxation. The horizontal radius under the bridge is also 1 step below standard and therefore this combination of relaxations is a departure from standards. The departure is considered acceptable by the design team as the reduction in SSD will be a momentary visibility impairment only. Increased visibility will be achievable over the VRS and behind the bridge pier.

4.6 A140 Grade Separated Junction

- 4.6.1 Due to the low flows predicted at the junction the diverge type is not specified in Figure 2/5 of TD22/06 for either the eastbound or westbound diverges from the mainline NDR carriageway. The traffic flows (vph) from the latest traffic modelling and corresponding diverge slip road design requirements are summarised in Tables F1, F2, F5 and F6 of Appendix G. The tables show that in both AM and PM peaks the traffic flows are below the threshold of 1200 vph for a Type A layout in both scenarios, suggesting that a Type A layout would be suitable. A Type A layout has therefore been adopted.
- 4.6.2 For the eastbound and westbound merge slip roads the traffic flows (vph) from the latest traffic modelling and corresponding design requirements are summarised in Tables F3, F4, F7 and F8 of Appendix G. The tables show that the ideal layout for the merge slip roads is a Type E lane gain layout. A

Type E layout would provide a single lane merge slip road joining a one lane NDR mainline carriageway to form a two lane downstream mainline carriageway. However, for reasons of route continuity, the NDR mainline has been designed with two lanes throughout. Therefore the nearest compliant layout is a Type A single lane taper merge. A Type A layout has therefore been adopted as a departure from standards.

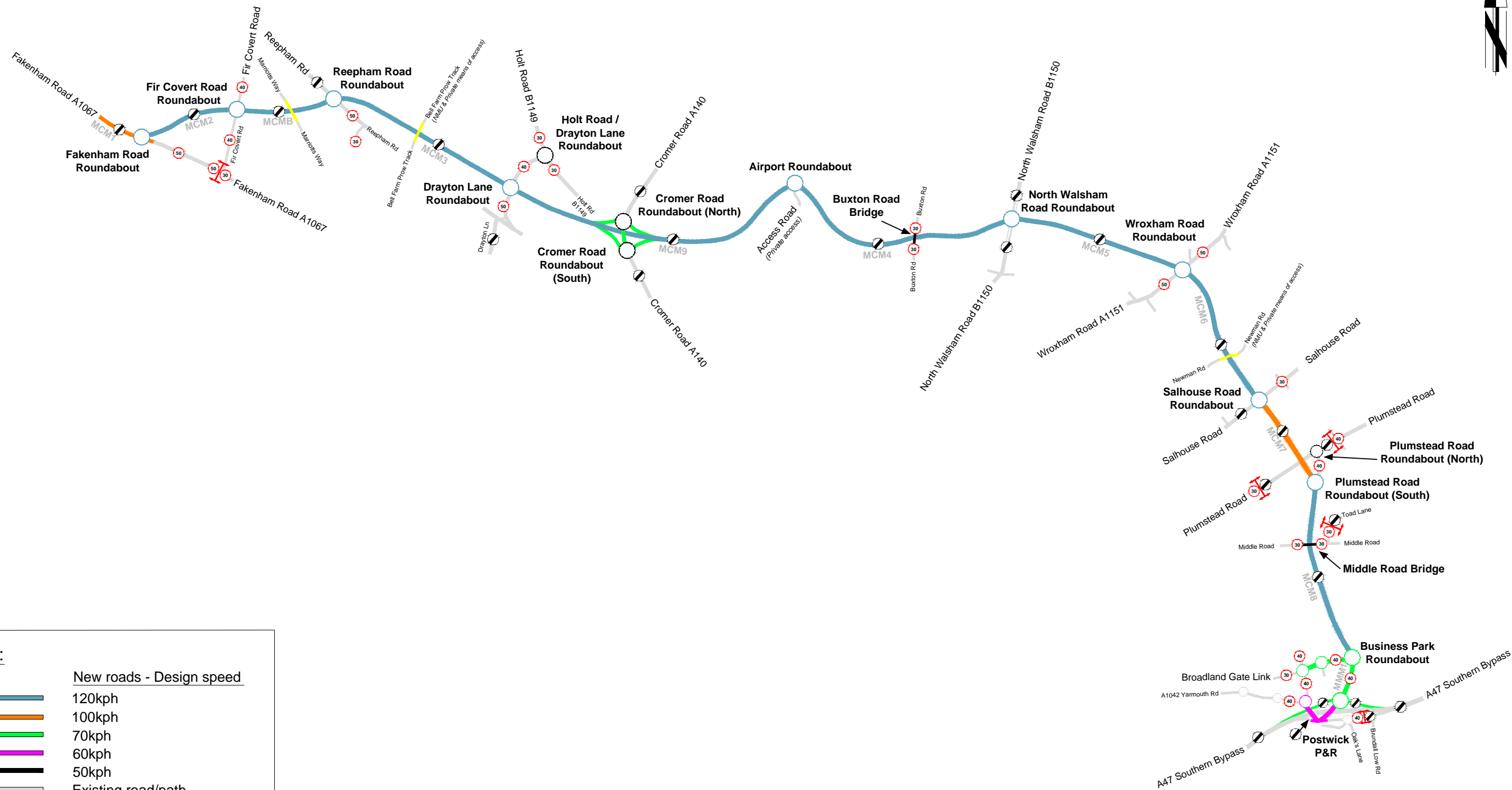
- 4.6.3 The westbound merge slip road has a two way section near the A140 Cromer Road Roundabout South. This is to allow access to a property and for maintenance vehicles to access the lagoon. Therefore the eastbound flow on the slip road will be extremely low. Paragraph 5.27 in TD22/06 states that two way slip roads must be dual carriageway with opposing traffic separated by a physical central reserve with vehicle restraint system. Due to the low opposing flow it is considered that a physical separation would result in an overdesigned layout. Therefore the two-way section of the slip road is a departure from standards and has been designed as a 7.3m wide two way carriageway. Signing will be provided to inform drivers of the layout ahead.

5 Conclusion

- 5.1.1 The proposed alignment follows the County Council's adopted preferred route for the NDR from the A1067 Fakenham Road at Attlebridge to the A47(T) at Postwick. The highway alignment and geometry of the junctions have been developed in accordance with the highway standards as far as reasonably practicable and with the objective of minimising its environmental impact within the available route corridor.
- 5.1.2 Compliance with the Design Manual for Roads and Bridges (DMRB) is mandatory for all Trunk Road works. Where it has not been possible to comply with the DMRB on the Trunk Road elements of the NDR scheme a departure from standards has been applied for. Four departure applications have been submitted to and approved by the Highways Agency. These departures are a result of working within the existing physical constraints of the River Yare/Railway Bridge and the Existing Postwick Bridge.
- 5.1.3 Where it has not been possible to comply with the DMRB on the local highway network sections of the NDR scheme the departures have been considered through the road safety audit process.
- 5.1.4 Two departures from standard are associated with the mainline alignment and two departures from standard are associated with the A140 grade separated junction. These departures have been reviewed during the road safety audit process and accepted by the independent safety audit team.

6 Appendices

Appendix A – R1C093-R1-4342 NDR Layout - Design Speeds



Key:

- New roads - Design speed
- 120kph
 - 100kph
 - 70kph
 - 60kph
 - 50kph
- Existing road/path
- Non motorised user (NMU) crossing
- Speed limit MPH/National
- Link road reference number

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REV.	DESCRIPTION	CHECKED	DATE

	INITIALS	DATE	DRAWING No.
SURVEYED BY	OS		R1C093-R1-4342
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Appendix B – Postwick A47 Slip Road Capacity Assessments

A47/A1042 Postwick Hub Junction Slip Roads – Layout Capacity Assessment

Eastbound Diverge Slip Road

	A47 Eastbound Diverge	A47 Eastbound Downstream	A47 Eastbound Upstream	Slip Road Requirement	Mainline Requirement	Diverge Type Required
AM	1,747	813	2,560	DG2E Two lanes with hardstrip	Two lanes upstream, One lane downstream	Not specified
PM	1,528	1,141	2,669	DG2E Two lanes with hardstrip	Two lanes upstream, One lane downstream	Not specified

Table F1 – A47 Eastbound diverge 2017 (Traffic volumes vph)

	A47 Eastbound Diverge	A47 Eastbound Downstream	A47 Eastbound Upstream	Slip Road Requirement	Mainline Requirement	Diverge Type Required
AM	2,236	844	3,080	DG2E Two lanes with hardstrip	Two lanes upstream, One lane downstream	Not specified
PM	2,006	1,175	3,181	DG2E Two lanes with hardstrip	Three lanes upstream, One lane downstream	Not specified

Table F2 – A47 Eastbound diverge 2032 (Traffic volumes vph)

Eastbound Merge Slip Road

	A47 Eastbound Merge	A47 Eastbound Upstream	A47 Eastbound Downstream	Slip Road Requirement	Mainline Requirement	Merge Required
AM	839	813	1,652	MG1C Single lane with hardshoulder	One lane upstream, Two lanes downstream	Type E (lane gain)
PM	1,210	1,141	2,351	MG2E Two lanes with hardstrip	One lane upstream, Two lanes downstream	Not specified

Table F3 – A47 Eastbound merge 2017 (Traffic volumes vph)

	A47 Eastbound Merge	A47 Eastbound Upstream	A47 Eastbound Downstream	Slip Road Requirement	Mainline Requirement	Merge Required
AM	864	844	1,708	MG1C Single lane with hardshoulder	One lane upstream, Two lanes downstream	Type E (lane gain)
PM	1,250	1,175	2,425	MG1E Two lanes with hardshoulder	One lane upstream, Two lanes downstream	Not specified

Table F4 – A47 Eastbound merge 2032 (Traffic volumes vph)

A47/A1042 Postwick Hub Junction Slip Roads – Layout Capacity Assessment

Westbound Diverge Slip Road

	A47 Westbound Diverge	A47 Westbound Downstream	A47 Westbound Upstream	Slip Road Requirement	Mainline Requirement	Diverge Type Required
AM	1,186	1,123	2,309	DG2E Two lanes with hardstrip	Two lanes upstream, One lane downstream	Not specified
PM	815	999	1,814	DG2E Two lanes with hardstrip	Two lanes upstream, One lane downstream	Not specified

Table F5 – A47 Westbound diverge 2017 (Traffic volumes vph)

	A47 Westbound Diverge	A47 Westbound Downstream	A47 Westbound Upstream	Slip Road Requirement	Mainline Requirement	Diverge Type Required
AM	1,222	1,273	2,495	DG2E Two lanes with hardstrip	Two lanes upstream, One lane downstream	Not specified
PM	590	1,184	1,774	DG1C Single lane with hardshoulder	Two lanes upstream, One lane downstream	Not specified

Table F6 – A47 Westbound diverge 2032(Traffic volumes vph)

Westbound Merge Slip Road

	A47 Westbound Merge	A47 Westbound Upstream	A47 Westbound Downstream	Slip Road Requirement	Mainline Requirement	Merge Required
AM	1,479	1,123	2,602	MG2E Two lanes with hardstrip	One lane upstream, Two lanes downstream	Not specified
PM	1,742	999	2,741	MG2E Two lanes with hardstrip	One lane upstream, Two lanes downstream	Not specified

Table F7 – A47 Westbound merge 2017 (Traffic volumes vph)

	A47 Westbound Merge	A47 Westbound Upstream	A47 Westbound Downstream	Slip Road Requirement	Mainline Requirement	Merge Required
AM	1,751	1,273	3,024	MG2E Two lanes with hardstrip	One lane upstream, Two lanes downstream	Not specified
PM	2,074	1,184	3,258	MG2E Two lanes with hardstrip	One lane upstream, Three lanes downstream	Not specified

Table F8 – A47 Westbound merge 2032 (Traffic volumes vph)

Appendix C – Horizontal Alignment Report

NDR - Main Alignment - Horizontal Report

DMRB Compliance of Horizontal Curve											
Control String	Design Speed (km/h)	Chainage	Radius (m)	Length (m)	Hand of Curve	Steps below Desirable	Transition requirement	Desirable Transition Compliance (q=0.3)	Super-elevation (%)	Comments	Relaxation or Departure
MCM1	100	0.000	Straight	17.665	NA	NA	NA	NA	NA	Straight	None
		17.665	Transition	68.939	NA	NA	NA	NA	NA	Transition	None
		86.604	1020	20.610	Left	0	Required	Yes	3.5	Superelevation achieved	None
		107.214	Transition	68.940	NA	NA	NA	NA	NA	Transition	None
		176.154	Straight	167.787	NA	NA	NA	NA	NA	Straight	None
		343.941	Transition	68.941	NA	NA	NA	NA	NA	Transition	None
		412.882	1020	295.049	Left	0	Required	Yes	3.5	Superelevation achieved	None
		707.932	50	8.401	Right	NA	NA	NA	NA	Not a design curve	None
		716.332	50	11.914	Left	NA	NA	NA	NA	Not a design curve	None
MCM2	120	0.000	50	30.860	Left	NA	NA	NA	NA	Not a design curve	None
		30.860	50	14.350	Right	NA	NA	NA	NA	Not a design curve	None
		45.210	1030	273.372	Left	0	Required	Yes	5	Superelevation achieved	None
		318.583	Transition	117.973	NA	NA	NA	NA	NA	Transition	None
		436.556	Transition	117.973	NA	NA	NA	NA	NA	Transition	None
		554.529	1030	646.771	Right	0	Required	Yes	5	Superelevation achieved	None
		1201.300	50	35.665	Left	NA	NA	NA	NA	Not a design curve	None
		1236.965	50	1.993	Right	NA	NA	NA	NA	Not a design curve	None
MCMB	120	0.000	50	32.792	Right	NA	NA	NA	NA	Not a design curve	None
		32.792	Straight	57.511	NA	NA	NA	NA	NA	Straight	None
		90.303	2040	1040.195	Left	0	NA	NA	NA	End to end curve	None
		1130.498	50	27.922	Left	NA	NA	NA	NA	Not a design curve	None
		1158.420	50	10.910	Right	NA	NA	NA	NA	Not a design curve	None
MCM3	120	0.000	50	36.869	Right	NA	NA	NA	NA	Not a design curve	None
		36.869	1030	457.953	Right	0	Required	Yes	5	Superelevation achieved	None
		494.822	Transition	117.973	NA	NA	NA	NA	NA	Transition	None
		612.795	Straight	1343.93	NA	NA	NA	NA	NA	Straight	None
		1956.730	Transition	12.151	NA	NA	NA	NA	NA	Transition	None
		1968.881	10000	402.233	Right	0	Not Required	Yes	NA	Radius > 2880m	None
		2371.114	75	42.784	Left	NA	NA	NA	NA	Not a design curve	None

NDR - Main Alignment - Horizontal Report

DMRB Compliance of Horizontal Curve											
Control String	Design Speed (km/h)	Chainage	Radius (m)	Length (m)	Hands of Curve	Steps below Desirable	Transition requirement	Desirable Transition Compliance (q=0.3)	Super-elevation (%)	Comments	Relaxation or Departure
MCM9	120	0.000	75	0.768	Left	NA	NA	NA	NA	Not a design curve	None
		0.768	75	43.585	Right	NA	NA	NA	NA	Not a design curve	None
		44.353	3500	609.854	Left	0	Not Required	NA	NA	Radius > 2880m	None
		654.207	Transition	8.302	NA	NA	NA	NA	NA	Transition	None
		662.509	4600	1728.39	Left	0	Not Required	NA	NA	Radius > 2880m	None
		2390.903	Transition	140.04	NA	NA	NA	NA	NA	Transition	None
		2530.943	730	507.899	Left	1	Required	Yes	7	Superelevation achieved	Relaxation
		3038.842	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		3205.297	Transition	117.973	NA	NA	NA	NA	NA	Transition	None
		3323.270	1030	455.19	Right	0	Required	Yes	5	Super achieved	None
		3778.461	45	13.457	Right	NA	NA	NA	NA	Not a design curve	None
MCM4	120	0.000	45	33.472	Right	NA	NA	NA	NA	Not a design curve	None
		33.472	1030	320.275	Right	0	Required	Yes	5	Superelevation achieved	None
		353.746	Transition	117.973	NA	NA	NA	NA	NA	Transition	None
		471.720	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		638.175	730	757.886	Left	1	Required	Yes	7	Superelevation achieved	Relaxation
		1396.061	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		1562.517	Straight	87.589	NA	NA	NA	NA	NA	Straight	None
		1650.105	Transition	117.973	NA	NA	NA	NA	NA	Transition	None
		1768.079	1030	229.757	Right	0	Required	Yes	5	Superelevation achieved	None
		1997.835	Transition	117.973	NA	NA	NA	NA	NA	Transition	None
		2115.809	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		2282.264	730	196.622	Left	1	Required	Yes	7	Superelevation achieved	Relaxation
		2478.886	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		2645.342	Transition	117.973	NA	NA	NA	NA	NA	Transition	None
		2763.315	1030	190.839	Right	0	Required	Yes	5	Superelevation achieved	None
		2954.154	75	22.522	Left	NA	NA	NA	NA	Not a design curve	None
		2976.676	75	3.036	Right	NA	NA	NA	NA	Not a design curve	None

NDR - Main Alignment - Horizontal Report

DMRB Compliance of Horizontal Curve

Control String	Design Speed (km/h)	Chainage	Radius (m)	Length (m)	Hands of Curve	Steps below Desirable	Transition requirement	Desirable Transition Compliance (q=0.3)	Super-elevation (%)	Comments	Relaxation or Departure
MCM5	120	0.000	75	43.926	Right	NA	NA	NA	NA	Not a design curve	None
		43.926	Straight	322.851	NA	NA	NA	NA	NA	Straight	None
		366.777	Transition	117.973	NA	NA	NA	NA	NA	Transition	None
		484.751	1030	88.687	Right	0	Required	Yes	5	Superelevation achieved	None
		573.438	Transition	117.973	NA	NA	NA	NA	NA	Transition	None
		691.411	Straight	832.997	NA	NA	NA	NA	NA	Straight	None
		1524.408	Transition	42.192	NA	NA	NA	NA	NA	Transition	None
		1566.599	2880	141.961	Left	0	Not Required	Yes	NA	Radius = 2880m	None
		1708.56	Transition	42.192	NA	NA	NA	NA	NA	Transition	None
		1750.752	Transition	77.397	NA	NA	NA	NA	NA	Transition	None
		1828.149	1570	274.463	Right	0	Required	Yes	3.3	Superelevation achieved	None
		2102.612	75	31.015	Left	NA	NA	NA	NA	Not a design curve	None
		2133.627	75	4.833	Right	NA	NA	NA	NA	Not a design curve	None
MCM6	120	0.000	74	43.555	Right	NA	NA	NA	NA	Not a design curve	None
		43.555	Straight	18.255	NA	NA	NA	NA	NA	Straight	None
		61.81	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		228.266	730	325.666	Right	1	Required	Yes	7	Superelevation achieved	Relaxation
		553.932	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		720.388	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		886.843	730	126.079	Left	1	Required	Yes	7	Superelevation achieved	Relaxation
		1012.922	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		1179.378	Straight	394.397	NA	NA	NA	NA	NA	Straight	None
		1573.775	Transition	38.575	NA	NA	NA	NA	NA	Transition	None
		1612.35	3150	206.084	Left	0	Not Required	Yes	NA	Radius > 2880m	None
		1818.435	75	43.371	Left	NA	NA	NA	NA	Not a design curve	None
		1861.805	75	1.072	Right	NA	NA	NA	NA	Not a design curve	None

NDR - Main Alignment - Horizontal Report

DMRB Compliance of Horizontal Curve											
Control String	Design Speed (km/h)	Chainage	Radius (m)	Length (m)	Hands of Curve	Steps below Desirable	Transition requirement	Desirable Transition Compliance	Super-elevation (%)	Comments	Relaxation or Departure
MCM7	100	0.000	75	43.862	Right	NA	NA	NA	NA	Not a design curve	None
		43.862	Straight	324.609	NA	NA	NA	NA	NA	Straight	None
		368.47	Transition	40.504	NA	NA	NA	NA	NA	Transition	None
		408.975	3000	234.759	Right	0	Not Required	Yes	NA	Radius > 2880m	None
		643.733	Transition	40.504	NA	NA	NA	NA	NA	Transition	None
		684.238	Straight	470.078	NA	NA	NA	NA	NA	Straight	None
		1154.316	50	25.383	Left	NA	NA	NA	NA	Not a design curve	None
		1179.699	50	22.039	Right	NA	NA	NA	NA	Not a design curve	None
MCM8	120	0.000	50	36.135	Right	NA	NA	NA	NA	Not a design curve	None
		36.135	Straight	489.811	NA	NA	NA	NA	NA	Straight	None
		525.946	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		692.402	730	155.681	Left	1	Required	Yes	7	Superelevation achieved	Relaxation
		848.083	Transition	166.456	NA	NA	NA	NA	NA	Transition	None
		1014.538	Straight	527.336	NA	NA	NA	NA	NA	Straight	None
		1541.874	Transition	99.194	NA	NA	NA	NA	NA	Transition	None
		1641.068	1225	75.346	Left	0	Required	Yes	4.2	Superelevation achieved	None
		1716.414	Transition	99.194	NA	NA	NA	NA	NA	Transition	None
		1815.608	Straight	356.27	NA	NA	NA	NA	NA	Straight	None
		2171.877	50	26.208	Left	NA	NA	NA	NA	Not a design curve	None
		2198.085	50	16.572	Right	NA	NA	NA	NA	Not a design curve	None
MMM1	70	0.000	50	36.983	Right	NA	NA	NA	NA	Not a design curve	None
		36.983	1020	512.655	Right	0	NA	NA	NA	End to end curve	None
		549.638	50	9.28	Left	NA	NA	NA	NA	Not a design curve	None
MMM5	60	0.000	1610	45.215	Left	NA	NA	NA	NA	Transition	None
		45.215	255	68.485	Right	0	Required	Yes	2.5	Approach to junction	None
		113.7	Straight	111.641	NA	NA	NA	NA	NA	Straight	None
		225.341	255	26.493	Right	NA	Required	NA	2.5	Not a design curve	None
		251.834	255	26.493	Left	NA	Required	NA	2.5	Not a design curve	None
		278.327	Straight	22.979	NA	NA	NA	NA	NA	Not a design curve	None
		301.306	50	26.454	Left	NA	NA	NA	NA	Not a design curve	None

Appendix D – Vertical Alignment Report

NDR - Main Alignment - Vertical Report

DMRB Compliance of Vertical Curve									
Control String	Design Speed (km/h)	Chainage	Grade (%)	K Value (m)	Curve type	Steps Level below	Within 1.5XSSD from Junction	Compliance Vertical	Relaxation or Departure
MCM1	100	0.000	1.06	Grade	NA	0	Y	Y	None
		133.108	1.69	26.00	Sag	0	Y	Y	None
		150.010	2.34	100.00	Hog	0	Y	Y	None
		654.732	-2.70	26.00	Sag	0	Y	Y	None
		725.033	0.00	Grade	NA	NA	N	NA	Not a design grade
MCM2	120	0.000	0.00	Grade	NA	NA	N	NA	Not a design grade
		1.448	0.00	2.00	Hog	NA	N	NA	Not a design grade
		8.028	-3.29	7.50	Sag	NA	N	NA	Not a design grade
		43.962	1.50	55.00	Hog	NA	Y	Y	Not a design grade
		71.545	1.00	Grade	NA	0	Y	Y	None
		255.170	1.00	182.00	Hog	0	Y	Y	None
		386.341	0.28	37.00	Sag	0	Y	Y	None
		487.007	3.00	Grade	NA	0	N	Y	None
		820.705	3.00	182.00	Hog	0	Y	Y	None
		1180.609	1.02	7.50	Hog	NA	Y	NA	Not a design grade
		1188.278	0.00	Grade	NA	NA	Y	NA	Not a design grade
MCMB	120	0.000	0.00	Grade	NA	NA	N	NA	Not a design grade
		0.863	0.00	7.50	Sag	NA	N	NA	Not a design grade
		16.677	2.11	7.50	Hog	NA	N	NA	Not a design grade
		27.973	0.60	182.00	Hog	0	Y	Y	None
		228.616	-0.50	Grade	NA	0	Y	Y	None
		1093.885	-0.50	37.00	Sag	0	Y	Y	None
		1112.385	0.00	Grade	NA	NA	Y	NA	Not a design grade
MCM3	120	0.000	0.00	Grade	NA	NA	N	NA	Not a design grade
		72.845	0.00	7.50	Hog	NA	Y	NA	Not a design grade
		79.394	-0.87	Grade	NA	0	Y	Y	None
		156.150	-0.87	50.00	Sag	0	Y	Y	None
		268.818	1.38	182.00	Hog	0	Y	Y	None
		754.645	-1.29	50.00	Sag	0	N	Y	None
		794.107	-0.50	Grade	NA	0	N	Y	None
		1681.407	-0.50	50.00	Sag	0	N	Y	None
		1736.469	0.60	Grade	NA	0	Y	Y	None

NDR - Main Alignment - Vertical Report

DMRB Compliance of Vertical Curve									
Control String	Design Speed (km/h)	Chainage	Grade (%)	K Value (m)	Curve type	Steps Level below	Within 1.5XSSD from Junction	Compliance Vertical	Relaxation or Departure
MCM9	120	0.000	0.60	Grade	NA	NA	N	NA	Not a design grade
		224.112	0.60	230.00	Hog	0	Y	Y	None
		553.235	-0.83	Grade	NA	0	N	Y	None
		947.247	-0.83	500.00	Hog	0	N	Y	None
		1388.017	-1.71	37.00	Sag	0	N	Y	None
		1510.603	1.60	Grade	NA	0	N	Y	None
		1859.536	1.60	220.00	Hog	0	N	Y	None
		2564.219	-1.60	Grade	NA	0	N	Y	None
		2746.227	-1.60	50.00	Sag	0	N	Y	None
		2801.223	-0.50	Grade	NA	0	N	Y	None
		3344.592	-0.50	50.00	Sag	0	Y	Y	None
		3394.582	-0.50	Grade	NA	0	Y	Y	None
MCM4	120	0.000	0.50	Grade	NA	0	N	Y	None
		116.195	0.50	182.00	Hog	0	Y	Y	None
		381.486	-0.96	Grade	NA	0	Y	Y	None
		585.790	-0.96	50.00	Sag	0	N	Y	None
		671.152	0.75	Grade	NA	0	N	Y	None
		1023.002	0.75	182.00	Hog	0	N	Y	None
		1460.630	-1.65	Grade	NA	0	N	Y	None
		1764.451	-1.65	37.00	Sag	0	N	Y	None
		1895.865	1.90	182.00	Hog	0	N	Y	None
		2150.165	0.50	Grade	NA	0	N	Y	None
		2462.536	0.50	182.00	Hog	0	Y	Y	None
		2644.535	-0.50	Grade	NA	0	Y	Y	None
		2903.062	-0.50	7.50	Hog	NA	Y	NA	Not a design grade
		2906.362	-0.94	Grade	NA	NA	Y	NA	Not a design grade

NDR - Main Alignment - Vertical Report

DMRB Compliance of Vertical Curve									
Control String	Design Speed (km/h)	Chainage	Grade (%)	K Value (m)	Curve type	Steps Level below	Within 1.5XSSD from Junction	Compliance Vertical	Relaxation or Departure
MCM5	120.00	0.000	-0.94	Grade	NA	NA	N	NA	Not a design grade
		71.962	-0.94	7.50	Hog	NA	Y	NA	Not a design grade
		78.037	-1.75	Grade	NA	0	Y	Y	None
		277.350	-1.75	50.00	Sag	0	Y	Y	None
		339.850	-0.50	Grade	NA	0	Y	Y	None
		519.890	-0.50	50.00	Sag	0	N	Y	None
		569.890	0.50	Grade	NA	0	N	Y	None
		738.140	0.50	182.00	Hog	0	N	Y	None
		1136.151	-1.69	50.00	Sag	0	N	Y	None
		1257.994	0.75	Grade	NA	0	N	Y	None
		1672.106	0.75	182.00	Hog	0	Y	Y	None
		1899.605	-0.50	Grade	NA	0	Y	Y	None
		2061.585	-0.50	7.50	Sag	NA	Y	NA	Not a design grade
		2065.335	0.00	Grade	NA	NA	Y	NA	Not a design grade
MCM6	120.00	0.000	0.00	Grade	NA	NA	NA	NA	Not a design grade
		75.636	0.00	7.50	Sag	NA	Y	NA	Not a design grade
		79.311	0.49	182.00	Hog	0	Y	Y	None
		259.492	-0.50	Grade	NA	0	Y	Y	None
		543.891	-0.50	37.00	Sag	0	N	Y	None
		674.837	3.14	182.00	Hog	0	N	Y	None
		1154.842	0.50	Grade	NA	0	N	Y	None
		1786.047	0.50	7.50	Hog	NA	Y	NA	Not a design grade
		1789.797	0.00	Grade	NA	NA	Y	NA	Not a design grade
MCM7	100	0.000	0.00	Grade	NA	NA	N	NA	Not a design grade
		60.806	0.00	7.50	Hog	NA	Y	NA	Not a design grade
		66.278	-0.73	Grade	NA	0	Y	Y	None
		283.829	-0.73	37.00	Sag	0	Y	Y	None
		416.22	2.85	100.00	Hog	0	N	Y	None
		1075.545	-3.74	26.000	Sag	0	Y	Y	None
		1107.093	-2.53	7.500	Sag	NA	Y	NA	Not a design grade
		1118.575	-1.00	Grade	NA	NA	Y	NA	Not a design grade

NDR - Main Alignment - Vertical Report

DMRB Compliance of Vertical Curve									
Control String	Design Speed (km/h)	Chainage	Grade (%)	K Value (m)	Curve type	Steps Level below	Within 1.5XSSD from Junction	Compliance Vertical	Relaxation or Departure
MCM8	120	0.000	-1.00	Grade	NA	NA	N	NA	Not a design grade
		56.927	-1.00	7.50	Sag	NA	Y	NA	Not a design grade
		68.176	0.50	Grade	NA	0	Y	Y	None
		532.07	0.50	182.00	Hog	0	N	Y	None
		738.308	-0.63	50.00	Sag	0	N	Y	None
		802.461	0.65	182.00	Hog	0	N	Y	None
		1011.724	-0.50	Grade	NA	0	N	Y	None
		1405.686	-0.50	50.00	Sag	0	N	Y	None
		1489.423	1.17	182.00	Hog	0	N	Y	None
		1794.222	-0.50	Grade	NA	0	Y	Y	None
		1958.870	-0.50	50.00	Sag	0	Y	Y	None
		2033.869	1.00	Grade	NA	0	Y	Y	None
		2136.250	1.00	7.50	Hog	NA	Y	NA	Not a design grade
		2143.75	0.00	Grade	NA	NA	Y	NA	Not a design grade
MMM1	70	0.000	-0.35	Grade	NA	0	Y	Y	None
MMM5	60	0.000	2.50	Grade	NA	NA	N	NA	Not a design grade
		1.635	2.50	13.00	Sag	0	N	Y	None
		47.135	6.00	Grade	NA	0	Y	Y	None
		140.831	6.00	17.00	Hog	0	Y	Y	None
		263.552	-1.16	34.00	Sag	0	Y	Y	None

Appendix E – Cross Sections Report

DMRB Compliance of Cross Sections													
	Left							Right					
CHAINAGE (m)	Swale	Verge	Hard Strip	Lane 1	Lane 2	Hard Strip	Central Reserve	Hard Strip	Lane 3	Lane 4	Hard Strip	Verge	Swale
		2.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	2.5	
0	3	1.5	1	3.65	Single Carriageway					3.65	1	2.5	n/a
250	3	1.5	1	3.65	Single Carriageway					3.65	1	2.5	n/a
500	Fakenham Road Roundabout												
750	n/a	2.5	1	3.65	3.65	1	8.35	1	3.65	3.65	1	2.5	n/a
1000	n/a	2.5	1	3.65	3.65	1	8.54	1	3.65	3.65	1	1.5	3
1250	n/a	2.5	1	3.65	3.65	1	8.55	1	3.65	3.65	1	3.03	3
1500	n/a	2.5	1	3.65	3.65	1	8.44	1	3.65	3.65	1	3.19	3
1750	Fir Covert Road Roundabout												
2000	3	1.5	1	3.65	3.65	1	3.14	1	3.65	3.65	1	1.5	3
2250	3	1.5	1	3.65	3.65	1	3.11	1	3.65	3.65	1	1.5	3
2500	3	1.5	1	3.65	3.65	1	2.95	1	3.65	3.65	1	1.5	3
2750	3	1.5	1	3.65	3.65	1	2.68	1	3.65	3.65	1	1.5	3
	Reepham Road Roundabout												
3000	Roundabout approach												
3250	n/a	2.5	1	3.65	3.65	1	3.38	1	3.65	3.65	1	3.19	3
3500	3	1.5	1	3.65	3.65	1	2.68	1	3.65	3.65	1	1.5	3
3750	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
4000	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
4250	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
4500	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
4750	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
5000	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
5250	Roundabout approach												
	Drayton Lane Roundabout												
5500	3	1.5	1	3.65	3.65	1	2.59	1	3.65	3.65	1	1.5	3
5750	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
6000	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3

NDR - Main Alignment - Cross Sections

CHAINAGE (m)	Left						Central Reserve	Right					
	Swale	Verge	Hard Strip	Lane 1	Lane 2	Hard Strip		Hard Strip	Lane 3	Lane 4	Hard Strip	Verge	Swale
		2.5	1	3.65	3.65	1		1	3.65	3.65	1	2.5	
6250	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
6500	n/a	3.93	1	3.65	3.65	1	2.5	1	3.65	3.65	1	2.12	Slip Rd
6750	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
	Cromer Road Overbridge												
7000	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
7250	3	2.84	1	3.65	3.65	1	2.5	1	3.65	3.65	Slip Road		
7500	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
7750	3	1.59	1	3.65	3.65	1	3.59	1	3.65	3.65	1	1.5	3
8000	3	5.06	1	3.65	3.65	1	5.7	1	3.65	3.65	1	2.5	n/a
8250	3	5.09	1	3.65	3.65	1	5.7	1	3.65	3.65	1	2.5	n/a
8500	3	1.5	1	3.65	3.65	1	6.92	1	3.65	3.65	1	1.5	3
8750	3	1.5	1	3.65	3.65	1	8.36	1	3.65	3.65	1	3.01	3
9000	3	1.5	1	3.65	3.65	1	8.36	1	3.65	3.65	1	3.22	3
	Airport Roundabout												
9250	3	1.5	1	3.65	3.65	1	3.38	1	3.65	3.65	1	3.86	3
9500	3	1.5	1	3.65	3.65	1	3.5	1	3.65	3.65	1	1.61	3
9750	3	3.93	1	3.65	3.65	1	5.66	1	3.65	3.65	1	2.5	n/a
10000	3	5.48	1	3.65	3.65	1	5.7	1	3.65	3.65	1	2.5	n/a
10250	3	5.48	1	3.65	3.65	1	5.7	1	3.65	3.65	1	1.5	3
10500	3	4.14	1	3.65	3.65	1	5.62	1	3.65	3.65	1	1.5	3
10750	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
11000	3	1.5	1	3.65	3.65	1	3.38	1	3.65	3.65	1	3.24	3
11250	3	1.5	1	3.65	3.65	1	4.43	1	3.65	3.65	1	1.5	3
11500	3	5.19	1	3.65	3.65	1	5.69	1	3.65	3.65	1	2.5	n/a
11750	3	1.5	1	3.65	3.65	1	7.11	1	3.65	3.65	1	1.5	3
12000	Roundabout approach												
	North Walsham Road Roundabout												
12250	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
12500	3	1.5	1	3.65	3.65	1	2.74	1	3.65	3.65	1	1.5	3
12750	3	1.5	1	3.65	3.65	1	2.78	1	3.65	3.65	1	1.5	3

NDR - Main Alignment - Cross Sections

CHAINAGE (m)	Left						Central Reserve	Right					
	Swale	Verge	Hard Strip	Lane 1	Lane 2	Hard Strip		Hard Strip	Lane 3	Lane 4	Hard Strip	Verge	Swale
		2.5	1	3.65	3.65	1		2.5	1	3.65	3.65	1	2.5
13000	3	1.5	1	3.65	3.65	1	2.53	1	3.65	3.65	1	1.5	3
13250	3	1.5	1	3.65	3.65	1	2.56	1	3.65	3.65	1	1.5	3
13500	3	1.5	1	3.65	3.65	1	2.59	1	3.65	3.65	1	1.5	3
13750	3	1.5	1	3.65	3.65	1	2.56	1	3.65	3.65	1	1.5	3
14000	3	1.5	1	3.65	3.65	1	4.7	1	3.65	3.65	1	1.5	3
14250	Wroxham Road Roundabout												
14500	n/a	2.5	1	3.65	3.65	1	4.7	1	3.65	3.65	1	1.5	3
14750	n/a	2.5	1	3.65	3.65	1	5.68	1	3.65	3.65	1	4.89	3
15000	3	1.5	1	3.65	3.65	1	5.67	1	3.65	3.65	1	1.5	3
15250	3	3.78	1	3.65	3.65	1	5.51	1	3.65	3.65	1	1.5	3
15500	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
15750	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
16000	n/a	4.52	1	3.65	3.65	1	3.19	1	3.65	3.65	1	1.5	3
	Salhouse Road Roundabout												
16250	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
16500	n/a	2.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	2.5	n/a
16750	n/a	2.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	2.5	n/a
17000	n/a	2.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	2.5	n/a
17250	Roundabout approach												
	Plumstead Road Roundabout South												
17500	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
17750	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
18000	3	3.68	1	3.65	3.65	1	5.55	1	3.65	3.65	1	1.5	3
18250	3	1.47	1	3.65	3.65	1	3.74	1	3.65	3.65	1	1.5	3
18500	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
18750	Lay-by		1	3.65	3.65	1	2.5	1	3.65	3.65	1	Lay-by	
19000	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3
19250	3	1.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	1.5	3

NDR - Main Alignment - Cross Sections

	Left							Right					
CHAINAGE (m)	Swale	Verge	Hard Strip	Lane 1	Lane 2	Hard Strip	Central Reserve	Hard Strip	Lane 3	Lane 4	Hard Strip	Verge	Swale
		2.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	2.5	
19500	Business Park Roundabout												
19750	n/a	4.5	1	3.65	3.65	1	2.5	1	3.65	3.65	1	2	6.586
20000	n/a	4.5	1	3.65	3.65	1	2.5	1	5.347	Island 3.29m	SLT 6.447m	verge 6.018m	
	Roundabout approach												
	North East Roundabout												
	New Postwick Bridge												
20250	n/a	Foot way = 3		3.65	3.65	Lane 3 = 3.65	1.8	n/a	3.65	n/a	Hardened verge1m		n/a
	Park and Ride Signalested Junction												

Appendix F – Stopping Sight Distance Report

NDR-Main Alignment SSD Report

Reference Strings	Design Speed (km/h)	SSD Required	Direction	Chainage Range	Lane	Step below standard	Relaxation or Departure	Reason	Comments
MCM1	100	215	Eastbound	0 to 715	1	None	None		
		215	Westbound	5 to 720	1	None	None		
MCM2	120	295	Eastbound	80 to 1105	1	None	None		
		295			2	None	None		
		295	Westbound	115 to 1110	1	None	None		
		295			2	None	None		
MCMB	120	295	Eastbound	110 to 1065	1	1 step	Relaxation		
		295			2	None	None		
		295	Westbound	115 to 1080	1	None	None		
		295			2	1 step	Relaxation		
MCM3	120	295	Eastbound	80 to 2300	1	1 step	Relaxation		
		295			2	2 step	Relaxation		
		295	Westbound	105 to 2335	1	1 step	Relaxation		
		295			2	None	None		
MCM9	120	295	Eastbound	85 to 3720	1	None	None		
		295			2	None	None		
		295	Westbound	310 to 3500	1	1 step	Relaxation		
		295			2	1 step	Relaxation		
MCM4	120	295	Eastbound	80 to 2835	1	1 step	Relaxation		
		295			2	2 step	Relaxation		
		295	Westbound	75 to 2890	1	1 step	Relaxation		
		295			2	1 step	Relaxation		
MCM5	120	295	Eastbound	75 to 2025	1	1 step	Relaxation		
		295			2	1 step	Relaxation		
		295	Westbound	95 to 2050	1	1 step	Relaxation		
		295			2	1 step	Relaxation		
MCM6	120	295	Eastbound	170 to 1740	1	None	None		
		295			2	1 step	Relaxation		
		295	Westbound	170 to 1775	1	1 step	Relaxation		
		295			2	1 step	Relaxation		
MCM7	100	215	Eastbound	170 to 1095	1	1 step	Relaxation		
		215			2	1 step	Relaxation		
		215	Westbound	175 to 1100	1	None	None		
		215			2	None	None		
MCM8	120	295	Eastbound	80 to 1950	1	1 step	Relaxation		
		295			2	1 step	Relaxation		
		295	Westbound	80 to 1945	1	1 step	Relaxation		
		295			2	2 step	Departure	Horizontal radius is 1 step below	Center reserve VRS - Visibility splay crosses VRS and Bridge piers
MMM1	70	120	Eastbound	100 to 460	1	None	None		
		120			2	None	None		
		120	Westbound	100 to 460	1	None	None		
		120			2	None	None		
MMM5	60	90	Eastbound	0 to 275	1	1 step	Relaxation		
		90	Westbound	0 to 275	1	1 step	Relaxation		
		90	Westbound	0 to 275	2	1 step	Relaxation		

Appendix G – NDR/A140 Slip Road Capacity Assessments

NDR/A140 Slip Roads – Layout Capacity Assessment

Eastbound Diverge Slip Road

	NDR Eastbound Diverge	NDR Eastbound Downstream	NDR Eastbound Upstream	Slip Road Requirement	Mainline Requirement	Diverge Type Required
AM	555	811	1,366	DG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Not Specified
PM	481	654	1,135	DG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Not Specified

Table F1 – NDR Eastbound diverge 2017 (Traffic volumes vph)

	NDR Eastbound Diverge	NDR Eastbound Downstream	NDR Eastbound Upstream	Slip Road Requirement	Mainline Requirement	Diverge Type Required
AM	653	1,172	1,825	DG1C Single lane with hardshoulder	Two lanes upstream, One lane downstream	Not Specified
PM	520	994	1,514	DG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Not Specified

Table F2 – NDR Eastbound diverge 2032 (Traffic volumes vph)

Eastbound Merge Slip Road

	NDR Eastbound Merge	NDR Eastbound Upstream	NDR Eastbound Downstream	Slip Road Requirement	Mainline Requirement	Merge Required
AM	289	811	1,100	MG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Type E (lain gain)
PM	296	654	950	MG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Type E (lain gain)

Table F3 – NDR Eastbound merge 2017 (Traffic volumes vph)

	NDR Eastbound Merge	NDR Eastbound Upstream	NDR Eastbound Downstream	Slip Road Requirement	Mainline Requirement	Merge Required
AM	443	1,172	1,615	MG1C Single lane with hardshoulder	One lane upstream, Two lanes downstream	Type E (lain gain)
PM	565	994	1,559	MG1C Single lane with hardshoulder	One lane upstream, Two lanes downstream	Type E (lain gain)

Table F4 – NDR Eastbound merge 2032 (Traffic volumes vph)

NDR/A140 Slip Roads – Layout Capacity Assessment

Westbound Diverge Slip Road

	NDR Westbound Diverge	NDR Westbound Downstream	NDR Westbound Upstream	Slip Road Requirement	Mainline Requirement	Diverge Type Required
AM	297	616	913	DG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Not Specified
PM	255	722	977	DG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Not Specified

Table F5 – NDR Westbound diverge 2017 (Traffic volumes vph)

	NDR Westbound Diverge	NDR Westbound Downstream	NDR Westbound Upstream	Slip Road Requirement	Mainline Requirement	Diverge Type Required
AM	618	883	1,501	DG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Not Specified
PM	395	967	1,362	DG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Not Specified

Table F6 – NDR Westbound diverge 2032(Traffic volumes vph)

Westbound Merge Slip Road

	NDR Westbound Merge	NDR Westbound Upstream	NDR Westbound Downstream	Slip Road Requirement	Mainline Requirement	Merge Required
AM	342	616	958	MG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Type E (lain gain)
PM	471	722	1,193	MG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Type E (lain gain)

Table F7 – NDR Westbound merge 2017 (Traffic volumes vph)

	NDR Westbound Merge	NDR Westbound Upstream	NDR Westbound Downstream	Slip Road Requirement	Mainline Requirement	Merge Required
AM	415	883	1,298	MG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Type E (lain gain)
PM	611	967	1,578	MG1C Single lane with hardshoulder	One lane upstream, One lane downstream	Type E (lain gain)

Table F8 – NDR Westbound merge 2032 (Traffic volumes vph)

7 Glossary

crest curve	a vertical curve that rises to a high point
grade separated junction	a road junction where roads cross at different levels
hardstrip	a surfaced strip that abuts the carriageway edge
mainline	the carriageway carrying the main flow of traffic (generally passing straight through a junction or interchange)
merge/diverge	a layout where merging or diverging traffic joins or leaves the mainline carriageway
sag curve	a vertical curve that falls to a low point
slip road	a connector road within a junction between a mainline carriageway and the local highway network, or visa versa.
vehicle restraint system	a concrete or steel barrier installed alongside, or on the central reserve of, a road to restrain vehicles and minimise the risk of their collision with hazardous features.