Appendix K – Environmental Options Appraisal Report

Lake Lothing Third Crossing

Environmental Options Appraisal Report

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Document Control Sheet

Project Title:	Lake Lothing Third Crossing
Report Title:	Environmental Options Appraisal Report
Document No:	1069948/ENV/01
Revision:	1
Status:	DRAFT
Control Date:	December 2015

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
1	Draft	M Roberts	14/12/2015	H Roberts	14/12/2015	N Venema	15/12/2015

Distribution

Organisation	Contact	Copies

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Acronyms

Acronym	Description
AADT	Annual Average Daily Traffic
AAP	Area Action Plan
AONB	Areas of Outstanding Natural Beauty
AQMA	Air Quality Management Area
AST	Appraisal Summary Table
CA	Conservation Area
CWS	County Wildlife Site
DBA	Desk Based Assessment
DEFRA	Department of Environment, Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
EA	Environment Agency
EIFCA	Eastern Inshore Fisheries and Conservation Authority
FBC	Full Business Case
GHG	Greenhouse Gases
GIS	Geographical Information Systems
HDV	Heavy Duty Vehicle
HER	Historic Environment Record
LEP	Local Enterprise Partnership
LNR	Local Nature Reserve
MMO	Marine Management Organisation
NAEI	National Atmospheric Emissions Inventory
NGR	National Grid Reference
NIA	Noise Important Areas
NOx	Nitrates of Oxygen
NPSNN	National Policy Statement for National Networks
NPV	Net Present Value
OBC	Outline Business Case
OS	Ordnance Survey
PCM	Pollution Climate Mapping
PM10	Particulate Matter
RBMP	River Basin Management Plan
SAC	Special Area of Conservation

Acronym	Description
SCC	Suffolk County Council
SCDC	Suffolk Coastal District Council
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
TAG	Transport Appraisal Guidance
tCO2e	Carbon Dioxide Equivalent
TUBA	Transport User Benefit Appraisal
URC	Urban Regeneration Company
WDC	Waveney District Council
WFD	Water Framework Directive
WIMBY	What's in My Backyard

1 Introduction

1.1 Overview and Purpose of the Report

1.1.1 This document is the Environmental Options Appraisal Report that has been prepared in support of the Outline Business Case (OBC) for the Lake Lothing Third Crossing (hereafter referred to as the 'Proposed Scheme'). It has been prepared on behalf of Suffolk County Council (SCC) for consideration by the New Anglia Local Enterprise Partnership (LEP) and the Department for Transport (DfT). The form and content of the Environmental Options Appraisal Report is informed by the guidance set out in the DfT's Transport Appraisal Guidance (TAG) Unit A3 – Environmental Impact Appraisal (November 2014).

1.1.2 The report assesses with sufficiently robust evidence the impacts on the environment of proposed options for the Proposed Scheme to support the OBC. Wherever feasible, impacts are quantified and converted into a monetary value. Where impacts cannot be quantified a qualitative assessment has been used. The results of the environmental assessments have been set out within the appropriate TAG Worksheets which have then been used to complete the Appraisal Summary Tables (ASTs) for the options being considered.

1.1.3 The OBC, which this environmental appraisal supports, explains why the Proposed Scheme should receive support and provides a clear audit trail for the purposes of public accountability.

1.2 Content of the Report

1.2.1 This report is structured as follows:

- Chapter 1: Provides an overview of the OBC and the purpose of the Environmental Options Appraisal Report.
- Chapter 2: Describes the site location and characteristics of the area and provides an overview of the options under consideration at the OBC stage.
- Chapter 3: Provides an overview of the appraisal methodology that has been followed for the environmental appraisal in support of the OBC.
- Chapters 4 - 11: These chapters set out the specific methodologies followed for each of the technical disciplines appraised. Furthermore, the chapters provide an evaluation of topic related constraints, and also set out the TAG Worksheets for each environmental discipline thereby presenting the required environmental appraisal of each option. Summary assessment scores are provided for each option appraisal where feasible.
- Chapter 12: Sets out the environmental inputs to the ASTs for each of the options under consideration.

2 Description of Route Options

2.1 Site Location and Characteristics

2.1.1 The Proposed Scheme is a new road crossing over Lake Lothing, a large saltwater lake which flows into the North Sea. It measures approximately 180m at its widest point, and forms the inner harbour of the Port of Lowestoft. This area has suffered greatly from the decline of shipbuilding and traditional industries, and is a key area for regeneration proposed by Waveney District Council. The Proposed Scheme will support regeneration by improving access to the lake area and by relieving congestion in, and around, the town centre.

2.1.2 Lake Lothing separates the north and south parts of the town. The A12 forms a north-south route on the eastern (seaward) side of Lowestoft, providing access to the town centre (on the north side) and crossing Lake Lothing by means of a bascule bridge. To the west, another north-south route is provided by the A146 and A1177, which crosses Lake Lothing by means of a lifting bridge. There are no other road crossings. The two north-south routes are linked by the A1144 and Denmark Road (north of Lake Lothing) and a section of the A146 (south of Lake Lothing).

2.1.3 The main transport links in the area include the A146 which links Lowestoft to Norwich and the A12 which runs northwards to Great Yarmouth, and southwards towards Ipswich and Felixstowe.

2.1.4 To the north of Lake Lothing, running directly east to west is a railway line that connects Lowestoft to Norwich to the north and Ipswich to the south. The railway to the south crosses Lake Lothing at its western end adjacent to the A1177 bridge and these are collectively known as the Mutford Bridges.

2.1.5 Leathes' Ham, a Local Nature Reserve (LNR) and Normanston Park an area of Open Space and playing fields.

2.1.6 **Error! Reference source not found.**1 below shows the area of the scheme in relation to the town and the local road network.

Figure 1: Location of the scheme in the context of the Lowestoft town centre

2.1.7 Three options are being considered for the Proposed Scheme and these are described below and are shown on Figures 1.1 to 1.3 in Appendix A.

2.2 Central Option (C11) (Bridge)

2.2.1 The central bridge option would run from a new roundabout on Denmark Road, east of the existing Peto Way / Denmark Road roundabout, and span both the railway line and Lake Lothing on a north – south alignment.

2.2.2 On the southern shore, the new crossing would follow the line of Riverside Road, initially at a high level, descending to a new roundabout at the junction of Riverside Road and Waveney Drive, west of the Lings Motor showroom. Improvements between this roundabout and the existing Waveney Road / Tom Crisp Way roundabout would provide access to the A12. Local roads which presently connect directly to Riverside Road would be served in the main from a new connection to Waveney Drive.

2.2.3 This option is shown on Figure 1.1 in Appendix A.

2.3 Western Option (W4) (Bridge)

2.3.1 The western bridge option would run from a new roundabout on Peto Way, to the north east of Leathes' Ham, and span both the railway line and Lake Lothing on a north – south alignment. So that the new roundabout and bridge do not sever Peto Way, the existing Peto Way traffic would be diverted under a new underbridge, connecting to the new roundabout. To the south of the Lake, the new crossing would

connect into Waveney Drive, to the east of Kimberley Road.

2.3.2 This option is shown on Figure 1.2, Appendix A.

2.4 Western Option (T3) (Tunnel)

2.4.1 The tunnel option follows an extremely similar alignment to the western bridge option, running from a new roundabout on Peto Way, to the north east of Leathes' Ham, passing beneath both the railway line and Lake Lothing on a north – south alignment. The existing alignment of Peto Way will be altered so that it can adjoin the newly created roundabout. To the south of the Lake, the tunnel would connect into Waveney Drive, to the east of Kimberley Road.

2.4.2 This option is shown on Figure 1.3, Appendix A.

3 Appraisal Methodology

3.1 WebTAG guidance

3.1.1 The WebTAG guidance for Environmental Impact Appraisals (TAG Unit A3, November 2014) provides guidance on appraising transport options against the Government's objective for transport. There are eight sub-objectives which deal with the impacts upon the environment which have been considered within this Environmental Options Appraisal Report. The sub-objectives are as follows:

- Noise;
- Air Quality;
- Greenhouse Gases;
- Landscape;
- Townscape;
- Biodiversity;
- Historic Environment; and
- Water Environment.

3.1.2 This report presents the findings of the assessment of the proposed route options against these sub-objectives. The methodology adopted for each technical appraisal is informed by the guidance provided in the relevant chapter of TAG Unit A3.

3.1.3 Where a monetary assessment is not feasible, WebTAG provides guidance on the qualitative assessment of the impacts. The impacts are then assessed using the recommended 7 point scale which breaks down impacts into Slight, Moderate or Large Beneficial or Adverse and Neutral. The WebTAG units also provide guidelines on the type of evidence to be used when applying this scale. These units may also contain worksheets which allow for a description of the qualitative impacts to be provided and then summarised in the AST (see below) to help inform the overall assessment of the options.

3.1.4 With regards to the air quality and noise assessments, a proportionate assessment has been undertaken to inform the OBC comprising a qualitative analysis of the likely impacts using available information, such as sensitive receptors (e.g., properties), and sensitive areas (e.g. Defra Noise Important Areas and Air Quality Management Areas). This option would not provide a Net Present Value (NPV). However, the assessment reflects the amount of information currently available for each of the options under consideration thereby allowing a proportionate assessment to take place.

3.1.5 Should the Proposed Scheme move forward to the Full Business Case (FBC), detailed modelling using traffic data will be undertaken to inform the air quality and noise assessment. This would provide quantification of the air quality and noise impacts, including the numbers of sensitive receptors likely to be impacted by the Proposed Scheme and an estimated NPV figure.

3.1.6 In order to inform the Environmental Options Appraisal works, desk-based data gathering was undertaken for each of the technical disciplines. This data search involved reviewing previous studies / reports and publically available datasets from sources such as online mapping, local authority websites and GIS digital downloads. This data gathering exercise was supplemented by site visits, where appropriate. An environmental constraints plan has been produced and is shown in Figure 1.4 in Appendix A.

3.1.7 Additional surveys and assessments were also undertaken, where deemed required, including a Phase I Habitat Survey (Appendix B) and an Archaeological Desk Based Assessment (Appendix C).

3.1.8 The results of the appraisal for each technical discipline are presented within the appropriate WebTAG worksheets in Chapters 4 to 10 of this report. The findings of the appraisal of each route option are summarised in the ASTs in Chapter 11.

3.2 Sub-Objectives to be Scoped Out

3.2.1 In line with the guidance set out in Chapter 5 (Environmental Capital Approach) of TAG Unit A3, each of the environmental sub-objectives has been subjected to an initial review to determine whether or not the Proposed Scheme will result in any significant impacts upon the specific sub-objectives. TAG Unit A3 Chapter 5 states that "*Appraisal should be no more detailed than is required to support robust decision making. Where impacts are deemed to be minimal, further analysis may be scoped out*".

3.2.2 The Proposed Scheme would be located wholly within the urban setting of Lowestoft, where the overriding character is defined predominantly through its built development and infrastructure. There are few constituent landscape types or features (for example agricultural land pattern, woodlands, farmlands, hedgerows, etc.) that would merit a separate landscape appraisal of the study area, other than through its function as a townscape setting. A review of relevant landscape characterisation and classification studies has shown that the area is classed as an "urban" landscape typology (Suffolk Landscape Character Assessment; Waveney District Landscape Character Assessment April 2008).

3.2.3 The Broads National Park is situated to the immediate west of Lake Lothing. Its land boundaries extend to Mutford Lock to the west of the A1117 bridge over Lake Lothing where it is recognised that there may be a potential for the Proposed Scheme to impact upon this nationally important landscape resource. The National Policy Statement for National Networks[1] (NPSNN) places great weight on the conservation of landscape and scenic beauty in National Parks and Areas of Outstanding Natural Beauty (AONB), where designated areas have statutory purposes which help to ensure their continued protection. Initial walk-over surveys, undertaken by an appropriately qualified and experienced landscape architect have concluded that none of the scheme alternatives would materially impact on the National Park, nor

[1] National Policy Statement for National Networks, Department for Transport (December 2014).

represent any impact on its perceived setting as a landscape.

3.2.4 In line with the guidance on the Environmental Capital Approach (Chapter 5 of TAG Unit A3), it has accordingly been concluded that, given the urban nature of the Proposed Scheme, the townscape sub-objective adequately considers the potential impacts in relation to the setting and that the landscape sub-objective would not be directly relevant to the decision making process. Accordingly, the landscape sub-objective has been scoped out of the overall assessment of options and a more detailed appraisal of this sub-objective has therefore not been undertaken.

3.3 Consultation

3.3.1 In addition to the above data gathering and surveys, the following organisations have been contacted or consulted during this appraisal in order to gather further information regarding environmental constraints and considerations:

- Suffolk County Council (SCC) Archaeology;
- Suffolk Coastal District Council (SCDC) Landscape and Trees Officer[2];
- SCC Senior Ecologist;
- Waveney District Council (WDC) Environmental Health;
- WDC Conservation Officer;
- Natural England;
- Environment Agency;
- Eastern Inshore Fisheries and Conservation Authority (EIFCA);
- Marine Management Organisation (MMO); and
- Historic England.

[2] Initial consultation with the Natural Environment Manager at Suffolk County Council advised that the Landscape and Trees Officer from Suffolk Coastal District Council was the appropriate consultee with whom to discuss landscape / townscape issues.

4 Noise

4.1 Introduction

4.1.1 The proposed alignments have the potential to affect traffic noise levels as experienced by sensitive receptors, such as residential properties, in the vicinity of the alignments.

4.1.2 It has not been possible to undertake a full quantitative monetised assessment of the Proposed Scheme Options at OBC, as detailed traffic data is not available to complete calculations in accordance with the DMRB, Volume 11, Section 3, Part 7, HD213/11 'Noise and Vibration'. Therefore, an alternative approach has been taken using the available information. Qualitative comments on the potential impact of the Proposed Scheme Options on noise, have been determined based on counts of sensitive receptors and sensitive areas within defined study areas around each alignment Proposed Scheme Option.

4.1.3 A high level review of traffic data has been undertaken, to give an indication of the distribution of likely impacts for each Proposed Scheme Option.

4.2 Appraisal Methodology

4.2.1 A study area for each of the Proposed Scheme Options has been created. The study area has been defined by the following process:

1. Identifying the start and end points of the physical works associated with the alignments;
2. Identify road links in the traffic model that intersect with the alignment options;
3. Identify main arterial roads in Lowestoft using the traffic model;
4. Define a boundary of 300m from the carriageway edge around each alignments;
5. The boundary defined in (4) is then split into the following bandings: 0 – 50m; 50 – 100m; 100 – 200m; 200 – 300m;
6. Define a boundary of 300m around roads links that intersect with the alignment options;
7. Define a boundary of 50m around main arterial roads in Lowestoft; and
8. For each alignment option combine boundaries defined in (4), (6) and (7) above. This combined area for each option is referred to as the 'total study area'.

4.2.2 A 300m study area has been adopted in line with guidance contained within Appendix A: Table A.2b of The Transport Appraisal Process guidance, DfT, January 2014 and outlined below:

- Counts of the number of sensitive receptors within the total study area as well as the bandings for each Proposed Scheme Option are made;
- Sensitive receptors are split into dwellings and Other Sensitive Receptors as is done within the DMRB. Examples of Other Sensitive Receptors include education, health and community facilities;

- The geographical location and the classification of sensitive receptors is taken from Ordnance Survey AddressBase data;
- Counts of the number of Defra Noise Important Areas within the total study area for each Proposed Scheme Option are made; and
- The geographical location of Defra Noise Important Areas taken from Environment Agency open source data.

4.3 Brief Evaluation of Topic Related Constraints

Proposed Scheme Option Sensitive Receptor Counts

4.3.1 A count of dwellings and other sensitive receptors has been undertaken using GIS software. These are presented for distance bands of 0-50m, 50-100m, 100-200m, and 200-300m from each Proposed Scheme Option are presented in Tables 4-1 and 4-2 below:

Table 4-1 - Dwelling Counts

Alignment	Banding Zones				Total study
	0-50m	50-100m	100-200m	200-300m	
C11	54	162	446	887	6360
W4	87	296	801	1445	6938
T3	84	291	792	1437	6940

Table 4-2 - Other Sensitive Receptor Counts

Alignment	Banding Zones				Total study
	0-50m	50-100m	100-200m	200-300m	
C11	2	3	3	4	61
W4	1	3	6	9	65
T3	1	2	6	9	65

Proposed Scheme Option Defra Important Area Counts

4.3.2 The same distance bands have been used to count the number of Defra identified Important Areas within the study area of each Proposed Scheme Option, as detailed in Table 4-3 below.

Table 4-3 - Defra Noise Important Areas Counts

Alignment	Banding Zones				Total study
	0-50m	50-100m	100-200m	200-300m	
C11	0	0	0	0	3
W4	0	0	0	0	3
T3	0	0	0	0	3

4.3.3 Details of each Important Area and its respective noise-making and noise-receiving Authorities are presented below in Table 4-4.

Table 4-4 - Defra Noise Important Areas

ID	Noise Making Authority	Noise Receiving Authority
5003	Suffolk County Council	Waveney District Council
5004	Suffolk County Council	Waveney District Council
11285	Suffolk County Council	Waveney District Council

Proposed Scheme Option Comparison T3 vs W4

4.3.4 There is no significant difference between T3 and W4 alignments in terms of dwelling count, other sensitive receptor count and Defra Important Areas across the banding zones and the total study area. This is because the over ground geographical extent of these two Proposed Scheme Options are virtually identical. The only geographical difference between the two being the bridge, although this section runs through an area which does not have residential development in close proximity. Accordingly, for the purpose of the noise appraisal the T3 and W4 options are considered to be the same.

Option Comparison C11 vs T3 / W4

4.3.5 The C11 alignment has lower dwelling counts than the T3 and W4 alignments in all banding zones as well as the total study area.

- 30-33 fewer dwellings between 0-50m;
- 129-134 fewer dwellings between 50-100m;
- 346-355 fewer dwellings between 100-200m; and
- 560-568 fewer dwellings between 200-300m.

4.3.6 There is no significant difference between C11 and T3 / W4 alignments in terms of other sensitive receptor counts and Defra Important Areas.

4.4 Noise Appraisal

4.4.1 Potential environmental impacts from noise can be split into two phases; notably, construction and operation.

4.4.2 During construction, the Proposed Scheme will cause a negative impact on nearby receptors, especially those residential areas in close proximity to the works.

4.4.3 During the operational phase, the Proposed Scheme is expected to impact upon those receptors located closest to chosen scheme.

4.4.4 The extent of each of the three Proposed Scheme Options are largely based on the existing road network. The exception to this are the bridges themselves, but these areas of new road carriageway are contained within largely non-residential areas.

4.4.5 All the Proposed Scheme Options have the potential to increase noise impact at sensitive receptors. The closer the sensitive receptors are to the Proposed Scheme, the larger the likely impact.

4.4.6 Sensitive receptors could experience an increase in noise impact due to an increase in traffic flows, increase in percentage of heavy vehicles, increase in traffic speeds and changes in alignment which move vehicles closer to receptors. A modelling exercise based on changes to traffic characteristics along the Proposed Scheme Options, would be required to assess this quantitatively.

4.4.7 Level of uncertainty in the appraisal is high because the methodology is primarily based on one parameter; notably, the number of sensitive receptors. The appraisal does not take into account modelled changes in noise levels as a result of changes in traffic flow, speed and compositions brought on by the route options as well as changes in natural terrain, such as screening from landforms, buildings, barriers and tunnels which can all influence the appraisal.

Traffic flow comparison

4.4.8 High level traffic data analysis has been undertaken on the projected flow data for each Proposed Scheme Option taken from the traffic model.

4.4.9 DMRB notes that a change in noise level of 1 dB $L_{A10,18h}$ is equivalent to a 25% increase or a 20% decrease in traffic flow, assuming other factors remain unchanged.

4.4.10 The traffic data for W4 indicates that flows are predicted to increase by 25% or more with the introduction of the Proposed Scheme along Long Road, Kirkley Run, Notley Road, Durban Road, The Avenue, Fir Lane and Norwich Road. However, decreases in traffic flow are predicted along the A146, Bridge Road, Normanston Drive, Colville Road and Highland Way.

4.4.11 The traffic data for T3 indicates increases and decreases on the same routes as W4 with further decreases along Cotmer Road and Elm Tree Road.

4.4.12 The traffic data for C11 indicates increases of 25% or more along Long Road, Tom Crisp Way, The Avenue, Peto Way, Rotterdam Road, Norwich Road, Avondale Road and Love Road. Decreases in traffic flow are predicted along the A146, Bridge Road, Normanston Drive, Colville Road, Highland Way, the A1144, Katwijk Way, Denmark

Road, and along the A12 from Yarmouth Road to Waveney Road.

Defra Noise Important Areas

4.4.13 Defra Noise Important Areas (NIA) are locations where the 1% of the population that are affected by the highest noise levels from major roads, according to the results of Defra's strategic noise maps.

4.4.14 There are no Defra Noise Important Areas within the geographical extent of any of the three Proposed Scheme Options but there may be some improvement in the three nearby Important Areas as a result of congestion relief.

4.5 Summary Assessment (including Assessment Score)

4.5.1 The impact from noise is considered to be Slight Adverse overall in the case of all three Proposed Scheme Options.

4.5.2 An overall Slight Adverse impact is chosen as sensitive receptors close to the new crossing are expected to experience an increase in noise impact as a result of increases in traffic flows and new road alignments/widening, and because the noise impact on the wider network is unquantifiable at this stage.

4.5.3 The aim of the Proposed Scheme is to relieve congestion on the wider Lowestoft road network. A reduction in traffic flows could result in a decrease in noise impact on the existing network. However, any improvement scheme that relieves congestion could serve to attract additional traffic to the vicinity which could result in increases in noise levels.

4.5.4 C11 is further away from sensitive receptors across all banding zones, and therefore this Proposed Scheme Option is expected to result in the lowest impact of the three Proposed Scheme Options.

4.5.5 Based on the available information, it is not possible to differentiate T3 and W4 from one another in terms of noise impact.

4.5.6 A detailed modelling study of changes to traffic characteristics along the Proposed Scheme Options would be required at the FBC stage to provide greater certainty, a monetised value to the change in the noise environment, and the social and distributional impact that would be experienced.

5 Air Quality

5.1 Introduction

5.1.1 This chapter provides a review of the Proposed Scheme Options associated with the third crossing of Lake Lothing, in accordance with the WebTAG transport appraisal guidance methodology for air quality.

5.1.2 The proposals will change the physical arrangement of the local road network and therefore result in changes to vehicle flow volumes, composition, and speeds. As such, there is the potential for local and regional concentrations of air pollutants to be affected by changes in vehicle emissions associated with the Proposed Scheme.

5.1.3 Emissions of oxides of nitrogen (NO_x), nitrogen dioxide (NO_2), and particulates with an aerodynamic diameter of 10µm or less (PM_{10}) from vehicle exhausts, are of primary concern with respect to air pollution within urban areas of the UK.

5.1.4 The relevant national air quality standards and objectives for NO_2 and PM_{10}, as prescribed through the Air Quality Strategy and most applicable for the appraisal of air quality, are presented in Table 5-1.

Table 5-1: Relevant National Air Quality Standards and Objectives

Pollutant	Averaging Period	Air Quality Standard		Objective Date
		Concentration	Allowance	
Nitrogen dioxide (NO_2)	1-Hour	200 µg/m^3	18 exceedances per calendar year (*)	31/12/05 (1)(2)
				01/01/10 (3)(4)
	Annual	40 µg/m^3	-	31/12/05 (1)(2)
				01/01/10 (3)(4)
Particulates (PM_{10})	24-Hour	50 µg/m^3	35 exceedances per calendar year (**)	31/12/04 (1)(2)
				01/01/05 (3)(4)
	Annual	40 µg/m^3	-	31/12/04 (1)(2)
				01/01/05 (3)(4)

* Expressed as the 99.79th percentile of hourly mean concentrations
** Expressed as the 90.41st percentile of daily mean concentrations
1) Air Quality (England) Regulations 2000.
2) Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 Vol 2.
3) EU Directive 2008/50/EEC on ambient air quality and cleaner air for Europe.
4) Air Quality Standards Regulations 2010.
5) Expressed as the 99.79th percentile of hourly mean concentrations.
6) Expressed as the 90.41st percentile of daily mean concentrations.

5.2 Appraisal Methodology

Baseline Review

5.2.1 A desk study was undertaken to inform the appraisal of options developed for the OBC. The desk study comprised a review of baseline air quality at and within the surrounding area of the Proposed Scheme.

5.2.2 The following data and information were used to inform the baseline review of air

quality:

- Presence of Air Quality Management Areas (AQMAs) within Waveney District[3] – designated as locations where a national Air Quality Strategy Objective(s) is not being and / or not likely to be achieved;
- Defra's local air quality background data for the 1 x 1 km^2 grids covering the scheme and surrounding area[4];
- Identification of Defra Pollution Climate Mapping (PCM) model links within study area;
- Number of sensitive receptors within 200m of the potentially affected roads using detailed OS mapping with address layer data;
- Presence of ecologically designated sites (Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Ramsar, and Sites of Special Scientific Interest (SSSIs)) that could be affected by Oxides of Nitrogen (NO_x) within 1 km of the Proposed Scheme[5]; and
- Local authority air quality monitoring data as contained within the Waveney District Council local air quality review and assessment reports[6] and provided by the Environmental Health Officer for Waveney District Council[7].

Local Air Quality Appraisal

5.2.3 TAG Unit A3 presents the methodology for assessing and valuing air pollution associated with the operation of the Proposed Scheme Options.

5.2.4 Traffic data relating to Do Minimum ('without scheme') and Do Something (with scheme') scenarios were provided in 24-hour annual average daily traffic (24-hr Annual Average Daily Traffic (AADT)) format, for each Proposed Scheme option:

- 2020 (Opening Year) Do Minimum;
- 2020 Do Something;
- 2035 (Design Year) Do Minimum; and
- 2035 Do Something.

5.2.5 For the purposes of the OBC, data relating to the 2020 Do Minimum and Do Something scenarios for each option were screened to identify the number of road links predicted to exceed the following criterion given by the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 1 (HA207/07)[8] (Local Air Quality Assessment) for determining route corridors where local air quality is likely to be impacted:

- Daily traffic flows will change by 1,000 AADT or more.

5.2.6 The results of the analyses were tabulated to display the number of road links predicted to experience an increase in traffic over the criterion value and thus have a potential adverse local air quality impact, specifically in terms of NO_2 and PM_{10}

[3] Department for Environment, Food and Rural Affairs (Defra) (2015) *Air Quality Management Areas* [online] http://uk-air.defra.gov.uk/aqma/ as accessed on the 20/10/15.

[4] Defra (2015) *Air Pollution Background Maps* [online] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html as accessed on the 20/10/15.

[5] Defra (2015) *MAGIC Geographic Information about the Natural Environment from across Government* [online] http://magic.defra.gov.uk/ as accessed on 21/10/15

[6] Waveney District Council (2012) *2012 Air Quality Updating and Screening Assessment for Waveney District Council*

[7] Communication with Environmental Health Officer, Waveney District Council (David Porter) Email 02/09/15

[8] The Department for Transport (1992 as amended 2013) *HA207/07 Design Manual for Roads and Bridges Volume 11: Environmental Assessment, Section 3, Part 1 'Air Quality'.*

concentrations. In addition, the number of links predicting a reduction in excess of the criterion were identified, indicating routes where air quality could potentially improve. Links identified to predict an increase or decrease of less than 1,000 AADT were considered to represent a potential neutral local air quality impact.

5.2.7 The number of potentially sensitive properties within 200m of each affected road link was approximated based on detailed Ordnance Survey (OS) mapping with address layer data, for each Proposed Scheme Option. This enabled a qualitative assessment of the potential for local air quality impacts resulting from the change in vehicle flows associated with the Do Something scenario. Sensitive receptors as defined in HA207/07 Section 11.3.1 for air quality, include:

- Residential dwellings;
- Designated ecological sites;
- Locations of the young and elderly (nurseries and care homes);
- Hospitals; and
- Schools.

5.2.8 Given the above qualitative approach to assessing potential local air quality impacts associated with each Proposed Scheme, for the purposes of the OBC, an economic valuation of air pollution was not possible.

Regional Air Quality Appraisal

5.2.9 For the purposes of the OBC, data relating to the 2020 Do Minimum and Do Something scenarios for each option were screened to identify the number of road links predicted to exceed the following criterion given by the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 1 (HA207/07)[9] (Regional Air Quality Assessment) for determining route corridors where regional air quality is likely to be impacted:

- Daily traffic flows (24-hr AADT) will change by 10% or more.

5.2.10 As per the local air quality approach, the results were tabulated to display the number of road links predicted to experience an increase or decrease in traffic over the criterion value. For regional air quality, the key pollutant for appraisal purposes is oxides of nitrogen (NO_x), which can be transported in the lower atmosphere over large distances, having the potential to contribute to regional air pollution through the formation of ozone. Carbon dioxide, emissions of which can also be transported over large distances within the atmosphere and has a high atmospheric residence time, are considered within Section 6 (Greenhouse Gases).

5.2.11 An economic valuation of regional air pollution was not possible and a qualitative assessment of regional air quality impacts was undertaken for the purposes of the OBC.

5.2.12 The study area within which traffic data were reviewed, for both local and regional air quality analyses, comprised an area covering 3.5km to the north, 3.2km to the south, 1.5km to the east and 3km to the west, of the Proposed Scheme centre.

[9] The Department for Transport (1992 as amended 2013) *HA207/07 Design Manual for Roads and Bridges Volume 11: Environmental Assessment, Section 3, Part 1 'Air Quality'.*

Future Modelling

5.2.13 The above approach to appraising air quality represents an initial, high-level qualitative review of potential air quality impacts associated with the Proposed Scheme Options. The FBC will include a detailed air quality modelling study, which will enable a comprehensive assessment of local and regional air quality impacts and air pollution valuation to be completed, in accordance with TAG Unit 3 and DMRB HA207/07.

5.2.14 The detailed assessment will consider the Proposed Scheme options for both the opening year (2020) and future design year (2035).

5.3 Baseline Air Quality Review

5.3.1 This section provides a brief review of local air quality associated with the Proposed Scheme location and surrounding area and within the context of relevant national air quality standards and objectives.

Air Quality Management Areas

5.3.2 There are no AQMAs declared within Waveney District, with no requirement for the Council to progress to a detailed assessment of air quality for any pollutant[6]. Therefore, air pollutant levels within Waveney District and thus at and in proximity to the Proposed Scheme, are not considered likely to exceed respective national air quality objective concentrations.

Designated Sites Sensitive to NO_x

5.3.3 DMRB HA 207/07 states that statutory designated conservation sites may be sensitive to NO_X and Nitrogen deposition, which can have direct and indirect impacts upon vegetation, affecting species composition and ecosystem health.

5.3.4 There are no designated sites falling under the definition prescribed by DMRB HA 207/07, which may be affected by NO_x emissions as a result of any of the Proposed Scheme Options.

Air Quality Monitoring in Waveney District

5.3.5 Local NO_2 passive diffusion tube monitoring data were provided by Waveney District Council[10] for the monitoring locations considered most appropriate to the Proposed Scheme. These data are provided in Table 5-2 for years 2013 and 2014. No automatic air quality monitoring is conducted within the study area by either the local authority or Defra.

[10] Communication with Environmental Protection Officer, Waveney District Council (David Porter) Email 02/09/15

Table 5-2: Waveney District Council NO_2 Diffusion Tube Monitoring

Site ID	Location	Type	XY Grid Reference		2013 Annual Mean NO_2	2014 Annual Mean NO_2
			X	Y		
PN4	Mutford Lock	Roadside	652301	293016	29.4	27.7
PN9	Belvedere Road	Roadside	654651	292619	24.0	29.3
PN10	Belvedere Road	Roadside	654651	292619	25.7	31.2
PN11	Pier Terrace/London Road South Junction	Roadside	654658	292598	35.3	29.9
PN12	Pier Terrace/London Road South Junction	Roadside	654658	292598	26.0	25.2
NO_2 Annual Mean Objective					**40 µg/m^3**	

5.3.6 The results demonstrate that there were no exceedances of the national objective for NO_2 for 2013 and 2014 at the five NO_2 diffusion tube air quality monitoring sites.

Background Pollutant Concentrations

5.3.7 Background pollutant concentrations for NO_x, NO_2 and PM_{10} are published on Defra's UK-AIR website for every 1km x 1km grid square covering the UK. The background estimates are available throughout the UK for years between 2010 and 2030. The relevant background concentrations which encompass each Proposed Scheme Option are presented in Table 5-3.

Table 5-3: Defra background mapped NO_2, NO_x and PM_{10} concentrations per grid square covering the Proposed Scheme Options

X	Y	NO_x (µg/m^3)			NO_2 (µg/m^3)			* PM_{10} (µg/m^3)		
		2013	2014	2015	2013	2014	2015	2013	2014	2015
652500	**293500**	21.2	20.8	20.4	13.8	13.5	13.3	13.8	13.7	13.5
653500	**293500**	21.5	21.0	20.5	13.9	13.6	13.3	14.0	13.8	13.7
654500	**293500**	23.9	23.3	22.8	15.3	15.0	14.7	14.3	14.1	14.0
652500	**292500**	22.0	21.5	21.0	14.2	13.9	13.6	14.3	14.1	14.0
653500	**292500**	20.3	19.9	19.5	13.2	13.0	12.7	14.0	13.8	13.7
654500	**292500**	24.3	23.7	23.0	15.5	15.2	14.8	14.3	14.1	13.9

** All background concentrations were obtained from the latest 2011 based background maps, the scaling factor of 0.91 recommended by Defra has been applied to PM_{10}. The values are rounded to 1 decimal place.*

5.3.8 The highest 2015 background NO_2 concentration of 14.8 µg/m^3 covers the area of the A12 Belvedere Rd/ Pier Terrace near to the existing crossing point over Lake Lothing. All background concentrations of NO_2 and PM_{10} are well below the relevant annual mean objective for NO_2 and PM_{10}.

Pollution Climate Mapping Links

5.3.9 Pollution Climate Mapping (PCM) modelling is undertaken by Defra to produce 1km x 1km background pollutant concentrations, such as those presented in Table 5-3, in addition to producing approximately 9,000 representative roadside pollutant concentrations based on a national network of road-link specific emissions. These modelled data are used to fulfil part of the UK's EU Directive (2008/50/EC) requirements to report on the concentrations of particular pollutants in the atmosphere, which includes NO_x, NO_2, and PM_{10}.

5.3.10 The PCM road links located within 200m of each Proposed Scheme Option, for which a roadside pollutant concentrations are produced by PCM modelling, were identified. The respective modelled roadside NO_2 concentration for the base (2015), opening (2020) and design year (2035) are given in Table 5-4.

Table 5-4: PCM Links within 200m of each Proposed Scheme Option

Route Alignment	PCM Links within 200m of each Proposed Scheme Option				
	Rd Name / Number	Census ID	2015 Base Year Roadside NO_2 (µg/m^3)	2020 Opening Year Roadside NO_2 (µg/m^3)	*2035 Design Year Roadside NO_2 (µg/m3)
C11	Peto Way / A1117	99879	18.7	13.2	9.0
	Normanston Drive / A1117, A1144	37595	23.7	16.3	11.3
		27570	17.1	12.9	11.9
	Horn Hill / A12	81156	21.6	14.9	10.3
	Tom Crisp Way / A12	81156	21.6	14.9	10.3
W4	Peto Way / A1117	99879	18.7	13.2	9.0
	Normanston Drive / A1117, A1144	37595	23.7	16.3	11.3
		27570	17.1	12.9	11.9
	Horn Hill / A12	81156	21.6	14.9	10.3
	Tom Crisp Way / A12	81156	21.6	14.9	10.3
T3	Peto Way / A1117	99879	18.7	13.2	9.0
	Normanston Drive / A1117, A1144	37595	23.7	16.3	11.3
		27570	17.1	12.9	11.9

** Design Year 2035 concentrations were obtained by linear interpolation based on the change between the year 2025 and year 2030 PCM Roadside NO_2 concentrations.*

5.3.11 The PCM modelled roadside NO_2 data for all links identified within 200m of each Proposed Scheme Option demonstrate that the 40µg/m^3 annual mean objective is not predicted to be exceeded in the Base Year (2015), the Opening Year (2020) and the Design Year (2035).

5.4 Local Air Quality Appraisal

5.4.1 Total 24-hour AADT data were provided for the opening year (2020) Do Minimum and Do Something scenarios for each Proposed Scheme Option and associated study area. These data were screened to identify the number of links for which daily traffic flows are anticipated to change by 1,000 AADT or more.

5.4.2 For each affected link, the number of sensitive properties within 200m was approximated using OS mapping. The results of these analyses for each Proposed Scheme Option are presented in Table 5-5.

Table 5-5: Number of affected road links and sensitive receptors within 200 m in terms of DMRB criterion for local air quality (2020 Do Minimum versus Do Something)

AADT change	Option C11		Option W4		Option T3	
	No. links	No. Receptors	No. links	No. Receptors	No. links	No. Receptors
Increase ≥1,000	13	8,532	10	4,497	20	5,041
Decrease ≥1,000	48	13,236	31	9,208	7	8,890
+/- <1,000	170	60,866	186	62,571	198	60,875
Total	**231**	**82,634**	**227**	**76,276**	**225**	**74,806**

5.4.3 The traffic data review indicates that Proposed Scheme Option C11 is predicted to result in 13 links (8,532 receptors) experiencing an increase over the DMRB criterion in 2020. Option C11 is predicted to cause the highest number of links to decrease above the criterion (48 links), with 13,236 receptors within 200m of the affected links. In total, 170 links (60,866 receptors) are predicted to experience a change in AADT below the criterion.

5.4.4 Proposed Scheme option W4 is predicted to result in the lowest number of links (10 no.) to experience an increase over the DMRB criterion in 2020, with an associated 4,497 receptors located within 200m of the affected links. A total of 31 links (9,208 receptors) are expected to decrease over the same criterion. In total, 186 links (62,571 receptors) are predicted to experience a change in AADT below the criterion.

5.4.5 Proposed Scheme option T3 is predicted to result in 20 links (5,041 receptors) experiencing an increase over the DMRB criterion in 2020, with 7 links decreasing (8,890 receptors). In total, 198 links (60,875 receptors) are predicted to experience a change in AADT below the criterion.

5.4.6 Road links that predict an increase in total average daily traffic above the DMRB criterion have the potential to adversely impact local air quality at sensitive receptors within 200m, through an increase in total vehicle emissions. Likewise, where reductions in average daily traffic above the criterion are predicted, a local air quality benefit at receptors within 200m may occur.

5.4.7 Based on the appraisal presented in Table 5-5 and the links that are expected to experience a change in excess of the DMRB criterion, the number of receptors within 200m of links showing a decrease in traffic flow is higher than the number of receptors within 200m of links showing an increase. However, the majority of links within the study area are predicted to experience a change in AADT below the criterion. As such, an overall neutral local air quality impact is considered most likely for each option.

5.4.8 Further detailed air quality modelling is required to predict the magnitude of local air quality impact relating to each scheme, which will take account of other key variables such as link speed, heavy duty vehicle (HDV) percentage, and meteorology. This modelling will be undertaken as part of the FBC and will also enable a monetary valuation to be completed in accordance with TAG Unit A3.

5.5 Regional Air Quality Appraisal

5.5.1 The review of 2020 Do Minimum and Do Something traffic data for each Proposed Scheme option is presented in Table 5-6, showing the number of links predicted to experience a change in daily traffic flows (24-hour AADT) by 10% or more.

Table 5-6: Number of affected road links in terms of DMRB criterion for regional air quality (2020 Do Minimum versus Do Something)

AADT change	Option C11	Option W4	Option T3
	No. links	No. links	No. links
Increase ≥10%	30	24	21
Decrease ≥10%	78	40	53
+/- <10%	108	146	140
Total	**216**	**210**	**214**

5.5.2 Proposed Scheme option C11 is predicted to result in the highest number of links to experience an increase in AADT (30) above the DMRB criterion, in addition to the highest number predicting a decrease (78). Both option W4 and option T3 also predict a higher number of links to experience a decrease above the criterion relative to links with an increase.

5.5.3 For all three options, the majority of links are predicted to experience a change in AADT below the DMRB criterion. As such, an overall neutral regional air quality impact is considered most likely for each option.

5.5.4 Detailed modelling will be undertaken as part of the Full Business Case and will also enable a monetary valuation to be completed in accordance with TAG Unit A3.

5.6 Air Quality Assessment - WebTAG Appraisal

5.6.1 The full air quality WebTAG appraisal worksheet could not be completed based on the qualitative review of traffic data relating to each Proposed Scheme Option. Modelling of predicted changes in air pollutant concentrations between the Do Minimum and Do Something scenarios was not completed for the OBC, thus a monetary valuation and assessment score could not be provided.

5.6.2 WebTAG appraisal summary tables provided below are based on the outcomes of the qualitative assessment reported in the previous sections.

Option C11 - Air Quality Worksheet

Table 5-7: AST Table Outputs Proposed Scheme Option C11

Impacts	0-200m Summary of Key Impacts	Assessment			
		Quantitative	Qualitative	NPV (£)	Distributional
Air Quality	Overall **neutral local and regional air quality impact** considered most likely based on traffic data review (2020 Do Minimum vs Do Something)	8,532 sensitive receptors with potential for adverse local air quality 13,236 sensitive receptors with potential for local air quality benefit 60,866 receptors with potential for neutral local air quality impact	No AQMA designated within or near to the study area Background mapped air pollutant concentrations are well below national objective values Max roadside PCM concentrations 2015: 23.7 µg/m^3 2020: 16.3 µg/m^3	Not calculated	Not calculated

Option W4 - Air Quality Worksheet

Table 5-8: AST Table Outputs Proposed Scheme Option W4

Impacts	0-200m Summary of Key Impacts	Assessment			
		Quantitative	Qualitative	NPV (£)	Distributional
Air Quality	Overall **neutral local and regional air quality impact** considered most likely based on traffic data review (2020 Do Minimum vs Do Something)	4,497 sensitive receptors with potential for adverse local air quality 9,208 sensitive receptors with potential for local air quality benefit 62,571 receptors with potential for neutral local air quality impact	No AQMA designated within or near to the study area Background mapped air pollutant concentrations are well below national objective values Max roadside PCM concentrations 2015: 23.7 µg/m^3 2020: 16.3 µg/m^3	Not calculated	Not calculated

Option T3 - Air Quality Worksheet

Table 5-9: AST Table Outputs Proposed Scheme Option T3

Impacts	0-200m Summary of Key Impacts	Assessment			
		Quantitative	Qualitative	NPV (£)	Distributional
Air Quality	Overall **neutral local and regional air quality impact** considered most likely based on traffic data review (2020 Do Minimum vs Do Something)	5,041 sensitive receptors with potential for adverse local air quality 8,890 sensitive receptors with potential for local air quality benefit 60,875 receptors with potential for neutral local air quality impact	No AQMA designated within or near to the study area Background mapped air pollutant concentrations are well below national objective values Max roadside PCM concentrations 2015: 23.7 µg/m^3 2020: 16.3 µg/m^3	Not calculated	Not calculated

6 Greenhouse Gases

6.1 Introduction

6.1.1 This chapter provides a qualitative review of Proposed Scheme Options with respect to the WebTAG appraisal method for greenhouse gases (GHG). The most recent version of the appraisal methodology (TAG Unit A3) was issued in November 2014[11].

6.1.2 The Proposed Scheme would change the physical layout of the road network, thus resulting in changes to vehicle flow, composition and speed. As such, it has the potential to cause changes in vehicular emissions of GHGs, which forms the focus of this appraisal.

6.1.3 This appraisal considers the potential changes in greenhouse gas emissions caused by the Proposed Scheme.

6.1.4 As defined by the Intergovernmental Panel on Climate Change, GHG emissions are expressed as tonnes of carbon dioxide equivalent (tCO_2e) for the purposes of this appraisal.

6.2 Legislative Background

6.2.1 The UK is legally bound by the Climate Change Act 2008[12] to achieve a target to reduce GHG emissions to at least 80% below base year (1990) levels by 2050.

6.2.2 The Act introduced five-year 'carbon budgets'[13], which set maximum GHG emission budgets not to be exceeded during the respective period, in order to achieve a specified reduction in GHG emissions versus base year levels. The budgets are:

- 2008 – 2012; 3,018 million tonnes CO_2e ($MtCO_2e$); 23% reduction below base year levels;
- 2013 – 2017; 2,782 $MtCO_2e$; 29% reduction below base year;
- 2018 – 2022; 2,544 $MtCO_2e$; 35% reduction below base year by 2020; and
- 2023 – 2027; 1,950 $MtCO_2e$; 50% reduction below base year by 2025.

6.2.3 The opening year of the Proposed Scheme is 2020, which falls within the fourth carbon budget. The design year for the Proposed Scheme is 2035, for which a carbon budget is yet to be established.

6.2.4 The chemical species within the Climate Change Act, for which road traffic is a source, are;

- CO_2; and
- N_2O.

6.3 Appraisal Methodology

6.3.1 TAG Unit A3 presents the methodology for assessing and valuing GHG emissions

[11] The Department for Transport (DfT) (2014), Transport Analysis Guidance, Unit A3 Environmental Impact Appraisal, Chapter 3

[12] Her Majesty's Stationary Office (HMSO) (2008) *Climate Change Act 2008*

[13] The Committee on Climate Change *Carbon Budgets and Targets* [online] https://www.theccc.org.uk/tackling-climate-change/reducing-carbon-emissions/carbon-budgets-and-targets/ as accessed on 02/11/15

(as tCO_2e) associated with the operation of the Proposed Scheme Options for a defined appraisal period.

6.3.2 For the purposes of the OBC, the Transport User Benefit Appraisal (TUBA) software program was used for each Proposed Scheme Option, accounting for a 60 year appraisal period (2020 – 2079).

6.3.3 Traffic data within the TUBA program were provided as annualised total trip numbers and disaggregated by vehicle type for specific time periods (AM peak, PM peak, inter-peak, off-peak, and weekend) for the Do Minimum ('without scheme') and Do Something ('with scheme') scenarios for each option. Fuel consumption was based on average speed for each vehicle trip, enabling total GHG emissions to be derived by applying an emissions factor (grams CO_2 per litre of fuel burnt).

6.3.4 The estimated change in GHG emissions throughout the appraisal period was calculated separately for non-traded (i.e. petrol, diesel, fuel oil) and traded (e.g. electricity) fuel consumption.

6.3.5 The TUBA output provided the net present value of the estimated change in CO_2e emissions from road-based fuel consumption that is in the non-traded sector only. The net present value was calculated based on the central cost estimates (£/tCO_2) for traded CO_2e emissions.

6.4 Brief Evaluation of Topic Related Constraints

Greenhouse Gases Baseline

6.4.1 The National Atmospheric Emissions Inventory (NAEI)[14] is operated by the Department for Energy and Climate Change (DECC) and provides outputs of UK emissions of GHGs from 1990 to 2013. Total national GHG emissions as $MtCO_2e$ are presented in Table 6-1, in addition to national emissions from the road transport sector, for the most recent annual inventory (2013).

6.4.2 Total and sector-specific emissions of CO_2e from within Suffolk County are also provided in Table 6-1 for comparison with national figures and to provide regional context with respect to the Proposed Scheme.

Table 6-1: 2013 Emissions Inventory Data for CO_2e

GHG emissions	Total annual emissions, 2013 ($MtCO_2e$)	Road transport emissions, 2013 ($MtCO_2e$)	Road transport emissions as % of total
National	568.3	107.9	18.9%
Suffolk County	5.2	1.4	27.4%

6.4.3 At a national level, GHG emissions from the transport sector account for approximately 19% of total emissions, with transport emissions within Suffolk equating to approximately 27% of total regional emissions.

6.4.4 GHG emissions associated with each Proposed Scheme Option were estimated using the TUBA software program, providing the NPV of the change in CO_2e

[14] Department for Environment, Food and Rural Affairs (Defra) (2015) *National Atmospheric Emissions Inventory [online]* http://naei.defra.gov.uk/ accessed on 02/11/15

emissions associated with the appraisal period (2020 – 2079). The outputs from the TUBA assessment are presented in the below subsections.

6.5 GHG Assessment - WebTAG Summary

6.5.1 A summary table displaying the TUBA outputs is provided for each Proposed Scheme Option, which includes the following data:

- Do Minimum ('*without scheme*') non-traded and traded CO_2e emissions totals for the appraisal period (2020 – 2079);
- Do Something ('*with scheme*') non-traded and traded CO_2e emissions totals for the appraisal period;
- Change in CO_2e emissions between Do Minimum and Do Something scenarios for the appraisal period; and
- NPV of change in CO_2e emissions from road-based fuel consumption associated with the Proposed Scheme, based on central cost estimates for traded CO_2e emissions only.

Option C11

6.5.2 A summary of the TUBA outputs relating to GHG emissions from Option C11 is presented in Table 6-2.

6.5.3 Both traded and non-traded road-based emissions associated with the Do Something scenario are estimated to be lower over the appraisal period relative to the Do Minimum case.

6.5.4 The reduction in non-traded emissions (-84,760 tCO_2e) equates to a NPV benefit of £3,916,000 for the assessed appraisal period.

Table 6-2: Option C11 TUBA Output Summary

Emissions Class	Appraisal Period GHG Emissions (tCO_2e)		Change (tCO_2e)	Net Present Value
	Do Minimum	Do Something		
Non-traded	18,781,302	18,696,541	-84,760	£3,916,000
Traded	39,246	39,102	-144	

Option W4

6.5.5 A summary of the TUBA outputs relating to GHG emissions from Option W4 is presented in Table 6-3.

6.5.6 Both traded and non-traded road-based emissions associated with the Do Something scenario are estimated to be lower over the appraisal period relative to the Do Minimum case.

6.5.7 The reduction in non-traded emissions (-64,228 tCO_2e) equates to a NPV benefit of £2,953,000 for the assessed appraisal period.

Table 6-3: Option W4 TUBA Output Summary

Emissions Class	Appraisal Period GHG Emissions (tCO_2e)		Change (tCO_2e)	Net Present Value
	Do Minimum	Do Something		
Non-traded	18,781,302	18,717,074	-64,228	£2,953,000
Traded	39,246	39,120	-126	

Option T3 - GHG Worksheet

6.5.8 A summary of the TUBA outputs relating to GHG emissions from Option T3 is presented in Table 6-3.

6.5.9 Both traded and non-traded road-based emissions associated with the Do Something scenario are estimated to be lower over the appraisal period relative to the Do Minimum case.

6.5.10 The reduction in non-traded emissions (-57,100 tCO_2e) equates to a NPV benefit of £2,622,000 for the assessed appraisal period.

Table 6-4: Option T3 TUBA Output Summary

Emissions Class	Appraisal Period GHG Emissions (tCO_2e)		Change (tCO_2e)	Net Present Value
	Do Minimum	Do Something		
Non-traded	18,781,302	18,724,201	-57,100	£2,622,000
Traded	39,246	39,142	-103	

Summary

6.5.11 The GHG appraisal, which informs the OBC, utilised the TUBA software program and followed the latest WebTAG guidance prescribed by the DfT.

6.5.12 Traffic data within the TUBA program were provided as annualised total trip numbers and disaggregated by vehicle type for specific time periods for the Do Minimum ('without scheme') and Do Something ('with scheme') scenarios. Fuel consumption was based on an average speed for each vehicle trip, enabling total GHG emissions to be derived by applying an emissions factor.

6.5.13 The total change in GHG emissions and associate NPV for the appraisal period (2020 – 2079) is summarised for each Proposed Scheme Option in Table 6-5.

Table 6-5: Summary of GHG emissions change and net present value for the appraisal period

Option	Change in emissions vs Do Minimum (tCO_2e)	Net Present Value	GHG Benefit?
C11	-84,904	£3,916,000	Yes
W4	-64,354	£2,953,000	Yes
T3	-57,203	£2,622,000	Yes

6.5.14 All Proposed Scheme Options are predicted to result in a reduction in GHG emissions from road-based fuel consumption, based on the TUBA analysis, thus resulting in a NPV benefit. Option C11 is estimated to yield the largest benefit in terms of GHG emissions reduction and NPV.

6.5.15 The reduction in GHG emissions is attributed to a predicted decrease in fuel consumption in the Do Something scenario for each option. This is a result of the Proposed Scheme being expected to reduce congestion – and thus increase fuel efficiency of vehicle engines – within the assessed road network.

7 Townscape

7.1 Introduction

7.1.1 The following section provides an assessment of potential townscape effects relating to the Proposed Scheme. The assessments describe and evaluate the townscape resource of the study area, report on the proposed changes as a result of the different alignments under consideration and make informed predictions of the likely effects.

7.2 Appraisal Methodology

7.2.1 A desk study has been undertaken to inform the appraisal of the options developed for the OBC. This desk study has included a review of designated and non-designated sites from the sources identified below:

- Ordnance Survey mapping and a site walk-over to identify the location of visual receptors;
- Information from the Local Planning Authority regarding townscape appraisals, conservation area (CA) appraisals and local plan policies relating to townscape; and
- The location and nature of any significant planned development.

7.2.2 The study area for the townscape appraisal has been derived from the geographical scope of the options developed for the OBC. Data gathering to inform the townscape appraisal has been informed through an initial walk-over survey undertaken by an appropriately qualified and experienced landscape architect. This has established that there would be no significant effects on townscape beyond an approximate 1.5km threshold from the lake setting.

7.2.3 The appraisal has followed the process described in TAG Unit A3 Chapters 5 and 7. The methodology for appraising the impact on the townscape follows the five step general approach to appraising 'environmental capital':

- Step 1: Scoping and identification of study area (as set out above);
- Step 2: The identification of the key townscape environmental resources and describing their features. In order to accurately assess the character of the key townscape environmental resources, it was necessary to identify and describe the features of the townscape as per the guidance set out in TAG Unit A3 Chapter 7. Therefore the townscape features have been described in terms of their layout, density and mix, scale, appearance, human interaction, cultural and land use to allow a summary of the townscape character to be developed;
- Step 3: The townscape appraisal has been undertaken against the following set of indicators to establish the significance of each key townscape resource: scale it matters, rarity, importance substitutability, and baseline changes;
- Step 4: An impact assessment has been undertaken of the various options under consideration for the OBC on the significance of the townscape. All impacts on the townscape, both adverse (damaging) and beneficial

(enhancing) have been identified along with their predicted magnitude. The appraisal process has addressed how the options could impact on and change:

  - The character of key townscape environmental resources, such as effects on the locally distinctive pattern of townscape features;
  - The ambience of an urban area and the way people interact with the key townscape environmental resource; and
  - The tolerance of the key townscape environmental resource to accommodate further change.

- Step 5: The significant impacts on the townscape have been summarised from the Townscape Appraisal Worksheets for inclusion in the AST (see Chapter 11). These are based on the seven point scale for scoring of impact in line with the guidance set out in TAG Unit A3 Chapter 7.

7.2.4 The appraisal has adopted the following design assumptions for each of the alternatives as presented:

- The long term development and regeneration aspirations for Lake Lothing in accordance with the Lowestoft Lake Lothing and Outer Harbour Area Action Plan[15];
- The provision of a functional bascule bridge form, with channel air drafts as necessary to facilitate the planned function of the waterspace, of a similar style to the existing structure on the A12 at the harbour entrance to the lake;
- The inclusion of appropriate mitigation measures in respect of streetscape improvements to widened or new roads and roundabout constructions; and
- The redefinition of the park edge and appropriate mitigation planting measures, for any alternatives which would materially impact on Normanston Park and Leathes' Ham LNR.

7.3 Consultation

7.3.1 The nature of the Proposed Scheme, its defined study area and relevant designations have been discussed with the Landscape and Trees Officer at Suffolk Coastal District Council.

7.4 Brief Evaluation of Topic Related Constraints

7.4.1 Lake Lothing is a large, urban industrial water space located within the town of Lowestoft. It forms a transitional gateway to The Broads National Park, providing passage and haven for a range of private and commercial craft travelling between Oulton Broad, the wider inland waterway network and the coastal waters of the North Sea.

7.4.2 Lake Lothing is linear in form, fringed by a low lying mainly industrial and maritime townscape. Its western length hosts working boatyards and marine related infrastructure, with extensive pontoon moorings that accommodate a mix of vessels. By contrast, the eastern part of the lake through North Quay and the Inner Harbour is

[15] Lowestoft Lake Lothing and Outer Harbour Area Action Plan. Waveney District Council, 2012.

more open and regular in form, frequented by larger sea-going craft and flanked by a mix of prominent waterside industry, railway and contemporary retail and commercial development.

7.4.3 The townscape surrounding the lake is varied in its quality and composition. The seafront at Lowestoft is a defining feature of the town, the majority with Conservation Area (CA) status (refer to Figure 1.4 for the location of the CAs), where the built frontages are reflective of the town's historical development as a recreational destination. The outer harbour adds to this coastal townscape character, with the open aspect of Lake Lothing itself providing a far reaching inland vista from the harbour crossing. This, while not remarkable in terms of townscape composition still affords a powerful sense of place in defining Lowestoft as a point of gateway to the inland waters of Norfolk and Suffolk.

7.4.4 Inland from Lowestoft's town centre and seafront, the quality of urban form surrounding Lake Lothing assumes a more disparate and fragmented pattern. Its northern edge is flanked by the town's railway, which separates a prominent industrial lake margin from the residential and retail fringes of north Lowestoft. To the south of the lake is a mix of maritime related industry, large tracts of vacant land and areas of new retail and commercial development. It is a townscape in transition, the area having been identified for significant regeneration within the Lowestoft Lake Lothing and Outer Harbour Area Action Plan. The plan aims to deliver a new, more diverse mixed use townscape, with public access to the water frontage and public spaces for people to meet and play, the waterspace being a primary focus and driver for this regeneration.

7.4.5 The wider townscape beyond the lake consists predominantly of established medium density residential development. Normanston Park and Leathes' Ham LNR are larger areas of established open green space set within this residential pattern which are adjacent to the lake but very much distinct in respect of their townscape quality and interaction. The park and LNR together provide a well-used recreational focus for the local area.

7.4.6 Oulton Broad, to the west of Lake Lothing, is situated within The Broads National Park. The industrial townscape of Lowestoft promptly gives way to a typical Broad landscape; a large body of water fringed by mature woodland with frequent waterside residential development and yacht/cruiser moorings. It is markedly more domestic in scale and character than the rest of Lake Lothing with the Mutford bridge crossings forging a divide between the recreational focus of Oulton Broad to the west and the more industrial maritime townscape of Lake Lothing and Lowestoft to the east.

7.4.7 Constraints in respect of townscape, specific to each of the design alternatives are identified as follows:

Option C11

- The residential and retail development edge of north Lowestoft, flanking the northern margin of Lake Lothing;

- The open aspect of Lake Lothing as a component of Lowestoft's townscape.
- Potential impacts on the emerging townscape form of the Kirkley Waterfront and Sustainable Urban Neighbourhood, as defined within the Area Action Plan; and
- The north facing residential edge of Waveney Drive.

Option W4

- The residential and retail development edge of north Lowestoft, flanking the northern margin of Lake Lothing;
- The open aspect of Lake Lothing as a component of Lowestoft's townscape.
- Potential impacts on the emerging townscape of the Kirkley Waterfront and Sustainable Urban Neighbourhood, as defined within the Area Action Plan.
- The townscape setting and function of Normanston Park and Leathes' Ham LNR, located to the north of Lake Lothing; and
- The north facing residential edge of Waveney Drive.

Option T3

- The residential and retail development edge of north Lowestoft, flanking the northern margin of Lake Lothing;
- The townscape setting and function of Normanston Park and Leathes' Ham LNR, located to the north of Lake Lothing; and
- The north facing residential edge of Waveney Drive.

7.5 Townscape Assessment - WebTAG Worksheets

7.5.1 The options are listed and described in the following order:

- Option C11;
- Option W4; and
- Option T3.

Option C11 Townscape Worksheet

Option C11 Townscape Worksheet							
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Changes in Without-scheme case**	**Impact**
Layout	Lake Lothing represents a significant and formative spatial aspect of the town's layout, linking the wider inland waterway network with the coastal townscape. The lake margin comprises a predominantly fragmented, coarse pattern of new retail, existing maritime industry/activity and vacant land, with the railway corridor along its northern edge. Beyond the lake and its linked land uses, the wider townscape is characterised by residential areas with a regular street pattern, interspersed by urban parkland. Lowestoft waterfront (comprising the North & South Lowestoft CAs) has a coherent townscape layout, relating to the towns identity as a seaside resort and port. To the west, the road and rail crossings between Lake Lothing and Oulton Broad bisect an animated, lake orientated townscape focus.	The layout, including the North and South CAs and Normanston Park, matters at a local scale.	The CAs would suggest local rarity in respect of the seafront context. The lake itself is a particular feature of the town. Elsewhere, layout has no rarity value.	The town centre and seafront townscape layout is of high importance at a local level. The lake setting is of moderate importance at a local level.	The seafront context and Lake Lothing waterspace are not readily substitutable. Townscape layout elsewhere is substitutable.	Dynamic townscape change in the immediate environs of Lake Lothing is likely to progress. Layout would not substantially alter.	**Slight Adverse** The road crossing would introduce a new feature in the existing townscape pattern. It would influence to some degree the future regeneration layout in respect of the Area Action Plan, although the existing road framework and adjacent built development would not significantly alter.
Density and mix	Varied development types and densities occupy the margins of Lake Lothing. Open tracts of vacant brownfield land are dispersed through a mix of industrial/domestic maritime land use, alongside more recently established medium density retail development. Residential densities are of mainly terraced, garden properties interspersed by a moderate proportion of open green space. A more intensive mix of retail and residential use is associated with the central and waterfront Lowestoft area, and to the west in the vicinity of Oulton Broad.	Composition and distribution within the townscape matters at a local scale.	The CAs would suggest local rarity in respect of the seafront context. No perceived rarity elsewhere.	The density and composition of the seafront townscape matters at a local level, equally the facilities provided by Normanston Park and Leathes' Ham LNR.	Density and mix are substitutable.	Density and mix of townscape would not substantially change or differ.	**Slight Adverse** There would be a minor influence on the density or mix of development.
Scale	The lake is large and linear in scale, with associated large scale industry and large commercial craft, in particular along its eastern length around the North Quay and Inner Harbour areas. Some of the industrial buildings adjoining the waterspace are particularly large and so are influential on the local townscape. Towards Mutford Bridges, the waterspace and associated townscape is less expansive in scale, flanked by boatyard buildings and structures with a waterspace populated by smaller craft. Beyond Mutford Bridges to the west, the scale of development is more domestic and dispersed in nature.	The scale of the local townscape matters at a local level.	The scale of the waterspace set within the urban fabric of Lowestoft has a rarity value, although expansive inland waterspace is a feature of the nearby rural Broads landscape. The overall scale of the seafront townscape from north to south Lowestoft is relatively scarce within the regional coastal landscape.	The scale of the waterspace is of moderate local importance, in terms of its distinctiveness and potential in defining townscape. The seafront townscape is important at a local level in respect of identity.	The scale of the townscape is substitutable.	A change of townscape scale is highly likely in the vicinity of the lake; a without scheme case would not substantially alter the scale of townscape evolution.	**Slight Adverse** The bascule bridge and elevated approaches would have a minor influence on the sense of open scale associated with the lake setting.
Appearance	Much of Lake Lothing's setting is unremarkable in appearance, it being a disparate mixture of redundant open space, industrial and maritime infrastructure, modern retail development and railway context. Despite its size and scale, the lake is predominantly concealed from view. The crossing points at either end of the lake, at Lowestoft Marina and at Mutford Bridges are the primary points of focus. These are areas of identity in terms of	The appearance of the local townscape around Lake Lothing matters at a local scale. The Lowestoft CAs would suggest more	The appearance of the buildings and structures that surround Lake Lothing are unremarkable.	The appearance of the seafront townscape and its architecture is important at a local level in terms of identity. The lake is of low current importance, but with the	The townscape appearance is substitutable. The potential for townscape change in and around Lake Lothing is high.	The likely nature of townscape change and its influence on the lake setting would not substantially differ.	**Slight Adverse** The elevated approaches to the bascule bridge would be an influence on existing townscape and on the emerging future townscape appearance in accordance

Option C11 Townscape Worksheet							
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Changes in Without-scheme case**	**Impact**
	local architecture/townscape and in affording a perspective on the waterspace. The lake provides a sense of animation to the townscape, with larger vessels occupying North Quay and a range of smaller vessels towards Mutford Bridges.	importance on the seafront appearance and character of Lowestoft.		potential as a catalyst for local townscape improvement and definition.			with the Area Action Plan objectives.
Human interaction	The industrial land use and boatyards that surround the majority of the lake restrict human interaction to mostly commercial maritime and recreational boating activity. The lake, set within its immediate low lying urban context is well concealed. The bridging points at each end of the lake afford the primary sense of place and interaction, these being areas of higher density public activity and facilities. New retail development has introduced an accessible, if currently remote promenade area on its southern edge. Normanston Park and Leathes' Ham LNR are well used open spaces, alongside Lake Lothing but with no real visual connection. A public footpath allows access to the lake, which mainly negotiates the boatyards and slipways of the north shore.	The scale of human interaction matters mainly at a local level. The town centre, seafront, Normanston Park and Mutford Bridges area near Oulton Broad provide the most land based interaction.	The context of Lake Lothing in respect of interaction matters at a local scale.	The waterspace itself is important at a sub-regional level in terms of its community and leisure interaction within the wider waterway network.	The nature of interaction is substitutable.	The likely increase in interaction as a result of the townscape evolution around Lake Lothing would not substantially change.	**Neutral** There would be no perceived impact on human activity and interaction as a result of the scheme's implementation.
Cultural	The lake and its maritime/industrial character form an integral part of Lowestoft's wider townscape, reflecting the town's identity as a port and link to the inland waterway network. It is a visible indicator of cultural and townscape change, where the role of the waterspace and its associated use continues to evolve. The existing large industrial buildings and boatyards around the lake edge are evident townscape features, along with the presence of larger sea going vessels. The distinctive waterfront of Lowestoft and the presence of boat activity are a major part of the town's cultural character. The bascule road bridge crossings at either end of Lake Lothing offer a further sense of townscape animation and a cultural link with boat passage as a part of the town's character.	The lake and its formative role in the townscape evolution matter at a local scale.	The open expanse of the waterspace and its functional use give rise to a distinct yet local townscape, specific to location.	The association of Lowestoft as a seaside destination, a port and point of passage to the inland waterways are important cultural aspects of the town, its townscape elements derived from this cultural baseline.	The cultural heritage of townscape features is not substitutable. Cultural change by its essence is ongoing and will modify townscape.	Cultural change would not differ in a without-scheme scenario.	**Neutral** The scheme would not alter the cultural context of Lake Lothing
Land use	The waterspace is utilised for a range of commercial and private boat traffic, linking Oulton Broad with the coastal waters of Lowestoft. Surrounding land use is a mixture of maritime and industrial activity, retail and railway corridor. The broader urban context is residential development with defined public open space in the vicinity of the lake. Lowestoft waterfront and Oulton Broad areas offer a mix of retail and residential activity, heavily linked with waterspace as a focus.	The associated function of Lake Lothing in terms of its passage for leisure and commercial craft matters at a sub-regional level.	The land use in the vicinity of the lake has no rarity value.	The use associated with Lake Lothing and its harbour area is of importance at a local level. The land take associated with the lake has a high potential for townscape evolution through change of land use.	Land use is substitutable. However the lake itself as a physical form is not easily substitutable.	The nature of land use change in the vicinity of the lake would not substantially alter.	**Slight adverse** The scheme would displace a small amount existing/planned land use.
Summary of character	Lake Lothing is a formative spatial aspect of the town's layout, linking the wider inland waterway network with the coastal townscape. Broadly linear, it is enclosed by a low lying urban/industrial townscape, a mix of prominent waterside industry, railway and retail development within a broader residential setting. Inland and away from the characteristic seafront architecture, the quality of urban form surrounding Lake Lothing is fragmented. It is a transitional townscape, one identified for significant regeneration within the Lowestoft Lake Lothing and Outer Harbour Area Action Plan. Normanston Park and Leathes' Ham Local LNR are areas of established open	Scale matters at a predominantly local level, with the CA designation emphasising the significance of relative scale of the seafront townscape.	The CAs would suggest local rarity in respect of the seafront context. No perceived rarity of townscape elsewhere.	The appearance of the seafront townscape and its architecture is important at a local level in terms of identity. The lake is of low current importance, but with the potential as a catalyst for local townscape improvement and definition.	The lake itself is not substitutable. The majority of the townscape surrounding the lake is substitutable, although the character of the seafront not readily so.	The townscape evolution around Lake Lothing would not significantly change in a without-scheme case.	**Slight Adverse** The bascule bridge and its approaches would be a visible feature of the lake setting, with some sense of sub-division of the lake's scale. Its location may influence future townscape development as defined by the Area Action Plan.

Option C11 Townscape Worksheet							
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Changes in Without-scheme case**	**Impact**
	green space adjacent to the lake, distinct in respect of townscape interaction. Oulton Broad is markedly more domestic in character than Lake Lothing, with road bridge and rail crossings forging a divide between its recreational focus and the progressively more urban, industrial environment of Lake Lothing to the east.						

Reference Sources

- Waveney Local Development Framework, Development Plan: Core Strategy (January 2009);
- Lowestoft Lake Lothing and Outer Harbour Area Action Plan (January 2012);
- Broads Authority Local Development Framework, Development Plan: Core Strategy 2007-2021 (September 2007); and
- South Lowestoft Conservation Area: Character Appraisal (June 2007).

Option C11 Summary Assessment (including Assessment Score)

7.5.2 The bascule bridge, its elevated approach roads and the railway crossing would be evident as a townscape intervention, prominent from the waterspace and from the lake's accessible margins. The bridge itself would be largely in character with the townscape qualities associated with the lake and its functional context, its relative prominence influenced by the scale and nature of future lakeside regeneration within the envisaged "Kirkley Waterfront and Sustainable Urban Neighbourhood" as detailed within the Lowestoft Lake Lothing and Outer Harbour Area Action Plan. The elevated approaches and railway crossing would extend the urban influence of the road infrastructure, which may impact on any planned or emerging townscape pattern.

7.5.3 There would be some sense of subdivision of the waterspace of North Quay, which may influence the perception of its apparent scale as a townscape element.

7.5.4 The modification of Peto Way would be largely in character with the existing townscape pattern. There would be some minor fragmentation of land arising from the new roundabout construction, although this in itself would not significantly alter the townscape quality.

Assessment Score: Slight Adverse

Option W4 Townscape Worksheet

Option W4 Townscape Worksheet							
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Changes in Without-scheme case**	**Impact**
Layout	Lake Lothing represents a significant and formative spatial aspect of the town's layout, linking the wider inland waterway network with the coastal townscape. The lake margin comprises a predominantly fragmented, coarse pattern of new retail, existing maritime industry/activity and vacant land, with the railway corridor along its northern edge. Beyond the lake and its linked land uses, the wider townscape is characterised by residential areas with a regular street pattern, interspersed by urban parkland. Lowestoft waterfront (comprising the North & South Lowestoft CAs) has a coherent townscape layout, relating to the towns identity as a seaside resort and port. To the west, the road and rail crossings between Lake Lothing and Oulton Broad bisect an animated, lake orientated townscape focus.	The layout, including the North and South CAs and Normanston Park, matters at a local scale.	The CAs would suggest local rarity in respect of the seafront context. The lake itself is a particular feature of the town. Elsewhere, layout has no rarity value.	The town centre and seafront townscape layout is of high importance at a local level. The lake setting is of moderate importance at a local level.	The seafront context and Lake Lothing waterspace are not readily substitutable. Townscape layout elsewhere is substitutable.	Dynamic townscape change in the immediate environs of Lake Lothing is likely to progress. Layout would not substantially alter.	**Slight Adverse** The road crossing would introduce a new feature within the townscape layout of the lake; potentially an influence on future regeneration alternatives in line with the Area Action Plan.
Density and mix	Varied development types and densities occupy the margins of Lake Lothing. Open tracts of vacant brownfield land are dispersed through a mix of industrial/domestic maritime land use, alongside more recently established medium density retail development. Residential densities are of mainly terraced, garden properties interspersed by a moderate proportion of open green space. A more intensive mix of retail and residential use is associated with the central and waterfront Lowestoft area, and to the west in the vicinity of Oulton Broad.	Composition and distribution within the townscape matters at a local scale.	The CAs would suggest local rarity in respect of the seafront context. No perceived rarity elsewhere.	The density and composition of the seafront townscape matters at a local level, equally the facilities provided by Normanston Park and Leathes' Ham LNR.	Density and mix are substitutable.	Density and mix of townscape would not substantially change or differ.	**Slight Adverse** There would be an impact on the density/mix of development, by way of material change to Normanston Park and Leathes' Ham LNR.
Scale	The lake is large and linear in scale, with associated large scale industry and large commercial craft, in particular along its eastern length around the North Quay and Inner Harbour areas. Some of the industrial buildings adjoining the waterspace are particularly large and so are influential on the local townscape. Towards Mutford Bridges, the waterspace and associated townscape is less expansive in scale, flanked by boatyard buildings and structures with a waterspace populated by smaller craft. Beyond Mutford Bridges to the west, the scale of development is more domestic and dispersed in nature.	The scale of the local townscape matters at a local level.	The scale of the waterspace set within the urban fabric of Lowestoft has a rarity value, although expansive inland waterspace is a feature of the nearby rural Broads landscape. The overall scale of the seafront townscape from north to south Lowestoft is relatively scarce within the regional coastal landscape.	The scale of the waterspace is of moderate local importance, in terms of its distinctiveness and potential in defining townscape. The seafront townscape is important at a local level in respect of identity.	The scale of the townscape is substitutable.	A change of townscape scale is highly likely in the vicinity of the lake; a without scheme case would not substantially alter the scale of townscape evolution.	**Slight Adverse** The bascule bridge and elevated approaches would have a minor influence on the sense of open scale associated with the lake setting.
Appearance	Much of Lake Lothing's setting is unremarkable in appearance, it being a disparate mixture of redundant open space, industrial and maritime infrastructure, modern retail development and railway context. Despite its size and scale, the lake is predominantly concealed from view. The crossing points at either end of the lake, at Lowestoft Marina and at Mutford Bridges are the primary points of focus. These are areas of identity in terms of local architecture/townscape and in affording a perspective on the	The appearance of the local townscape around Lake Lothing matters at a local scale. The Lowestoft CAs would suggest more	The appearance of the buildings and structures that surround Lake Lothing are unremarkable.	The appearance of the seafront townscape and its architecture is important at a local level in terms of identity. Normanston Park and	The townscape appearance is substitutable. The potential for townscape change in and around Lake Lothing is high.	The likely nature of townscape change and its influence on the lake setting would not substantially differ.	**Slight Adverse** The elevated approaches to the bascule bridge would be an influence on existing townscape and on the emerging future townscape appearance in accordance

Option W4 Townscape Worksheet							
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Changes in Without-scheme case**	**Impact**
	waterspace. The lake provides a sense of animation to the townscape, with larger vessels occupying North Quay and a range of smaller vessels towards Mutford Bridges.	importance on the seafront appearance and character of Lowestoft.		Leathes' Ham LNR appearance are important at a local level. The lake is of low current importance, but with the potential as a catalyst for local townscape improvement and definition.			with the Area Action Plan objectives. **Moderate Adverse** The townscape appearance of Normanston Park and the Leathes' Ham LNR would be modified.
Human interaction	The industrial land use and boatyards that surround the majority of the lake restrict human interaction to mostly commercial maritime and recreational boating activity. The lake, set within its immediate low lying urban context is well concealed. The bridging points at each end of the lake afford the primary sense of place and interaction, these being areas of higher density public activity and facilities. New retail development has introduced an accessible, if currently remote promenade area on its southern edge. Normanston Park and Leathes' Ham LNR are well used open spaces, alongside Lake Lothing but with no real visual connection. A public footpath allows access to the lake, which mainly negotiates the boatyards and slipways of the north shore.	The scale of human interaction matters mainly at a local level. The town centre, seafront, Normanston Park and Mutford Bridges area near Oulton Broad provide the most land based interaction.	The context of Lake Lothing in respect of interaction matters at a local scale.	The waterspace itself is important at a sub-regional level in terms of its community and leisure interaction within the wider waterway network.	The nature of interaction is substitutable.	The likely increase in interaction as a result of the townscape evolution around Lake Lothing would not substantially change.	**Slight Adverse** There would be some impact on human activity and interaction as a result of the scheme, in particular at Normanston Park and Leathes' Ham LNR.
Cultural	The lake and its maritime/industrial character form an integral part of Lowestoft's wider townscape, reflecting the town's identity as a port and link to the inland waterway network. It is a visible indicator of cultural and townscape change, where the role of the waterspace and its associated use continues to evolve. The existing large industrial buildings and boatyards around the lake edge are evident townscape features, along with the presence of larger sea going vessels. The distinctive waterfront of Lowestoft and the presence of boat activity are a major part of the town's cultural character. The bascule road bridge crossings at either end of Lake Lothing offer a further sense of townscape animation and a cultural link with boat passage as a part of the town's character.	The lake and its formative role in the townscape evolution matter at a local scale.	The open expanse of the waterspace and its functional use give rise to a distinct yet local townscape, specific to location.	The association of Lowestoft as a seaside destination, a port and point of passage to the inland waterways are important cultural aspects of the town, its townscape elements derived from this cultural baseline.	The cultural heritage of townscape features is not substitutable. Cultural change by its essence is ongoing and will modify townscape.	Cultural change would not differ in a without-scheme scenario.	**Neutral** The scheme would not alter the cultural context of Lake Lothing
Land use	The waterspace is utilised for a range of commercial and private boat traffic, linking Oulton Broad with the coastal waters of Lowestoft. Surrounding land use is a mixture of maritime and industrial activity, retail and railway corridor. The broader urban context is residential development with defined public open space in the vicinity of the lake. Lowestoft waterfront and Oulton Broad areas offer a mix of retail and residential activity, heavily linked with waterspace as a focus.	The associated function of Lake Lothing in terms of its passage for leisure and commercial craft matters at a sub-regional level.	The land use in the vicinity of the lake has no rarity value.	The use associated with Lake Lothing and its harbour area is of importance at a local level. The land take associated with the lake has a high potential for townscape evolution through change of land use.	Land use is substitutable. However the lake itself as a physical form is not easily substitutable.	The nature of land use change in the vicinity of the lake would not substantially alter.	**Moderate adverse** The scheme would displace some existing open green space and associated facilities.
Summary of character	Lake Lothing is a formative spatial aspect of the town's layout, linking the wider inland waterway network with the coastal townscape. Broadly linear, it is enclosed by a low lying urban/industrial townscape, a mix of prominent waterside industry, railway and retail development within a broader residential setting.	Scale matters at a predominantly local level, with the CA designation emphasising the	The CAs would suggest local rarity in respect of the seafront context. No perceived rarity	The appearance of the seafront townscape and its architecture is important at a local level in terms of identity.	The lake itself is not substitutable. The majority of the townscape surrounding the lake is	The townscape evolution around Lake Lothing would not significantly change in a without-	**Slight Adverse** The bascule bridge and its approaches would be a visible feature of the lake setting, with some sense of

Option W4 Townscape Worksheet							
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Changes in Without-scheme case**	**Impact**
	Inland and away from the characteristic seafront architecture, the quality of urban form surrounding Lake Lothing is fragmented. It is a transitional townscape, one identified for significant regeneration within the Lowestoft Lake Lothing and Outer Harbour Area Action Plan. Normanston Park and Leathes' Ham LNR are areas of established open green space adjacent to the lake, distinct in respect of townscape interaction. Oulton Broad is markedly more domestic in character than Lake Lothing, with road bridge and rail crossings forging a divide between its recreational focus and the progressively more urban, industrial environment of Lake Lothing to the east.	significance of relative scale of the seafront townscape.	of townscape elsewhere.	The lake is of low current importance, but with the potential as a catalyst for local townscape improvement and definition.	substitutable, although the character of the seafront not readily so.	scheme case.	sub-division of the lake's scale. The route location may influence future townscape development as defined by the Area Action Plan. **Moderate Adverse** There would be a net reduction of recreational open green space at Normanston Park and Leathes' Ham LNR, with an erosion of spatial quality as a locally valued part of the townscape.

Reference Sources

- Waveney Local Development Framework, Development Plan: Core Strategy (January 2009);
- Lowestoft Lake Lothing and Outer Harbour Area Action Plan (January 2012);
- Broads Authority Local Development Framework, Development Plan: Core Strategy 2007-2021 (September 2007); and
- South Lowestoft Conservation Area: Character Appraisal (June 2007).

Option W4 Summary Assessment (including Assessment Score)

7.5.5 The bascule bridge, its elevated approach roads and the railway crossing would be evident as a townscape feature, both from the waterspace and from the lake's accessible margins. The bascule bridge itself would be largely in character with the townscape qualities associated with the lake and its context. There would however be some sense of subdivision of the North Quay water space, which may influence the perception of the lake's overall scale and prospect.

7.5.6 The elevated crossing approaches and the railway overbridge would extend the urban influence of the road infrastructure, which may impose on any planned or emerging local townscape pattern in connection with the envisaged "Kirkley Waterfront and Sustainable Urban Neighbourhood" as detailed in the Lowestoft Lake Lothing and Outer Harbour Area Action Plan.

7.5.7 The Peto Road and railway overbridge would be a perceived new townscape influence on Normanston Park and Leathes' Ham LNR, in combination with the re-alignment of Peto Way and the introduction of a new roundabout at the corner of Normanston Park requiring the removal of park facilities. This would influence the context of these recreational areas. Mitigation measures over time by way of planting and a redefinition of the park edge would lessen this impact, although there would be a net reduction in recreational open green space and a consequent impact on how these spaces are perceived within the townscape.

7.5.8 There were would be no long term adverse impact on townscape arising from the roundabout constructions adjacent to existing retail development on Peto Way.

Assessment Score: The overall impact is considered to be in the upper order of Slight Adverse.

Option T3 Townscape Worksheet

Option T3 Townscape Worksheet							
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Changes in Without-scheme case**	**Impact**
Layout	Lake Lothing represents a significant and formative spatial aspect of the town's layout, linking the wider inland waterway network with the coastal townscape. The lake margin comprises a predominantly fragmented, coarse pattern of new retail, existing maritime industry/activity and vacant land, with the railway corridor along its northern edge. Beyond the lake and its linked land uses, the wider townscape is characterised by residential areas with a regular street pattern, interspersed by urban parkland. Lowestoft waterfront (comprising the North & South Lowestoft CAs) has a coherent townscape layout, relating to the towns identity as a seaside resort and port. To the west, the road and rail crossings between Lake Lothing and Oulton Broad bisect an animated, lake orientated townscape focus.	The layout, including the North and South CAs and Normanston Park, matters at a local scale.	The CAs would suggest local rarity in respect of the seafront context. The lake itself is a particular feature of the town. Elsewhere, layout has no rarity value.	The town centre and seafront townscape layout is of high importance at a local level. The lake setting is of moderate importance at a local level.	The seafront context and Lake Lothing waterspace are not readily substitutable. Townscape layout elsewhere is substitutable.	Dynamic townscape change in the immediate environs of Lake Lothing is likely to progress. Layout would not substantially alter.	**Slight Adverse** The road crossing would have a slight influence on townscape layout at Normanston Park.
Density and mix	Varied development types and densities occupy the margins of Lake Lothing. Open tracts of vacant brownfield land are dispersed through a mix of industrial/domestic maritime land use, alongside more recently established medium density retail development. Residential densities are of mainly terraced, garden properties interspersed by a moderate proportion of open green space. A more intensive mix of retail and residential use is associated with the central and waterfront Lowestoft area, and to the west in the vicinity of Oulton Broad.	Composition and distribution within the townscape matters at a local scale.	The CAs would suggest local rarity in respect of the seafront context. No perceived rarity elsewhere.	The density and composition of the seafront townscape matters at a local level, equally the facilities provided by Normanston Park and Leathes' Ham LNR.	Density and mix are substitutable.	Density and mix of townscape would not substantially change or differ.	**Slight Adverse** There would be an impact on density/mix of development, by way of material change to Normanston Park and Leathes' Ham LNR.
Scale	The lake is large and linear in scale, with associated large scale industry and large commercial craft, in particular along its eastern length around the North Quay and Inner Harbour areas. Some of the industrial buildings adjoining the waterspace are particularly large and so are influential on the local townscape. Towards Mutford Bridges, the waterspace and associated townscape is less expansive in scale, flanked by boatyard buildings and structures with a waterspace populated by smaller craft. Beyond Mutford Bridges to the west, the scale of development is more domestic and dispersed in nature.	The scale of the local townscape matters at a local level.	The scale of the waterspace set within the urban fabric of Lowestoft has a rarity value, although expansive inland waterspace is a feature of the nearby rural Broads landscape. The overall scale of the seafront townscape from north to south Lowestoft is relatively scarce within the regional coastal landscape.	The scale of the waterspace is of moderate local importance, in terms of its distinctiveness and potential in defining townscape. The seafront townscape is important at a local level in respect of identity.	The scale of the townscape is substitutable.	A change of townscape scale is highly likely in the vicinity of the lake; a without scheme case would not substantially alter the scale of townscape evolution.	**Neutral** The scale of the setting would not be altered.
Appearance	Much of Lake Lothing's setting is unremarkable in appearance, it being a disparate mixture of redundant open space, industrial and maritime infrastructure, modern retail development and railway context. Despite its size and scale, the lake is predominantly concealed from view. The crossing points at either end of the lake, at Lowestoft Marina and at Mutford Bridges are the primary points of focus. These are areas of identity in terms of local architecture/townscape and in affording a perspective on the	The appearance of the local townscape around Lake Lothing matters at a local scale. The Lowestoft CAs would	The appearance of the buildings and structures that surround Lake Lothing are unremarkable.	The appearance of the seafront townscape and its architecture is important at a local level in terms of identity. The lake is of low current importance, but with the	The townscape appearance is substitutable. The potential for townscape change in and around Lake Lothing is high.	The likely nature of townscape change and its influence on the lake setting would not substantially differ.	**Neutral** The tunnel arrangement would not change the overall appearance at Lake Lothing. **Moderate Adverse** The townscape appearance of Normanston Park and Leathes'

Option T3 Townscape Worksheet							
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Changes in Without-scheme case**	**Impact**
	waterspace. The lake provides a sense of animation to the townscape, with larger vessels occupying North Quay and a range of smaller vessels towards Mutford Bridges.	suggest more importance on the seafront appearance and character of Lowestoft.		potential as a catalyst for local townscape improvement and definition.			Ham LNR would be influenced to some degree.
Human interaction	The industrial land use and boatyards that surround the majority of the lake restrict human interaction to mostly commercial maritime and recreational boating activity. The lake, set within its immediate low lying urban context is well concealed. The bridging points at each end of the lake afford the primary sense of place and interaction, these being areas of higher density public activity and facilities. New retail development has introduced an accessible, if currently remote promenade area on its southern edge. Normanston Park and Leathes' Ham LNR are well used open spaces, alongside Lake Lothing but with no real visual connection. A public footpath allows access to the lake, which mainly negotiates the boatyards and slipways of the north shore.	The scale of human interaction matters mainly at a local level. The town centre, seafront, Normanston Park and Mutford Bridges area near Oulton Broad provide the most land based interaction.	The context of Lake Lothing in respect of interaction matters at a local scale.	The waterspace itself is important at a sub-regional level in terms of its community and leisure interaction within the wider waterway network.	The nature of interaction is substitutable.	The likely increase in interaction as a result of the townscape evolution around Lake Lothing would not substantially change.	**Slight Adverse** There would some impact on human activity and interaction as a result of the scheme, in particular at Normanston Park and Leathes' Ham.
Cultural	The lake and its maritime/industrial character form an integral part of Lowestoft's wider townscape, reflecting the town's identity as a port and link to the inland waterway network. It is a visible indicator of cultural and townscape change, where the role of the waterspace and its associated use continues to evolve. The existing large industrial buildings and boatyards around the lake edge are evident townscape features, along with the presence of larger sea going vessels. The distinctive waterfront of Lowestoft and the presence of boat activity are a major part of the town's cultural character. The bascule road bridge crossings at either end of Lake Lothing offer a further sense of townscape animation and a cultural link with boat passage as a part of the town's character.	The lake and its formative role in the townscape evolution matter at a local scale.	The open expanse of the waterspace and its functional use give rise to a distinct yet local townscape, specific to location.	The association of Lowestoft as a seaside destination, a port and point of passage to the inland waterways are important cultural aspects of the town, its townscape elements derived from this cultural baseline.	The cultural heritage of townscape features is not substitutable. Cultural change by its essence is ongoing and will modify townscape.	Cultural change would not differ in a without-scheme scenario.	**Neutral** The scheme would not alter the cultural context of Lake Lothing
Land use	The waterspace is utilised for a range of commercial and private boat traffic, linking Oulton Broad with the coastal waters of Lowestoft. Surrounding land use is a mixture of maritime and industrial activity, retail and railway corridor. The broader urban context is residential development with defined public open space in the vicinity of the lake. Lowestoft waterfront and Oulton Broad areas offer a mix of retail and residential activity, heavily linked with waterspace as a focus.	The associated function of Lake Lothing in terms of its passage for leisure and commercial craft matters at a sub-regional level.	The land use in the vicinity of the lake has no rarity value.	The use associated with Lake Lothing and its harbour area is of importance at a local level. The land take associated with the lake has a high potential for townscape evolution through change of land use.	Land use is substitutable. However the lake itself as a physical form is not easily substitutable.	The nature of land use change in the vicinity of the lake would not substantially alter.	**Moderate adverse** The scheme would displace some existing open green space and associated facilities.
Summary of character	Lake Lothing is a formative spatial aspect of the town's layout, linking the wider inland waterway network with the coastal townscape. Broadly linear, it is enclosed by a low lying urban/industrial townscape, a mix of prominent waterside industry, railway and retail development within a broader residential setting. Inland and away from the characteristic seafront architecture, the quality of urban form surrounding Lake Lothing is fragmented. It is a transitional townscape, one identified for significant regeneration within the Lowestoft	Scale matters at a predominantly local level, with the CA designation emphasising the significance of relative scale of the seafront	The CAs would suggest local rarity in respect of the seafront context. No perceived rarity of townscape elsewhere.	The appearance of the seafront townscape and its architecture is important at a local level in terms of identity. The lake is of low current importance, but with the potential as a catalyst for local townscape	The lake itself is not substitutable. The majority of the townscape surrounding the lake is substitutable, although the character of the seafront not readily	The townscape evolution around Lake Lothing would not significantly change in a without-scheme case.	**Neutral** There would be no change to townscape character across the lake setting. **Moderate Adverse**: There would be a net reduction of recreational open green

Option T3 Townscape Worksheet							
Features	**Description**	**Scale it matters**	**Rarity**	**Importance**	**Substitutability**	**Changes in Without-scheme case**	**Impact**
	Lake Lothing and Outer Harbour Area Action Plan. Normanston Park and Leathes' Ham LNR are areas of established open green space adjacent to the lake, distinct in respect of townscape interaction. Oulton Broad is markedly more domestic in character than Lake Lothing, with road bridge and rail crossings forging a divide between its recreational focus and the progressively more urban, industrial environment of Lake Lothing to the east.	townscape.		improvement and definition.	so.		space at Normanston Park and Leathes' Ham LNR, with an erosion of spatial quality as a locally valued part of the townscape.

Reference Sources

- Waveney Local Development Framework, Development Plan: Core Strategy (January 2009);
- Lowestoft Lake Lothing and Outer Harbour Area Action Plan (January 2012);
- Broads Authority Local Development Framework, Development Plan: Core Strategy 2007-2021 (September 2007); and
- South Lowestoft Conservation Area: Character Appraisal (June 2007).

Option T3 Summary Assessment (including Assessment Score)

7.5.9 The assessment has considered the development in terms of its impact on the immediate setting of Lake Lothing and on the recreational townscape setting of Normanston Park and Leathes' Ham LNR.

7.5.10 The tunnel would have no significant influence on the wider established townscape surrounding Lake Lothing. The townscape pattern adjacent to Lake Lothing in terms of the planned Kirkley Waterfront and Sustainable Urban Neighbourhood (Lowestoft Lake Lothing and Outer Harbour AAP) would not be compromised.

7.5.11 The re-alignment of Peto Way, along with the introduction of a new roundabout junction on the edge of Normanston Park and Leathes' Ham LNR would have a material impact on these recreational areas, requiring the relocation or modification of some park facilities. Mitigation measures over time by way of planting and a redefinition of the park edge would lessen this impact, however there would be a net reduction in recreational open green space and a consequent impact on how these spaces are perceived within the townscape.

Assessment Score: The summary score is assessed on balance to be in the order of Slight Adverse

8 Biodiversity

8.1 Introduction

8.1.1 This chapter of the Environmental Options Appraisal Report addresses the potential impacts of the proposed alignments for the Proposed Scheme on ecological receptors, including direct impacts resulting from activities integral to the project, indirect impacts and cumulative impacts. It is particularly important to read this chapter in conjunction with the Phase I Habitat Survey which is included in Appendix B.

8.2 Appraisal Methodology

8.2.1 A desk study and Phase I Habitat Survey has been undertaken to inform the appraisal of options developed for the OBC. The desk study has identified changes to known biodiversity resources previously identified by other studies and has identified any new features. This includes designated and non-designated sites.

8.2.2 The appraisal has considered two study areas:

- ***Main Study Area***: The main study area is defined as extending to a distance of 0.5km around the route options; and
- ***Broad Study Area***: the broad study area for the appraisal comprises the wider environment in which the route options are located and within which it is possible that significant effects could occur. The broad study area, for example, has considered impacts up to 5km from the route options with respect to European Sites (30km for SACs designated for bats).

8.2.3 The Biodiversity appraisal has been undertaken with reference to the following guidance:

- TAG Unit A3 Chapters 5 and 9 (which also references DMRB Volume 11 Section 3 Part 4);
- 'Guidelines for Ecological Impact Assessment in the UK' (Chartered Institute for Ecological and Environmental Management (CIEEM),2006); and
- DMRB Volume 11 Section 4 Assessment of the Implications (of Highways and/or Road Projects) on European Sites (including Appropriate Assessment).

8.2.4 The appraisal has followed the five step process outlined in TAG Unit A3 as set out below:

- Step 1: Scoping and identification of study area (as detailed above);
- Step 2: the identification of the key environmental resources and describing their features. Following the completion of the desk study and the Phase I Habitat Survey the features and environmental resources have been described as per TAG Unit A3 Chapter 9, in terms of their qualities and functions (local, regional, national or international value);

- Step 3: The appraisal has considered the following set of indicators to establish the significance of each key biodiversity area or feature in question: the scale at which it matters, the importance, and trend. The value of the feature or area will be derived using the criteria set out in Tables 9 and 10 of TAG Unit A3, Chapter 9;
- Step 4: An impact assessment of the options on biodiversity resources in terms of significance and integrity has been undertaken. The assessment has considered whether impacts may be direct or indirect, individual or cumulative, temporary or permanent, may be geographically dispersed, and may be harmful or beneficial. The criteria used for assessing the magnitude of the impact are set out in Chapter 9, Table 11 of TAG Unit A3.
- Step 5: an assessment of the significance of likely impacts on the receptors has been undertaken for each of the options. An overall score has been determined using the definitions for overall impact outlined in TAG Unit A3 Table 12. The significant impacts on biodiversity have been summarised on the Biodiversity Worksheets (see Section 8.6) for inclusion in the AST.

8.3 Consultation

8.3.1 Contact was made with the Lead Advisor for Planning and Conservation at Suffolk County Council, to determine if they were aware of any ecological constraints for any of the proposed alignments that may not be available via other resources, such as the Suffolk Biological Records Centre, or the Department of Environment, Food and Rural Affairs' (DEFRA) MAGIC website. They responded that, to their knowledge, there were no data that was not freely available via the appropriate information sources.

8.3.2 The Environment Agency also advised that there were protected species records within the area; namely water vole, otter, bats, grass snake and slow worm, and that protected species surveys would be needed. They also suggested that any bridge design should include bird and bat roosting boxes. The Phase 1 report investigated the protected species records and found that reptiles and bats may be affected by all three proposed alignments; however it concluded water vole and otter to be far enough away from the proposed alinement so as not to be affected.

8.4 Brief Evaluation of Topic Related Constraints

Constraints common to all Alignments

8.4.1 Buildings are present within the vicinity of the proposed alignments that may support roosting bats. It is therefore recommended that:

- A survey should be undertaken to identify likely bat roosts within 50m of the proposed route;
- Surveys should be undertaken to confirm the status of likely bat roosts identified; and
- Where appropriate, mitigation should be designed and implemented.

8.4.2 The proposed route passes through habitat suitable for reptiles. Because reptile populations are known to be present within 0.5km of the proposed alignment it is recommended that:

- A reptile survey should be undertaken within areas of suitable habitat to confirm whether reptile species are present and estimate population sizes; and
- If required based on the findings of the survey, a mitigation plan should be designed and implemented as appropriate.

8.4.3 Habitat likely to be used by breeding birds has been identified within the proposed alignment. It is therefore recommended that:

- Any necessary vegetation clearance should be undertaken with appropriate consideration of breeding birds;
- Ideally, vegetation clearance should be undertaken outside of the typical bird breeding season (generally taken as mid-March to mid-August). This measure will greatly reduce any risk of an offence under the Wildlife and Countryside Act 1981 (as amended) being committed; and
- If vegetation clearance is required during the typical bird breeding season, then a suitably experienced ecologist should supervise the work.

8.4.4 If active bird nests are found then the ecologist should advise an appropriate approach to avoiding adverse effects.

Route option C11

8.4.5 The route passes through suitable reptile and nesting bird habitat, and is within 0.5km of known populations of reptiles. There are also buildings with 50m of the proposed alignment that could offer suitable bat roosting sites.

Route option W4

8.4.6 The new alignment of Peto Way will encroach into Leathes' Ham LNR, which has been designated due to the mix of habitats found within the site and its suitability for wading birds. It is recommended that mitigation for the loss of habitat is provided in consultation with the current owners/management.

8.4.7 The alignment will also run through the Brooke Yachts and Jeld-Wen Mosaic. This County Wildlife site has a known population of reptiles, holds the only mudflat habitat within Lake Lothing, and has suitable habitat for nesting birds.

Route option T3

8.4.8 The new alignment of Peto Way will encroach into Leathes' Ham LNR, which has been designated due to the mix of habitats found within the site and its suitability for wading birds. It is recommended that mitigation for the loss of habitat is provided in consultation with the current owners/management.

8.4.9 The alignment will also run through the Brooke Yachts and Jeld-Wen Mosaic. This County Wildlife site has a known population of reptiles, holds the only mudflat habitat within Lake Lothing, and has suitable habitat for nesting birds.

8.5 Biodiversity Assessment - WebTAG Worksheets

8.5.1 The options are listed and described in the following order:

- Option C11;
- Option W4; and
- Option T3.

Option C11 Biodiversity Worksheet

Option C11 Biodiversity Worksheet							
Area	**Description of feature/ attribute**	**Scale (at which attribute matters)**	**Importance (of attribute)**	**Trend (in relation to target)**	**Biodiversity and earth heritage value**	**Magnitude of impact**	**Assessment Score**
The Broads National Park / RAMSAR / SPA / SAC	A network of mostly navigable waterways that were created by the flooding of peat works. They now house a diverse range of habitats and are home to many rare and unique species of plants and animals.	International	Habitats are the primary reason for international selection. Namely; Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp., Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation, Transition mires and quaking bogs, Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae,* Alkaline fens, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*	These habitats are very rare in the UK, and hold very rare species of plants. With the recent National Park designation it is hoped that these habitats will continue to support their diversity of plant life with the added security of a national designation.	Very-High	Neutral	Neutral
Leathes' Ham Local Nature Reserve	Centred on a freshwater lake with a mix of wooded and grassland habitats. The site is home to many bird species and wet woodland.	National	The site has a fresh water lake, marshes, reedbeds and a dyke network, and is known as a breeding site for wildfowl. Plants found here include ragged robin, southern marsh orchid and purple small reed.	The site is currently under management of the Suffolk Wildlife Trust, and represents an important wildfowl breeding area.	High	Neutral	Neutral
Brooke Yachts and Jeld-Wan Mosaic County Wildlife Site	The area contains a mosaic of different habitats that range from grassland and scrub to mud flats. The site has a diverse range of species including reptiles and breeding birds	County	An ex industrial area that now has a mixture of grassland and ruderal habitats with fringing mudflats. There is a large population of common lizards and many breeding birds.	This site is managed by the Suffolk Wildlife Trust and although it may not be directly affected, the close proximity of reptiles and breeding birds may prove to be a constraint to works.	High	Neutral	Neutral
Kirkly Ham County Wildlife Site	The area has a mosaic of habitats with a population of reptiles and suitable breeding bird habitat.	County	The area forms part of the flood control system for that part of the local town and comprises of numerous habitats bisected by a disused railway line. There has been a viable population of common lizards found here recently	The site lies south of the proposed works and although it may not be directly affected, the close proximity of a reptiles population may prove to be a constraint to works.	Medium	Minor negative	Slight adverse
Harbour Kittiwake Colony County Wildlife Site	The area is home to a kittiwake colony at the mouth of lake Lothing.	County	The colony inhabits an artificial cliff on the northern pier extension. There are approximately 200 nests around the harbour with an additional 53 on the artificial cliff.	The works are unlikely to affect the artificial cliff, although there is a small risk of disturbing nesting birds outside of the artificial cliff	Medium	Minor negative	Slight adverse
Reptiles	Protected species	National	Due to the removal of potential habitat, reptiles may be affected by the proposed works	Reptiles are protected under schedule 5 of the Wildlife and Countryside Act (as amended) and therefore deliberate destruction of the animal or their resting place constitute and offence.	Medium	Intermediate negative	Moderate adverse
Bats	Protected species	National	Due to the proximity of structures that hold the potential for suitable bat roosting sites that may be affected by the proposed works.	Bat are protected under schedule 5 of the Wildlife and Countryside Act (as amended) and therefore deliberate destruction of the animal or their resting place constitute and offence	Medium	Intermediate negative	Moderate adverse
Birds	Protected species	National	Due to the close proximity of several statutory and non –statutory protected sites and other suitable vegetation, the proposed works may disturb nesting birds	All nesting birds are protected under The Wildlife and Countryside Act 1981 (as amended) and therefore the disturbance of their nesting places is considered an offence	Medium	Intermediate negative	Moderate adverse

Reference Sources

- Suffolk Biodiversity Records Centre; and
- Phase 1 Survey Data.

Option C11 Summary Assessment (including Assessment Score)

8.5.2 As the alignment passes through several areas of habitat that are suitable for both breeding birds and reptiles, these protected species may be affected. There are also several buildings which may have suitable bat roost within them that could also cause an ecological constraint.

8.5.3 Once assessment of these populations have been made and potential mitigating activities completed the overall result should not exceed a slight adverse effect.

Assessment Score: Moderate Adverse

Option W4 Biodiversity Worksheet

Option W4 Biodiversity Worksheet							
Area	**Description of feature/ attribute**	**Scale (at which attribute matters)**	**Importance (of attribute)**	**Trend (in relation to target)**	**Biodiversity and earth heritage value**	**Magnitude of impact**	**Assessment Score**
The Broads National Park / RAMSAR / SPA / SAC	A network of mostly navigable waterways that were created by the flooding of peat works. They now house a diverse range of habitats and are home to many rare and unique species of plants and animals.	International	Habitats are the primary reason for international selection. Namely; Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp., Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation, Transition mires and quaking bogs, Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae,* Alkaline fens, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*	These habitats are very rare in the UK, and hold very rare species of plants. With the recent National Park designation it is hoped that these habitats will continue to support their diversity of plant life with the added security of a national designation.	Very-High	Neutral	Neutral
Leathes' Ham Local Nature Reserve	Centred on a freshwater lake with a mix of wooded and grassland habitats. The site is home to many bird species and wet woodland.	National	The site has a fresh water lake, marshes, reedbeds and a dyke network, and is known as a breeding site for wildfowl. Plants found here include ragged robin, southern marsh orchid and purple small reed.	The site is currently under management of the Suffolk Wildlife Trust, and represents an important wildfowl breeding area.	High	Intermediate negative	Moderate adverse
Brooke Yachts and Jeld-Wan Mosaic County Wildlife Site	The area contains a mosaic of different habitats that range from grassland and scrub to mud flats. The site has a diverse range of species including reptiles and breeding birds	County	An ex-industrial area that now has a mixture of grassland and ruderal habitats with fringing mudflats. There is a large population of common lizards and many breeding birds.	This site is managed by the Suffolk Wildlife Trust and any alteration to the lake banks must be designed to minimise the impact on this site.	High	Major negative	High adverse
Kirkly Ham County Wildlife Site	The area has a mosaic of habitats with a population of reptiles and suitable breeding bird habitat.	County	The area forms part of the flood control system for that part of the local town and comprises of numerous habitats bisected by a disused railway line. There has been a viable population of common lizards found here recently	The site lies east of the proposed works and although it may not be directly affected, the close proximity of a reptile population may prove to be a constraint to works.	Medium	Minor negative	Slight adverse
Harbour Kittiwake Colony County Wildlife Site	The area is home to a kittiwake colony at the mouth of lake Lothing.	County	The colony inhabits an artificial cliff on the northern pier extension. There are roughly 200 nests around the harbour with an additional 53 on the artificial cliff.	The works are unlikely to affect the artificial cliff, although there is a small risk of disturbing nesting birds outside of the artificial cliff	Medium	Minor negative	Slight adverse
Reptiles	Protected species	National	Due to the removal of potential habitat, reptiles may be affected by the proposed works	Reptiles are protected under schedule 5 of the Wildlife and Countryside Act (as amended) and therefore deliberate destruction of the animal or their resting place constitute and offence.	Medium	Intermediate negative	Moderate adverse
Bats	Protected species	National	Due to the proximity of structures that hold the potential for suitable bat roosting sites that may be affected by the proposed works.	Bat are protected under schedule 5 of the Wildlife and Countryside Act (as amended) and therefore deliberate destruction of the animal or their resting place constitute and offence	Medium	Intermediate negative	Moderate adverse
Birds	Protected species	National	Due to the close proximity of several statutory and non –statutory protected sites and other suitable vegetation, the proposed works may disturb nesting birds	All nesting birds are protected under The Wildlife and Countryside Act 1981 (as amended) and therefore the disturbance of their nesting places is considered an offence	Medium	Intermediate negative	Moderate adverse

Reference Sources

- Suffolk Biodiversity Records Centre; and
- Phase 1 Survey Data.

Option W4 Summary Assessment (including Assessment Score)

8.5.4 The alignment will encroach Leathes' Ham LNR and run through Brooke Yachts Jeld-Wen Mosaic, a CWS. These sites are important for wildlife and contain priority habitats and known protected species populations.

8.5.5 Through mitigation the effects can be reduced, but accurate population densities must be obtained through surveys, and mitigation agreed for the loss of important priority habitat such as wet woodland and mudflats.

Assessment Score: Moderate Adverse

Option T3 Biodiversity Worksheet

Option T3 Biodiversity Worksheet							
Area	**Description of feature/ attribute**	**Scale (at which attribute matters)**	**Importance (of attribute)**	**Trend (in relation to target)**	**Biodiversity and earth heritage value**	**Magnitude of impact**	**Assessment Score**
The Broads National Park / RAMSAR /SPA / SAC	A network of mostly navigable waterways that were created by the flooding of peat works. They now house a diverse range of habitats and are home to many rare and unique species of plants and animals.	International	Habitats are the primary reason for international selection. Namely; Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp., Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation, Transition mires and quaking bogs, Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae,* Alkaline fens, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*	These habitats are very rare in the UK, and hold very rare species of plants. With the recent National Park designation it is hoped that these habitats will continue to support their diversity of plant life with the added security of a national designation.	Very-High	Neutral	Neutral
Leathes' Ham Local Nature Reserve	Centred on a freshwater lake with a mix of wooded and grassland habitats. The site is home to many bird species and wet woodland.	National	The site has a fresh water lake, marshes, reedbeds and a dyke network, and is known as a breeding site for wildfowl. Plants found here include ragged robin, southern marsh orchid and purple small reed.	The site is currently under management of the Suffolk Wildlife Trust, and represents an important wildfowl breeding area.	High	Intermediate negative	Moderate adverse
Brooke Yachts and Jeld-Wan Mosaic County Wildlife Site	The area contains a mosaic of different habitats that range from grassland and scrub to mud flats. The site has a diverse range of species including reptiles and breeding birds	County	An ex industrial area that now has a mixture of grassland and ruderal habitats with fringing mudflats. There is a large population of common lizards and many breeding birds.	This site is managed by the Suffolk Wildlife Trust and any alteration to the lake banks must be designed to minimise the impact on this site.	High	Major negative	High adverse
Kirkly Ham County Wildlife Site	The area has a mosaic of habitats with a population of reptiles and suitable breeding bird habitat.	County	The area forms part of the flood control system for that part of the local town and comprises of numerous habitats bisected by a disused railway line. There has been a viable population of common lizards found here recently	The site lies east of the proposed works and although it may not be directly affected, the close proximity of a reptile population may prove to be a constraint to works.	Medium	Minor negative	Slight adverse
Harbour Kittiwake Colony County Wildlife Site	The area is home to a kittiwake colony at the mouth of lake Lothing.	County	The colony inhabits an artificial cliff on the northern pier extension. There are roughly 200 nests around the harbour with an additional 53 on the artificial cliff.	The works are unlikely to affect the artificial cliff, although there is a small risk of disturbing nesting birds outside of the artificial cliff	Medium	Minor negative	Slight adverse
Reptiles	Protected species	National	Due to the removal of potential habitat, reptiles may be affected by the proposed works	Reptiles are protected under schedule 5 of the Wildlife and Countryside Act (as amended) and therefore deliberate destruction of the animal or their resting place constitute and offence.	Medium	Intermediate negative	Moderate adverse
Bats	Protected species	National	Due to the proximity of structures that hold the potential for suitable bat roosting sites that may be affected by the proposed works.	Bat are protected under schedule 5 of the Wildlife and Countryside Act (as amended) and therefore deliberate destruction of the animal or their resting place constitute and offence	Medium	Intermediate negative	Moderate adverse
Birds	Protected species	National	Due to the close proximity of several statutory and non –statutory protected sites and other suitable vegetation, the proposed works may disturb nesting birds	All nesting birds are protected under The Wildlife and Countryside Act 1981 (as amended) and therefore the disturbance of their nesting places is considered an offence	Medium	Intermediate negative	Moderate adverse

Reference Sources

- Suffolk Biodiversity Records Centre; and
- Phase 1 Survey Data.

Option T3 Summary Assessment (including Assessment Score)

8.5.6 The alignment will encroach Leathes' Ham LNR and run through/underneath Brooke Yachts Jeld-Wen Mosaic, a County Wildlife Site. These sites are important for wildlife and contain priority habitats and known protected species populations.

8.5.7 Through mitigation the effects can be reduced, but accurate population densities must be obtained through surveys, and mitigation agreed for the loss of important priority habitat such as wet woodland and mudflats.

Assessment Score: Moderate Adverse

9 Historic Environment

9.1 Introduction

9.1.1 This chapter identifies and assess the potential impacts upon cultural heritage resources as a result of the options being considered for the Proposed Scheme. The heritage resource consists of archaeology, historic buildings and the historic landscape and covers both designated and non-designated assets. It is particularly important to read this chapter in conjunction with the Archaeological Desk Based Assessment (DBA) which is set out in Appendix C.

9.2 Appraisal Methodology

9.2.1 A desk study and DBA (refer to Appendix C for further details) have been undertaken to inform the appraisal of the options developed for the OBC. The desk study has identified any changes to known heritage resources previously identified by other studies and has identified any new features including designated and non-designated sites. The following sources of information have been interrogated to inform the appraisal:

- Suffolk Historic Environment Record (HER) – for all records relating to known heritage assets and secondary source material including archaeological reports;
- Suffolk Record Office – for all historic maps, and other documentary evidence; and
- Historic England Archive.

9.2.2 The desk study has been supplemented by an initial walk-over survey by an appropriately qualified and experienced archaeologist in order to understand the overall cultural heritage context of the area.

9.2.3 The historic environment assessment has focused on a 500m study area around each of the options to account for potential impacts upon the settings of any historic environment features.

9.2.4 The appraisal has followed the assessment methodology as required by TAG Unit A3 Chapters 5 and 8. This follows the five step approach to appraising 'environmental capital':

- Step 1: Scoping and identification of study area (as detailed above);
- Step 2: the key environmental resources have been identified and their features described as per the requirements of TAG Unit A3 Chapter 8, in terms of their Form, Survival, Condition, Complexity, Context and Period;
- Step 3: The appraisal has been undertaken against the following set of indicators to establish the significance of each key historic environmental resource in question; the scale at which it matters, significance (value) and rarity;

- Step 4: An impact assessment has been undertaken of the options on the historic environmental resources in terms of seriousness and scale. Incremental, secondary and cumulative impacts have also been considered. The extent to which resource is adversely affected or enhanced will be described; and
- Step 5: An assessment of the significant of all impacts on the receptors has been undertaken to determine the overall appraisal score using the definitions for overall impact outlined in TAG Unit A3 Table 8. The significant impacts on the historic environment have been summarised on the Historic Environment Worksheets (see Section 10.6) for inclusion in the AST.

9.3 Consultation

9.3.1 The following organisations were consulted during preparation of the Desk Based Assessment:

- Historic England (Inspector of Historic Buildings and Areas);
- Suffolk County Council (Senior Archaeological Officer); and
- Waveney District Council (Design and Conservation Officer).

9.4 Brief Evaluation of Topic Related Constraints

Constraints Common to all options

9.4.1 The options lie close to one another and the underlying historic environment characteristics of the area is relevant to all options. The study area contains 91 recorded heritage assets and events, but many of the records relate to demolished Second World War defences. Modern archaeological investigation has been limited and the level of primary evidence pertaining to each route is not sufficient to definitively demonstrate an absence or presence of archaeological resources along any of the routes.

9.4.2 A remote possibility exists that in situ Lower Palaeolithic archaeological remains lie deeply buried within the Cromer Forest Bed Formation below Lowestoft. If such remains were present they would be of national or international importance.

9.4.3 Later Prehistoric evidence is confined to three isolated find spots of Neolithic worked flint, and discovery of one Neolithic pit. An area of cropmarks, perhaps including prehistoric features, has been identified within the study area but the cropmarks are undated. However, it is possible that palaeoenvironmental and archaeological evidence of the later prehistoric periods is preserved beneath and within remnants of marine, peat and alluvial deposits located in the vicinity of Lake Lothing.

<u>Route Option C11</u>

9.4.4 The constraints affecting this option are:

- Possible presence of prehistoric palaeoenvironmental evidence and archaeological remains;

- Possible presence of archaeological remains of the Roman period related to use of the River Waveney for transport and communication;
- Possible presence of archaeological remains of the medieval and post medieval periods associated with activity at the ports of Lowestoft and Kirkley;
- Possible remains of WWII defensive structures;
- Setting of the South Lowestoft Conservation Area;
- Setting of the Grade II listed Port House; and
- Setting of the Grade II* listed Royal Norfolk and Suffolk Yacht Club.

Route Option W4

9.4.5 The constraints affecting this option are:

- Possible presence of prehistoric palaeoenvironmental evidence and archaeological remains; and
- Possible remains of WWII defensive structures.

Route Option T3

9.4.6 The constraints affecting this option are:

- Possible presence of prehistoric palaeoenvironmental evidence and archaeological remains; and
- Possible remains of WWII defensive structures.

9.4.7 The results of the appraisal of the archaeological and historic impacts associated with each of the route options are presented in the WebTAG worksheets below.

9.5 Historic Environment Assessment - WebTAG Worksheets

9.5.1 The options are listed and described in the following order:

- Option C11;
- Option W4; and
- Option T3.

Option C11 Historic Environment Worksheet

Option C11 Historic Environment Worksheet					
Feature	**Description**	**Scale it matters**	**Significance**	**Rarity**	**Impact**
Form	The part of the Study Area in proximity to this proposed alignment has an industrial, commercial, transportation, and at the far north and south, a slight residential character. It is located c.700m to the west of the late post medieval and modern core of Lowestoft. Except for the shoreline of Lake Lothing this area was mostly enclosed agricultural land until the early 20th century. Only one listed structure is located within 300m of this alignment and is screened from it by modern commercial development. The HER records 12 sites in the vicinity of the alignment; the majority are demolished WWII defences. Four sites have been subject to archaeological investigation. Subsurface evidence of the late prehistoric periods could survive in this area and there is a remote possibility that deeply buried Lower Palaeolithic archaeological remains may be present.	The listed structure in proximity to this alignment is Grade II and is of local importance. The presence of in situ Lower Palaeolithic remains would be of national or international importance and the presence of later prehistoric palaeoenvironmental and archaeological remains of regional or local importance. All other identified assets are of local importance	In situ Lower Palaeolithic remains would be of national or international significance and survival of later prehistoric palaeoenvironmental and archaeological remains of regional or local significance; The Grade II listed buildings is of local significance. Other identified archaeological remains are of regional or local significance	With the exception of the uncertain presence of in situ Lower Palaeolithic remains, and possible presence of later prehistoric palaeoenvironmental and archaeological remains, the known heritage resource at this part of the study area is not rare within a national or regional context. However, the current level of archaeological work means that potential sub-surface remains are rare locally.	The proposed bridge would bisect Lake Lothing interrupting views to the east and west and would result in a **moderate adverse** impact on the character of the historic landscape. The alignment would have **neutral** impact on the single listed building. There would be a **major adverse** impact on unknown sub-surface heritage assets at areas disturbed by deep excavations depending upon the final construction methods chosen
Survival	The area was extensively developed during the early 20th century and the construction of buildings and infrastructure will have adversely impacted sub-surface remains of earlier periods. Little archaeological investigation has occurred and the survival of archaeological remains is indeterminate.	The presence and importance of sub-surface remains is indeterminate.	The significance of sub-surface heritage assets is indeterminate	Lower Palaeolithic remains are rare. All other remains would be of regional or local importance	There would be **neutral** impact on the listed building. There would be a **major adverse** impact on the survival of sub-surface heritage assets at areas of deep excavation depending upon the final construction methods chosen
Condition	The listed building is in good condition. The condition of unknown sub-surface archaeological remains is indeterminate.	The condition of heritage assets is important on a national, regional and local scale.	The condition of heritage assets is significant on a national, regional and local scale.	The condition of the known heritage assets is common locally.	There would be **neutral** impact on the listed building. There would be a **major adverse** impact on the condition of sub-surface heritage assets at areas of deep excavation depending upon the final construction methods chosen
Complexity	The immediate vicinity of this alignment has and industrial and commercial character associated with the port and modern trading estates.	Locally important	Locally significant	Common locally	**Neutral** impact
Context	This alignment crosses industrial, transport and commercial areas located either side of Lake Lothing.	Locally important	Locally significant	Common locally and regionally	**Neutral** impact
Period	The dominant historic character is 20th century industrial, transportation and commercial.	Locally important	Locally significant	Common locally and regionally	**Neutral** impact

Reference Sources

- TAG Unit A3 Chapters 5 and 8; and
- Lowestoft URC (Urban Regeneration Company) Area, Suffolk: Cultural Heritage Assessment (Scott Wilson, 2006)

Option C11 Summary Assessment (including Assessment Score)

9.5.2 This alignment would have neutral impact on the listed building located in relatively close proximity to it. Groundwork during bridge construction would have a major adverse impact on any unknown sub-surface archaeological remains.

Assessment Score: Minor Adverse

Option W4 Historic Environment Worksheet

Option W4 Historic Environment Worksheet					
Rarity	**Rarity**	**Rarity**	**Rarity**	**Rarity**	**Rarity**
Form	The part of the Study Area in proximity to this proposed alignment has an industrial, transport, commercial, recreational and slight residential character. It is located at the west of Lake Lothing c.1.5km from the 19th and 20th century core of Lowestoft. One listed building is located c.300m east of the proposed alignment, but is screened from it by topography and the built environment. The HER records 14 sites in the vicinity of the alignment; the majority are demolished WWII defences. One site has been subject to archaeological investigation. Subsurface evidence of the late prehistoric periods could survive in the vicinity of the alignment and there is a remote possibility that deeply buried Lower Palaeolithic archaeological remains may be present. The area was mostly enclosed agricultural fields or marginal land until the mid-20th century. The area was then extensively developed although playing fields are present on both sides of the lake and an area of undeveloped reclaimed land is located on the southern side of Lake Lothing.	The Grade II listed structure in proximity to this alignment is of local importance. The presence of in situ Lower Palaeolithic remains would be of national or international importance and the presence of later prehistoric palaeoenvironmental and archaeological remains of regional or local importance. All other known heritage assets are of local importance.	In situ Lower Palaeolithic remains would be of national or international significance and later prehistoric palaeoenvironmental and archaeological remains of regional or local significance; The Grade II listed building is of local significance. Other identified archaeological remains are of regional or local significance	With the exception of the uncertain presence of in situ Lower Palaeolithic remains, and possible presence of later prehistoric palaeoenvironmental and archaeological remains, the known heritage resource at this part of the study area is not rare within a national or regional context. However, archaeological work has been limited in the area of this alignment and this means that sub-surface remains are rare locally.	The proposed alignment would result in a **moderate adverse** impact on the form and character of the historic landscape. The alignment would have **neutra**l impact on the single listed building. There would be a **major adverse** impact on unknown sub-surface heritage assets at areas disturbed by deep excavation depending upon the final construction methods chosen
Survival	There is one listed building in relatively close proximity to this alignment. The area was developed during the 20th century and the construction of buildings and infrastructure will have adversely impacted sub-surface remains of earlier periods. Where the alignment crosses recreational or reclaimed land well preserved palaeoenvironmental and archaeological deposits may be preserved. However, little archaeological investigation has occurred and the survival of sub-surface archaeological remains pre-dating the modern period is indeterminate.	The listed building is important on a local scale. The presence and importance of sub-surface remains is indeterminate.	The survival of the listed building is significant at a local scale. The significance of sub-surface heritage assets is indeterminate	Lower Palaeolithic remains are rare. All other remains would be of regional or local importance	There would be **neutral** impact on the listed building There would be a **major adverse** impact on the survival of sub-surface remains at areas of deep excavation depending upon the final construction methods chosen
Condition	The listed building is in good condition. The WWII defences were comprehensively demolished after the war and any remnants are likely to be in poor condition. The condition of sub-surface archaeological remains of other periods is indeterminate.	The condition of heritage assets is important on a national, regional and local scale.	The condition of heritage assets is significant on a national, regional and local scale.	The condition of the known heritage assets is common locally.	The position of this alignment would preserve open views along Lake Lothing. There would be **slight beneficial** impact to the condition of listed buildings and the conservation area at the town centre through the diversion of a large volume of through traffic. There would be a **major adverse** impact on the survival of sub-surface heritage assets at areas of deep excavation depending upon the final construction methods chosen
Complexity	The immediate vicinity of this alignment is relatively complex. An industrial, transportation and commercial character is evident at the area flanking Lake Lothing. Recreational areas are present to the north and south beyond which lie residential areas.	Locally important	Locally significant	Common locally	**Neutral** impact
Context	This alignment crosses industrial, transport, commercial and recreational areas located either side of Lake Lothing.	Locally important	Locally significant	Common locally and regionally	**Neutral** impact
Period	The dominant historic character is 19th and 20th century industrial, transportation, recreational and commercial.	Locally important	Locally significant	Common locally and regionally	**Neutral** impact

Reference Sources

- TAG Unit A3 Chapters 5 and 8;
- Lowestoft URC (Urban Regeneration Company) Area, Suffolk: Cultural Heritage Assessment (Scott Wilson, 2006); and
- Land at Brooke Peninsula, Lowestoft, Suffolk (CgMS 2013)

Options W4 Summary Assessment (including Assessment Score)

9.5.3 This alignment would have neutral impact on the listed building located in relatively close proximity to it. Groundwork during construction would have a major adverse impact on any unknown sub-surface archaeological remains.

Assessment Score: Minor Adverse

Option T3 Historic Environment Worksheet

Option T3 Historic Environment Worksheet					
Feature	**Description**	**Scale it matters**	**Significance**	**Rarity**	**Impact**
Form	The Study Area in proximity to this option has an industrial, transport, commercial, recreational and slight residential character. It is located at the west of Lake Lothing c.1.5km from the 19th and 20th century core of Lowestoft. One listed building is located c.300m east of the option, but is screened from it by topography and the built environment. The HER records 14 sites near the alignment; the majority are demolished WWII defences. One site has been subject to archaeological investigation. Subsurface evidence of the late prehistoric periods could survive along the alignment and there is a remote possibility that deeply buried Lower Palaeolithic archaeological remains may be present. The area was mostly enclosed agricultural fields or marginal land until the mid 20th Century when the area was extensively developed. Playing fields are present on both sides of the lake and an area of undeveloped reclaimed land is located on the southern side of Lake Lothing.	The Grade II listed structure in proximity to this alignment is of local importance. The presence of in situ Lower Palaeolithic remains would be of national or international importance and the presence of later prehistoric palaeoenvironmental and archaeological remains of regional or local importance. All other known heritage assets are of local importance.	In situ Lower Palaeolithic remains would be of national or international significance and later prehistoric palaeoenvironmental and archaeological remains of regional or local significance; The Grade II listed building is of local significance. Other identified archaeological remains are of regional or local significance	With the exception of the uncertain presence of in situ Lower Palaeolithic remains, and possible presence of later prehistoric palaeoenvironmental and archaeological remains, the known heritage resource at this part of the study area is not rare within a national or regional context. However, archaeological work has been limited and this means that sub-surface remains are rare locally.	The proposed alignment would result in a **minor adverse** impact on the form and character of the historic landscape through the incorporation of some recreational land into the upgraded road network. The alignment would have **neutra**l impact on the single listed building. There would be a **major adverse** impact on unknown sub-surface heritage assets at areas disturbed by deep excavation depending upon the final construction methods chosen
Survival	There is one listed building relatively close to this alignment. The area was developed during the 20th century and the construction of buildings and infrastructure will have adversely impacted sub-surface remains of earlier periods. Well preserved palaeoenvironmental and archaeological deposits could be preserved at areas where deep excavations would be necessary. However, little archaeological investigation has occurred and the survival of sub-surface archaeological remains pre-dating the modern period is indeterminate.	The listed building is important on a local scale. The presence and importance of sub-surface remains is indeterminate.	The survival of the listed building is significant at a local scale. The significance of sub-surface heritage assets is indeterminate	Lower Palaeolithic remains are rare. All other remains would be of regional or local importance	There would be **neutral** impact on the listed building There would be a **major adverse** impact on the survival of sub-surface remains at areas of deep excavation depending upon the final construction methods chosen
Condition	The listed building is in good condition. The WWII defences were comprehensively demolished after the war and any remnants are likely to be in poor condition. The condition of sub-surface archaeological remains of other periods is indeterminate.	The condition of heritage assets is important on a national, regional and local scale.	The condition of heritage assets is significant on a national, regional and local scale.	The condition of the known heritage assets is common locally.	The proposed tunnel would preserve open views along Lake Lothing. There would be **slight beneficial** impact to the condition of listed buildings and the conservation area at the town centre through the diversion of through traffic. There would be a **minor adverse** impact on the character of the historic landscape through incorporation of some recreational land into the upgraded road network. There would be a **major adverse** impact upon sub-surface heritage assets at areas of deep excavation depending upon the final construction methods chosen
Complexity	The immediate vicinity of this alignment is relatively complex. An industrial, transportation and commercial character is evident at the area flanking Lake Lothing. Recreational areas are present to the north and south beyond which lie residential areas.	Locally important	Locally significant	Common locally	**Neutral** impact
Context	This alignment crosses beneath industrial, transport, commercial and recreational areas located either side of Lake Lothing.	Locally important	Locally significant	Common locally and regionally	**Neutral** impact
Period	The dominant historic character is 19th and 20th century industrial, transportation, recreational and commercial.	Locally important	Locally significant	Common locally and regionally	**Neutral** impact

Reference Sources

- TAG Unit A3 Chapters 5 and 8;
- Lowestoft URC (Urban Regeneration Company) Area, Suffolk: Cultural Heritage Assessment (Scott Wilson, 2006); and
- Land at Brooke Peninsula, Lowestoft, Suffolk (CgMS 2013)

Option T3 Summary Assessment (including Assessment Score)

9.5.4 This alignment would have neutral impact on the listed building located in relatively close proximity to it. Groundwork during construction would have a major adverse impact on any unknown sub-surface archaeological remains.

Assessment Score: Minor Adverse

10 Water Environment

10.1 Introduction

10.1.1 This section assesses the potential impacts on the water environment and takes into account; surface hydrology and quality; groundwater quality and hydrogeology; and fluvial geomorphology. A desk study of the hydrological and hydrogeological features associated with the proposed alignments has been undertaken and a site walk-over was carried out to supplement the desk study.

10.2 Appraisal Methodology

10.2.1 A desk study has been undertaken to inform the appraisal of options developed for OBC. The desk study has identified any changes to known water environment resources previously identified by other studies and has also considered any new features including designated and non-designated sites. The following sources of information have been interrogated as part of the desk based exercise:

- Environment Agency 'What's in My Backyard' (WIMBY) Online Mapper;
- British Geological Survey's Onshore GeoIndex Online Mapper;
- Ordnance Survey Opendata; and
- Defra's online GIS portal - http://www. magic.defra.gov.uk/

10.2.2 The study area has been defined as the physical area of the route options under consideration and a buffer of 1km either side of the route alignments and any surface or groundwater bodies or water dependent conservation sites located up to 1km downstream of any potential future outfalls that will discharge highway drainage.

10.2.3 Potential water abstractions from both surface and groundwater sources have been considered. The Environment Agency (EA) list abstractions within the WIMBY interactive mapper, however this is considered to be a non-exhaustive list with the potential for smaller abstractions, falling outside of the EA's licensing criteria to occur.

10.2.4 Water Framework Directive (WFD) data[16] for surface water is based on consultation data given by the EA17. Groundwater bodies and their associated WFD data are based on the 2009 River Basin Management Plans (RBMP) assessment18.

10.2.5 The appraisal will follow the methodology as required by TAG Unit A3 Chapters 5 and 10. This follows the five step approach to appraising 'environmental capital':

- Step 1: Scoping and identification of study area (as detailed above);
- Step 2: key environmental resources have been identified and their features described. The resources have been described in terms of features or services that the resources provide (including supporting water supply,

[16] Environment Agency, (2011). Anglian district RBMP Annex B: Current state of Waters. Retrieved 2nd November 2015 from: https://www.gov.uk/government/publications/anglian-district-river-basin-management-plan

[17] Email Correspondence 27th November 2015: Graham Steel, Environment Agency

[18] Environment Agency, (2011). Anglian district RBMP. Available from: https://www.gov.uk/government/publications/anglian-district-river-basin-management-plan

biodiversity, aesthetics and cultural heritage), which have then be used to describe the key environmental resources;

- Step 3: The indicators that have been used to make a judgement on the importance of a feature under consideration are quality, scale, rarity and substitutability. Having gathered information against each of the four indicators, a summary of the value of each feature has been established based upon the criteria in TAG Unit A3 Chapter 10, Table 14;
- Step 4: An impact assessment of the Scheme on identified water features has then been undertaken. Incremental, secondary and cumulative impacts have been considered and the extent to which resources are adversely affected or enhanced has been described; and
- Step 5: This step combines the appraisal of the importance of the water environment features, with the appraisal of the magnitude of the impacts, to determine the consequence of those impacts. A two-step process is required. The first step has assessed the significance of a potential impact on each affected feature (refer to Table 16 of TAG Unit A3, Chapter 10) based on the likely impact magnitude and the importance of the feature. The second step has combined the assessment of each feature into an assessment score for each key water environmental resource (based on the definitions given in Table 17 of TAG Unit A3, Chapter 10). The significant impacts on the water environment have been summarised on the Water Environment Worksheets (see Section 11.5) for inclusion in the AST.

10.3 Consultation

10.3.1 Consultation has been undertaken specifically relating to the water environment. The EA has stated that no flood defences are present within each Proposed Scheme Option or the surrounding land.

10.4 Brief Evaluation of Topic Related Constraints

General Water Environment

10.4.1 All route alignment options cross Lake Lothing once. The water body is a heavily modified saltwater lake with a tidal flow regime. The lake can be broadly defined as falling between Mutford Lock (TM 5913 9278), upstream of which is a waterbody known as Oulton Broad, and where Lake Lothing discharges into the North sea at the Outer Harbour (TM 5514 9264). Oulton Broad provides access to The Broads National Park, a network of navigable rivers. Both Oulton Broad and Lake Lothing have differing tidal ranges due to the influence of Mutford Lock. Lake Lothing was an enclosed inland lake, which was heavily modified for the purposes of navigation and to increase port capacity linking to the North Sea and Outer harbour of Lowestoft, resulting in the water body now being characterised as an estuary.

10.4.2 Under the WFD the EA has cited Lake Lothing as an estuarine water body, part of the Bure & Waveney & Yare & Lothing water body (GB510503410700), currently holding an overall status of Poor.

10.4.3 All route alignments are underlain by sands of the Crag Group Bedrock, shallow water marine and estuarine sands supporting moderate groundwater yields of up to

40l/s.

10.4.4 Each route option is predominantly underlain by superficial deposits consisting of Alluvium (Clay, Silts, Sands and Gravel) which broadly define Lake Lothing's floodplain. Smaller areas of Happisburgh Glacigenic Formation sands confine these Alluvium deposits, generally found at the far northern and southern extents of each route option. These deposits are likely to be thin and may provide local water supplies.

10.4.5 Under WFD each route alignment option falls within the Broadland Rivers Chalk & Crag groundwater body (GB40501G400300), which holds a poor quantitative status.

10.4.6 The aquifer is designated as a principal bedrock aquifer with a high vulnerability. Superficial aquifers are cited as Secondary A. A source protection zone (SPZ) is centred on a large groundwater abstraction located at an approximate national grid reference of TM 5225 9420. It is unknown what the exact use of this abstraction is, but for the purposes of the assessment it has been assumed to be for the purpose of public water supply or consumption.

Route Option C11

10.4.7 Route Option C11 consists of a bridge structure between North Quay (NGR: TM 5392 9282) and Quay Wharf (NGR: TM 5390 9271), spanning Lake Lothing's Inner Harbour. At this location the water body is approximately 100m wide and is characterised as a heavily modified water body, with artificial, developed banks and a tidal flow regime.

10.4.8 Route Option C11 predominantly crosses floodplain cited as Flood Zone 3 with small areas of Flood Zone 2 (land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year) impinging upon the Option at Riverside Road, where the route connects into the existing road network. A smaller unnamed watercourse (known locally as Kirkley Stream) converges with Lake Lothing approximately 50m downstream of the crossing location. The watercourse flows north through the south of Lowestoft and has an approximate catchment size of 11km2. Between its confluence with Lake Lothing (NGR: TM 5398 9269) and Kirkley Fen Park (TM 5373 9207) the watercourse is culverted for approximately 0.5km of its lower course.

10.4.9 Kirkley Stream is classified under the Waveney (Sth) (Tidal) waterbody (GB105034045890). The water body currently characterised as of a moderate ecological quality[19].

10.4.10 Route C11 does not fall within a Source Protection Zone (SPZ) but does fall within an aquifer where SPZs are present. From its nearest point, this route alignment this is approximately 1km south west of Zone 3 of the SPZ.

[19] Based on 2009 cycle RBMP.

Route Option W4

10.4.11 Route Option W4 consists of a bridge crossing linking the existing Peto Way Road and Brooke Business and Industrial Park. The route crosses approximately 100m of Lake Lothing between NGR: TM 5329 9298 and TM 5327 9286. At this location the waterbody is heavily modified with a tidal flow regime.

10.4.12 The majority of the route crosses floodplain cited as Flood Zone 3 with small areas of Flood Zone 2. Flood Zone 2 floodplain is crossed at Peto Way and within land centred on TM 5316 9264, broadly between Industrial units, Heath Road and the B1531 Waveney Drive.

10.4.13 Additional planned routes linking the bridge crossing to Riverside Road and Waveney Road crosses flood plain cited as Flood Zone 2. Further areas of Flood Zone 2 and 3 at the confluence of Lake Lothing and Kirkley Stream, where Kirkley Ham Wharf is located, is shown on Figure 1.4.

10.4.14 The route would also impinge on Leathes' Ham, a small freshwater lake and designated Local Nature Reserve (LNR) and Brooke Yachts and Jeld-Wen Mosaic County Wildlife Site (CWS), a grassland and mudflat habitat with semi natural shoreline. Both features provide important flood storage areas during flooding events from Lake Lothing and habitats for biodiversity.

10.4.15 The route does not fall within the SPZ detailed previously but does fall within the same aquifer. From its nearest point, the route alignment is approximately 200m south west of Zone 3 of the SPZ.

Route Option T3

10.4.16 Route Option T3 consists of a tunnel crossing of Lake Lothing and realignment of Peto Way, between TM 5325 9343 and TM 5323 9241. To accommodate the tunnel entrance at the northern end of the scheme Peto Way would be diverted and realigned, with a new route diverted through and underneath Leathes' Ham, a small freshwater lake and LNR. The southern end of the scheme would link into Waveney Drive at TM 5323 9241, crossing Brooke Yachts and Jeld-Wen Mosaic on the southern banks of Lake Lothing.

10.4.17 The majority of the route falls within flood plain cited as Flood Zone 3, with areas of Flood Zone 2 across the southern portion of the route alignment, before tying in with Waveney Drive. Neither entrance occurs within the floodplain boundary, however, potential works during construction are likely to fall within the Flood Zone 2 and Flood Zone 3 boundaries on both the northern and southern banks, with potential areas of floodplain loss at key asset locations such as Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic CWS.

10.4.18 A groundwater abstraction, defined by the EA as 'large' is located approximately 1km north west of the scheme and assumed to be for public water supply or consumption. This assumption is based on an SPZ zone of influence surrounding the abstraction. The realignment a roundabout at the northern end of the scheme will fall within Zone 3 of the SPZ.

10.5 Water Environment Assessment - WebTAG Worksheets

10.5.1 The options are listed and described in the following order:

- Option C11;
- Option W4; and
- Option T3.

Option C11 Water Environment Worksheet

Option C11 Water Environment Worksheet									
Description of study area/ summary of potential impacts	**Key environmental resource**	**Features**	**Quality**	**Scale**	**Rarity**	**Substitutability**	**Importance**	**Magnitude**	**Significance**
Surface Water									
Potential floodplain loss and increased flood risk	Seas and Estuaries- Lake Lothing	Conveyance of flood levels and overland flows, flood risk	Majority of route falls within Flood Zone 3. Small areas on southern floodplain of Lake Lothing Flood Zone 2 area.	Approximately 500m of flood plain crossed. Entire scheme within floodplain. Southern connection with existing road network shows areas of flood zone 2 crossed.	Feature of all watercourses and estuaries	Floodplain is heavily developed with urban environments and artificial surfaces on both floodplains where scheme crosses land. Major compensation of floodplain likely to be required.	Medium	Large Adverse	Significant
Pollution to surface waters from construction	Sea and Estuaries- Lake Lothing	Water quality	WFD Chemical - Good WFD Overall - Poor Ecological Status (Heavily Modified Water Body)	Regional	Medium	Limited	Medium	Slight adverse	Insignificant
Pollution to surface waters from routine runoff	Sea and Estuaries- Lake Lothing	Water quality	WFD Chemical – Good WFD Overall - Poor Ecological Status (Heavily Modified Water Body)	Regional	Medium	Limited	Medium	Slight adverse	Insignificant
Pollution to surface waters from accidental spillage	Sea and Estuaries- Lake Lothing	Water quality	WFD Chemical - Good WFD Overall - Poor Ecological Status (Heavily Modified Water Body)	Regional	Medium	Limited	Medium	Negligible	Insignificant
Alteration to surface flow characteristics that may affect channel, erosive or deposition processes	Sea and Estuaries- Lake Lothing	Channel geomorphology	WFD - Heavily Modified Water Body Urbanised environment with numerous channel modifications	Local	Low	Limited	Low	Negligible	Insignificant
Alteration to availability of surface water abstractions	Sea and Estuaries- Lake Lothing	Water supply	Tidal watercourse, with high saline content reducing resource demand	Local	Low	High	Low	Slight adverse	Insignificant
Chemical impacts of Lake Lothing through diffuse pollution and highways discharge	Seas and Estuaries- Lake Lothing Stillwater- Leathes' Ham Grassland/Wetland- Brooke Yachts and Jeld-Wen Mosaic CWS	Chemical Water Quality	Currently good chemical status	Measured on catchment wide basis. All Lake Lothing classified as single water body.	Common, regional wide	Substitute to ground water discharge	Medium	Minor Adverse	Insignificant
Pollution or flow alterations, including structures	Sea and Estuaries- Lake Lothing	Chemical Water Quality- Transport and dilution of waste	Tidal watercourse with potential for transport and dilution from consented discharges.	Local	Medium	Not feasible	Low	Negligible	Insignificant

Option C11 Water Environment Worksheet									
Description of study area/ summary of potential impacts	**Key environmental resource**	**Features**	**Quality**	**Scale**	**Rarity**	**Substitutability**	**Importance**	**Magnitude**	**Significance**
		products	Currently Good chemical status						
Chemical impacts of Lake Lothing through diffuse pollution and highways discharge	Seas and Estuaries- Lake Lothing	Chemical Water Quality	Currently good chemical status	Measured on catchment wide basis. All Lake Lothing classified as single water body.	Common, regional wide	Substitute to ground water discharge	Medium	Minor Adverse	Insignificant
Groundwater									
Impact upon groundwater supply and abstractions	Water Supply- Broadland Rivers Chalk and Crag WFD body, SPZ	SPZ within regional area. Principal Aquifer	Water has high mineral content. Hard water. Upward chemical deterioration of aquifer.	Regional feature and important for supply. Route falls outside SPZ	Principal bedrock aquifer. SPZ within aquifer.	Widespread aquifer, surface water over abstraction. Unlikely to be substituted.	Very High	Negligible	Low significance
Impact and introduction of groundwater discharges and diffuse pollution to groundwater sources.	Groundwater Quality- Broadland Rivers Chalk and Crag WFD body, SPZ	Groundwater Vulnerability WFD status	Major bedrock aquifer of high vulnerability WFD Poor status with deteriorating chemical quality.	Regional. SPZ located within aquifer.	Important principal aquifer. Regional importance for industrial supply.	Unlikely to substitute. Promotion of surface water abstraction unlikely due to pressures on supply and abundance.	Low	Negligible	Insignificant
Restriction or disruption of infiltration and groundwater flow	Groundwater Flow - Broadland Rivers Chalk and Crag WFD body, SPZ	Urbanised area.	Heavily urbanised area with numerous impermeable surfaces and reduced permeable areas.	Small increase in permeable area in regional or local context	Common in urban area.	Potential to offset with introduction of space and permeable areas.	Low	Negligible	Insignificant

Reference Sources

- Environment Agency 'What's in My Backyard' (WIMBY) Online Mapper
- British Geological Survey's Onshore GeoIndex Online Mapper;
- Ordnance Survey Opendata; and
- http://www.magic.defra.gov.uk/

Option C11 Summary Assessment (including Assessment Score)

10.5.2 The route is deemed to be of a significant adverse impact to the water environment as a result of impacts to floodplain. Groundwater flows and hydrological linkages between the route option and potential groundwater abstractions would need to be established. It is unlikely that increased impermeable surfaces would impact upon the permeability of surrounding land and aquifer recharge, given the urbanised land use.

Assessment Score: Moderate Adverse

Option W4 Water Environment Worksheet

Option W4 Water Environment Worksheet									
Description of study area/ summary of potential impacts	**Key environmental resource**	**Features**	**Quality**	**Scale**	**Rarity**	**Substitutability**	**Importance**	**Magnitude**	**Significance**
Surface water									
Potential floodplain loss and increased flood risk	Seas and Estuaries – Lake Lothing Leathes' Ham- Stillwater & Floodplain Flood Risk/Floodplain/Wetland- Brooke Yachts and Jeld-Wen Mosaic CWS	Conveyance of flood levels and overland flows, potential flood risk increase. Floodplain at Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic crossed.	Majority of route falls entirely within Flood Zone 3. Potential Loss at Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic	Over 1km of flood plain crossed. Large majority of scheme within floodplain.	Feature of all watercourses and estuaries	Floodplain is heavily developed with urban environments and artificial surfaces on both floodplains where scheme crosses land. Major compensation of floodplain likely to be required.	High	Large Adverse	Highly Significant
Pollution to surface waters from construction	Sea and Estuaries- Lake Lothing	Water quality	WFD Chemical - Good WFD Overall - Poor Ecological Status (Heavily Modified Water Body)	Regional	Medium	Limited	Medium	Slight adverse	Insignificant
Pollution to surface waters from routine runoff	Sea and Estuaries- Lake Lothing	Water quality	WFD Chemical - Good WFD Overall - Poor Ecological Status (Heavily Modified Water Body)	Regional	Medium	Limited	Medium	Slight adverse	Insignificant
Pollution to surface waters from accidental spillage	Sea and Estuaries- Lake Lothing	Water quality	WFD Chemical - Good WFD Overall - Poor Ecological Status (Heavily Modified Water Body)	Regional	Medium	Limited	Medium	Negligible	Insignificant
Alteration to surface flow characteristics that may affect channel, erosive or deposition processes	Sea and Estuaries- Lake Lothing	Channel geomorphology	WFD - Heavily Modified Water Body Urbanised environment with numerous channel modifications	Local	Low	Limited	Low	Negligible	Insignificant
Alteration to availability of surface water abstractions	Sea and Estuaries- Lake Lothing	Water supply	Tidal watercourse, with high saline content reducing resource demand	Local	Low	High	Low	Slight adverse	Insignificant
Pollution or flow alterations, including structures	Sea and Estuaries-Lake Lothing	Chemical Water Quality- Transport and dilution of waste products	Tidal watercourse with potential for transport and dilution from consented discharges. Currently Good chemical status	Local	Medium	Not feasible	Low	Negligible	Insignificant

Option W4 Water Environment Worksheet									
Description of study area/ summary of potential impacts	**Key environmental resource**	**Features**	**Quality**	**Scale**	**Rarity**	**Substitutability**	**Importance**	**Magnitude**	**Significance**
Chemical impacts of Lake Lothing through diffuse pollution and highways discharge	Seas and Estuaries- Lake Lothing Stillwater- Leathes' Ham Grassland/Wetland- Brooke Yachts and Jeld-Wen Mosaic CWS	Chemical Water Quality	Currently good chemical status	Measured on catchment wide basis. All Lake Lothing classified as single water body.	Common, regional wide	Substitute to ground water discharge	Medium	Minor Adverse	Insignificant
Groundwater									
Impact upon groundwater supply and abstractions	Water Supply- Broadland Rivers Chalk and Crag WFD body, SPZ	SPZ within regional area. Principal Aquifer	Water has high mineral content. Hard water. Upward chemical deterioration of aquifer.	Regional feature and important for supply. Route falls outside SPZ	Principal bedrock aquifer. SPZ within aquifer.	Widespread aquifer, surface water over abstraction. Unlikely to be substituted.	Very High	Slight Adverse	Significant
Impact and introduction of groundwater discharges and diffuse pollution to groundwater sources.	Groundwater Quality- Broadland Rivers Chalk and Crag WFD body, SPZ	Groundwater Vulnerability WFD status	Major bedrock aquifer of high vulnerability WFD Poor status with deteriorating chemical quality.	Regional. Route falls out with SPZ.	Important principal aquifer. Regional importance for industrial supply.	Unlikely to substitute. Promotion of surface water abstraction unlikely due to pressures on supply and abundance.	Low	Negligible	Insignificant
Restriction or disruption of infiltration and groundwater flow	Groundwater Flow within Aquifer- Broadland Rivers Chalk and Crag WFD body, SPZ	Urbanised area.	Heavily urbanised area with numerous impermeable surfaces and reduced permeable areas.	Small increase in permeable area in regional or local context	Common in urban area.	Potential to offset with introduction of green space and permeable areas.	Low	Negligible	Insignificant

Reference Sources

- Environment Agency 'What's in My Backyard' (WIMBY) Online Mapper
- British Geological Survey's Onshore GeoIndex Online Mapper;
- Ordnance Survey Opendata; and
- www.magic.defra.gov.uk/

Option W4 Summary Assessment (including Assessment Score)

10.5.3 Route option W4 has highly significant impacts and redevelopment of floodplain, most notably to Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic CWS. Approximately 1km of route will be built in floodplain and would need to be mitigated through structural or sustainable flood management measures. Significant impacts with regards to groundwater and abstractions. Potential losses of important strategic/functional floodplain at Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic CWS mean that significant measures would be required to mitigate impacts to these key water environment and ecological features.

Assessment Score: Large Adverse

Option T3 Water Environment Worksheet

Option T3 Water Environment Worksheet									
Description of study area/ summary of potential impacts	**Key environmental resource**	**Features**	**Quality**	**Scale**	**Rarity**	**Substitutability**	**Importance**	**Magnitude**	**Significance**
Surface water									
Potential floodplain loss and increased flood risk	Seas and Estuaries- Lake Lothing Stillwater- Leathes' Ham Flood Risk/Floodplain/Wetland- Brooke Yachts and Jeld-Wen Mosaic CWS	Conveyance of flood levels and overland flows. Loss of key flood storage areas at Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic. Flood risk	Majority of overland route falls within Flood Zone 3.	300m of realigned road (Peto Way) within northern floodplain.	Feature of all watercourses and estuaries	Floodplain is heavily developed with urban environments and artificial surfaces on both floodplains where scheme crosses land. Major compensation of floodplain likely to be required. Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic important areas of functional floodplain.	High	Large Adverse	Highly Significant
Pollution to surface waters from routine runoff	Sea and Estuaries- Lake Lothing	Water quality	WFD Chemical - Good WFD Overall - Poor Ecological Status (Heavily Modified Water Body)	Regional	Medium	Limited	Medium	Slight adverse	Insignificant
Pollution to surface waters from accidental spillage	Sea and Estuaries- Lake Lothing	Water quality	WFD Chemical - Good WFD Overall - Poor Ecological Status (Heavily Modified Water Body)	Regional	Medium	Limited	Medium	Negligible	Insignificant
Alteration to surface flow characteristics that may affect channel, erosive or deposition processes	Sea and Estuaries- Lake Lothing	Channel geomorphology	WFD - Heavily Modified Water Body Urbanised environment with numerous channel modifications	Local	Low	Limited	Low	Negligible	Insignificant
Alteration to availability of surface water abstractions	Sea and Estuaries- Lake Lothing	Water supply	Tidal watercourse, with high saline content reducing resource demand	Local	Low	High	Low	Slight adverse	Insignificant
Pollution or flow alterations, including structures	Sea and Estuaries-Lake Lothing	Chemical Water Quality- Transport and dilution of waste products	Tidal watercourse with potential for transport and dilution from consented discharges	Local	Medium	Not feasible	Low	Negligible	Insignificant
Pollution or flow alterations, including structures	Sea and Estuaries-Lake Lothing	Chemical Water Quality- Transport and dilution of	Tidal watercourse with potential for transport and	Local	Medium	Not feasible	Low	Negligible	Insignificant

Option T3 Water Environment Worksheet									
Description of study area/ summary of potential impacts	**Key environmental resource**	**Features**	**Quality**	**Scale**	**Rarity**	**Substitutability**	**Importance**	**Magnitude**	**Significance**
		waste products	dilution from consented discharges. Currently Good Status						
Chemical impacts of Lake Lothing through diffuse pollution and highways discharge	Seas and Estuaries- Lake Lothing Stillwater- Leathes' Ham Grassland/Wetland- Brooke Yachts and Jeld-Wen Mosaic CWS	Chemical Water Quality	Currently good chemical status	Measured on catchment wide basis. All Lake Lothing classified as single water body.	Common, regional wide	Substitute to ground water discharge	Medium	Minor Adverse	Insignificant
Groundwater									
Impact upon groundwater supply and abstractions	Water Supply	SPZ within regional area. Principal Aquifer	Water has high mineral content. Hard water. Upward chemical deterioration of aquifer.	Regional feature and important for supply. Route falls within SPZs.	Principal bedrock aquifer. Falls within zone 3 of SPZs.	Widespread aquifer, surface water over abstraction. Unlikely to be substituted.	Very High	Slight Adverse	Significant
Impact and introduction of groundwater discharges and diffuse pollution to groundwater sources.	Groundwater Quality of Aquifer	Groundwater Vulnerability WFD status	Major bedrock aquifer of high vulnerability WFD Poor status with deteriorating chemical quality.	Regional. Route falls out with SPZ.	Important principal aquifer. Regional importance for industrial supply.	Unlikely to substitute. Promotion of surface water abstraction unlikely due to pressures on supply and abundance.	Low	Negligible	Insignificant
Restriction or disruption of infiltration and groundwater flow	Groundwater Flow within aquifer	Urbanised area.	Heavily urbanised area with numerous impermeable surfaces and reduced permeable areas.	Small increase in permeable area in regional or local context	Common in urban area.	Potential to offset with introduction of green space and permeable areas.	Low	Negligible	Insignificant

Reference Sources

- Environment Agency 'What's in My Backyard' (WIMBY) Online Mapper
- British Geological Survey's Onshore GeoIndex Online Mapper;
- Ordnance Survey Opendata; and
- www.magic.defra.gov.uk/

Option T3 Summary Assessment (including Assessment Score)

10.5.4 Route option T3 has highly significant impacts to floodplain and significant impacts with regards to groundwater and abstractions. The loss of important strategic/functional floodplain at Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic and their designations for important biodiversity value mean that significant measures would be required to mitigate impacts to these key water environment features.

Assessment Score: Large Adverse

11 Appraisal Summary Tables – Environment

11.1 Introduction

11.1.1 The AST displays the degree to which the five Central Government objectives for transport (environment, safety, economy, accessibility and integration) would be achieved. It is from this AST that a judgement should be made about the overall value-for-money of the option or options in achieving the Government's objectives.

11.1.2 The information provided in the AST enable a consistent view to be taken about the value of the options developed for the Proposed Scheme.

11.1.3 Sections 11.2 to 11.4 present summary extracts from the environmental assessments focusing on the environmental sub-objectives of the ASTs for the Proposed Scheme Options.

11.2 Option C11 Appraisal Summary Table

Appraisal Summary Table

Date produced:	16/12/15

Contact:	
Name	
Organisation	
Role	Promoter/Official

Name of scheme:	Lake Lothing Third Crossing
Description of scheme:	Option C11, for details on Option C11 refer to Section 2.2

Impacts		Summary of key impacts	Assessment			
			Quantitative	Qualitative	Monetary £(NPV)	Distributional 7-pt scale/ vulnerable grp
Environmental	Noise	54 dwellings within 50m; 162 between 50-100m; 446 100-200m; 887 200-300m, with 6360 inside total study area. Increases predicted along Long Road, Tom Crisp Way, The Avenue, Peto Way, Rotterdam Road, Norwich Road, Avondale Road, and Love Road. Decreases predicted along the A146, Bridge Road, Normanston Drive, Colville Road, Highland Way, the A1144, Katwijk Way, Denmark Road, and along the A12 from Yarmouth Road to Waveney Road	As a qualitative assessment has been undertaken there is no monetised appraisal information to present, and this will be undertaken for the preferred option as part of any FBC application	A number of increases in noise levels at dwellings adjacent to the alignment option would be anticipated, however a larger number of reductions are likely adjacent to routes which are relieved by the scheme.	Not calculated at OBC, full monetised NPV will be provided for the preferred option at FBC	Neutral
	Air Quality	Overall neutral local and regional air quality impact considered most likely based on a qualitative traffic data review (2020 Do Minimum vs Do Something)	8,532 sensitive receptors with potential for adverse local air quality 13,236 sensitive receptors with potential for local air quality benefit 60,866 receptors with potential for neutral local air quality impact	No AQMA designated within or near to the study area Background mapped air pollutant concentrations are well below national objective values Max roadside PCM concentrations 2015: 23.7 µg/m^3 2020: 16.3 µg/m^3	Not calculated at OBC, full monetised NPV will be provided for the preferred option at FBC	Not calculated
	Greenhouse gases	GHG emissions associated with traffic in the Do Something scenario are predicted to be lower than the Do Minimum scenario over the same appraisal period. Therefore, a greenhouse gas benefit is predicted.	Change in non-traded carbon over 60y (CO2e): -84,670 Change in traded carbon over 60y (CO2e): -144	Both traded and non-traded road-based emissions associated with the Do Something scenario are estimated to be lower over the appraisal period (2020 – 2079) relative to the Do Minimum case.	£3,916,000	N/A
	Landscape	N/A	N/A	N/A	N/A	N/A – scoped out of assessment
	Townscape	Bascule road bridge crossing across the central waterspace; elevated road approaches towards the bascule bridge; some displacement of land use on north bank.	N/A	The elevated bridge approaches would have some influence on emerging land use and townscape south of the lake. The bascule crossing would represent some sub-division of the open waterspace associated with North Quay.	N/A	Slight Adverse
	Historic Environment	The option would bisect Lake Lothing resulting in a moderate adverse impact on the character of the historic landscape and a slight adverse impact on the setting of the Port House. The option would have neutral impact on a listed building located c.300m to the north. The option has the potential to have a major adverse impact on unknown sub-surface heritage assets including palaeoenvironmental remains.	N/A	A geoarchaeological deposit model should be prepared to assess the distribution of deposits containing palaeoenvironmental information and the presence/absence and depth of the Cromer Forest Bed Formation. The impact on the setting of designated and undesignated built heritage should be considered during the option selection and design process.	N/A	Slight adverse

				Mitigation would be required in advance of construction. The scope of the mitigation to be informed by the geoarchaeological deposit model and the impact on setting and significance of designated and undesignated built heritage.		
	Biodiversity	Potential to impact reptiles due to removal of suitable habitat. Potential to impact bat roosts due to removal of potential roost sites. Potential to impact breeding birds due to removal of suitable nesting habitat.	N/A	As the alignment passes through several areas of habitat that are suitable for both breeding birds and reptiles, these protected species may be affected. There are also several buildings which may have suitable bat roosts within them that could also be an ecological constraint.	N/A	Moderate Adverse
	Water Environment	Water environment impacts include increased discharge into water bodies (surface and groundwater), which may cause a slight decrease in water quality. Increased potential for accidental spillage contaminating surface water or groundwater. Any road cuttings required may impact local aquifers during construction. Increase in flood risk along all watercourses due to increase in run-off and reduction of floodplain. Largest decrease in floodplain compared to options W4 and T3 Short term impact in navigation of Lake Lothing during construction. Flood risk increase considered key element of concern.	N/A	The route is deemed to be of a significant impact to the water environment with the extent of floodplain loss greater than other routes. Groundwater flows and hydrological linkages between the route option and potential groundwater abstractions would need to be established. It is unlikely that increased impermeable surfaces would impact upon the permeability of surrounding land and aquifer recharge, given the urbanised land use.	N/A	Moderate Adverse

11.3 Option W4 Appraisal Summary Table

Appraisal Summary Table

Date produced:	16/12/15

Contact:	
Name	
Organisation	
Role	Promoter/Official

Name of scheme:	Lake Lothing Third Crossing
Description of scheme:	Option W4, for details on Option W4 refer to Section 2.3

Impacts		Summary of key impacts	Assessment			
			Quantitative	Qualitative	Monetary £(NPV)	Distributional 7-pt scale/ vulnerable grp
Environmental	Noise	87 dwellings within 50m; 296 between 50-100m; 801 100-200m; 1445 200-300m, with 6938 inside total study area. Predicted increases along Long Road, Kirkley Run, Notley Road, Durban Road, The Avenue, Fir Lane and Norwich Road. Decreases predicted along the A146, Bridge Road, Normanston Drive, Colville Road, and Highland Way.	As a qualitative assessment has been undertaken there is no monetised appraisal information to present, and this will be undertaken for the preferred option as part of any Full Business Case application	A number of increases in noise levels at dwellings adjacent to the alignment option would be anticipated. However a larger number of reductions are likely adjacent to routes which are relieved by the scheme.	Not calculated at OBC, full monetised NPV will be provided for the preferred option at FBC	Neutral
	Air Quality	Overall neutral local and regional air quality impact considered most likely based on qualitative traffic data review (2020 Do Minimum vs Do Something)	4,497 sensitive receptors with potential for adverse local air quality 9,208 sensitive receptors with potential for local air quality benefit 62,571 receptors with potential for neutral local air quality impact	No AQMA designated within or near to the study area Background mapped air pollutant concentrations are well below national objective values Max roadside PCM concentrations 2015: 23.7 µg/m^3 2020: 16.3 µg/m^3	Not calculated at OBC, full monetised NPV will be for the preferred option provided at FBC	Not calculated
	Greenhouse gases	GHG emissions associated with traffic in the Do Something scenario are predicted to be lower than the Do Minimum scenario over the same appraisal period. Therefore, a greenhouse gas benefit is predicted.	Change in non-traded carbon over 60y (CO_2e): -64,228 Change in traded carbon over 60y (CO_2e): -126	Both traded and non-traded road-based emissions associated with the Do Something scenario are estimated to be lower over the appraisal period (2020 – 2079) relative to the Do Minimum case.	£2,953,000	N/A
	Landscape	N/A	N/A	N/A	N/A	N/A – scoped out of assessment
	Townscape	Bascule road bridge crossing across the central waterspace; elevated road approaches towards the bascule bridge; material impact on Normanston Park and Leathes' Ham LNR.	N/A	The elevated bridge approaches would have some influence on emerging land use and townscape south of the lake. The bascule crossing would represent some sub-division of the open waterspace associated with North Quay. Normanston Park and Leathes' Ham LNR would be eroded in scale, with modification of setting.	N/A	Slight Adverse
	Historic Environment	The option would be a visual intrusion across Lake Lothing resulting in a slight adverse impact on the historic landscape. The option would have a slight adverse impact on the historic landscape through encroachment of the upgraded road network onto recreational land at Normanston Park. The option would have neutral impact on a listed building located c.300m to the east. The option has the potential to have a major	N/A	A geoarchaeological deposit model should be prepared to assess the distribution of deposits containing palaeoenvironmental information and the presence/absence and depth of the Cromer Forest Bed Formation. The impact on the setting of designated and undesignated built heritage should be considered during the option selection and design process.	N/A	Slight adverse

		adverse impact on unknown sub-surface heritage assets including palaeoenvironmental remains.		Mitigation would be required in advance of construction. The scope of the mitigation would be informed by the geoarchaeological deposit model and the impact on setting and significance of designated and undesignated built heritage.		
	Biodiversity	Potential to impact reptiles due to removal of suitable habitat. Potential to impact bat roosts due to removal of potential roost sites. Potential to impact breeding birds due to removal of suitable nesting habitat. Damage and encroachment to Leathes' Ham LNR from re-alinement of Peto Way. Damage and encroachment to Brook Yachts and Geld-Wen Mosaic due to the alignment being built within its boundary	N/A	The alignment will encroach Leathe's Ham LNR and run through Brooke Yachts Geld-Wen Mosaic. These sites are important for wildlife and contain priority habitats and known protected species populations.	N/A	Moderate Adverse
	Water Environment	Impacts include increased discharge into water bodies (surface and groundwater), which may cause a slight decrease in water quality. Increased potential for accidental spillage contaminating surface water or groundwater. Any road cuttings required may impact local aquifers during construction. Increase in flood risk along all watercourses due to increase in run-off and reduction of floodplain. Potential short term navigation of Lake Lothing impacted through construction. Potential impact upon Leathes' Ham nature reserve and Brook Yachts and Jeld Wen Mosaic county wildlife site through highways runoff, loss of green space and hydro morphological character. Flood risk increase considered key element of concern.	N/A	Route option W4 has the potential for significant impacts and redevelopment of the floodplain, most notably to Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic CWS. Approximately 1km of route will be built in floodplain and would need to be mitigated through structural or sustainable flood management measures. Significant impacts with regards to groundwater and abstractions. Potential losses of important strategic/functional floodplain at Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic CWS mean that significant measures would be required to mitigate impacts to these key water environment and ecological features.	N/A	Large Adverse

11.4 Option T3 Appraisal Summary Table

Appraisal Summary Table

Date produced:	16/12/15

Contact:	
Name	
Organisation	
Role	Promoter/Official

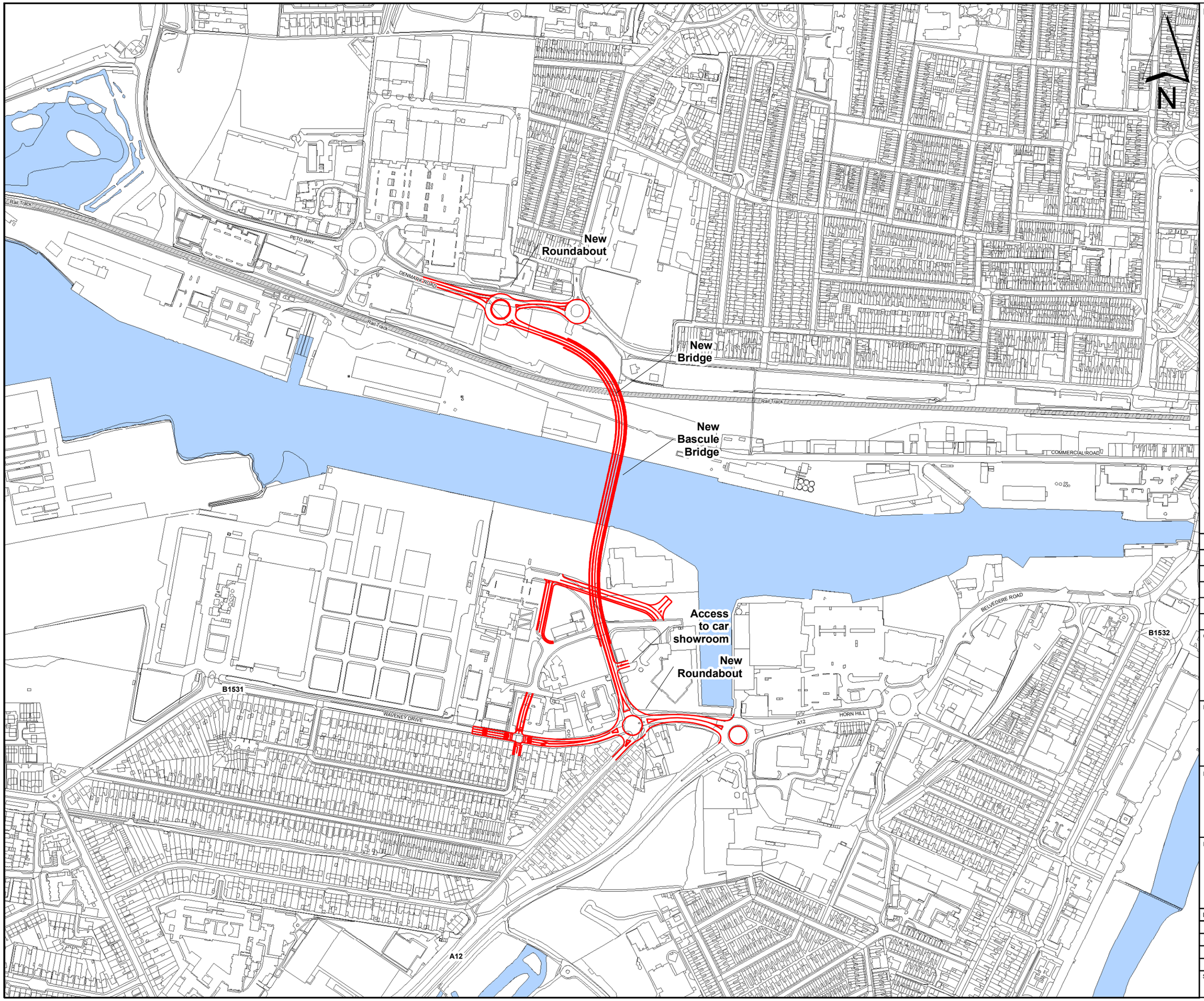
Name of scheme:	Lake Lothing Third Crossing
Description of scheme:	Option T3, for details on Option T3 refer to Section 2.4

Impacts		Summary of key impacts	Assessment			
			Quantitative	Qualitative	Monetary £(NPV)	Distributional 7-pt scale/ vulnerable grp
Environmental	Noise	84 dwellings within 50m; 291 between 50-100m; 792 100-200m; 1437 200-300m, with 6940 inside total study area. Predicted increases along Long Road, Kirkley Run, Notley Road, Durban Road, The Avenue, Fir Lane and Norwich Road. Decreases predicted along the A146, Bridge Road, Normanston Drive, Colville Road, Cotmer Road, Elm Tree Road, and Highland Way.	As a qualitative assessment has been undertaken there is no monetised appraisal information to present, and this will be undertaken for the preferred option as part of any Full Business Case application	A number of increases in noise levels at dwellings adjacent to the alignment option would be anticipated, however a larger number of reductions are likely adjacent to routes which are relieved by the scheme.	Not calculated at OBC, full monetised NPV will be provided for the preferred option at FBC	Neutral
	Air Quality	Overall neutral local and regional air quality impact considered most likely based on qualitative traffic data review (2020 Do Minimum vs Do Something)	5,041 sensitive receptors with potential for adverse local air quality 8,890 sensitive receptors with potential for local air quality benefit 60,875 receptors with potential for neutral local air quality impact	No AQMA designated within or near to the study area Background mapped air pollutant concentrations are well below national objective values Max roadside PCM concentrations 2015: 23.7 µg/m^3 2020: 16.3 µg/m^3	Not calculated at OBC, full monetised NPV will be provided for the preferred option at FBC	Not calculated
	Greenhouse gases	GHG emissions associated with traffic in the Do Something scenario are predicted to be lower than the Do Minimum scenario over the same appraisal period. Therefore, a greenhouse gas benefit is predicted.	Change in non-traded carbon over 60y (CO2e): -57,100 Change in traded carbon over 60y (CO2e): -103	Both traded and non-traded road-based emissions associated with the Do Something scenario are estimated to be lower over the appraisal period (2020 – 2079) relative to the Do Minimum case.	£2,622,000	N/A
	Landscape	N/A	N/A	N/A	N/A	N/A – scoped out of assessment
	Townscape	Material impact on Normanston Park and Leathes' Ham LNR	N/A	Normanston Park and Leathes' Ham LNR would be eroded in scale, with some modification of setting.	N/A	Slight Adverse
	Historic Environment	The option would be a visual intrusion across Lake Lothing resulting in a slight adverse impact on the historic landscape. The option would have a slight adverse impact on the historic landscape through encroachment of the upgraded road network onto recreational land at Normanston Park. The option would have neutral impact on a listed building located c.300m to the east. The option has the potential to have a major adverse impact on unknown sub-surface heritage assets including palaeoenvironmental remains.	N/A	A geoarchaeological deposit model should be prepared to assess the distribution of deposits containing palaeoenvironmental information and the presence/absence and depth of the Cromer Forest Bed Formation. The impact on the setting of designated and undesignated built heritage should be considered during the option selection and design process. Mitigation would be required in advance of construction. The scope of the mitigation to be informed by the geoarchaeological deposit model and the impact on setting and significance of designated and undesignated built heritage.	N/A	Slight adverse

	Biodiversity	Potential to impact reptiles due to removal of suitable habitat. Potential to impact bat roost, due to removal of potential roost sites. Potential to impact breeding birds due to removal of suitable nesting habitat. Damage and encroachment to Leathes' Ham LNR, from re-alinement of Peto Way. Damage and encroachment to Brook Yachts and Geld-Wen Mosaic, due to the alignment being built within its boundary	N/A	The alinement will encroach Leathes' Ham LNR and run through Brooke Yachts Geld-Wen Mosaic. These sites are important for wildlife and contain priority habitats and known protected species populations.	N/A	Moderate Adverse
	Water Environment	Impacts include increased discharge into water bodies (surface and groundwater), which may cause a slight decrease in water quality. Increased potential for accidental spillage contaminating surface water or groundwater. Any road cuttings required may impact local aquifers during construction. Increase in flood risk along all watercourses due to increase in run-off and reduction of floodplain. Short term impact in navigation of Lake Lothing during construction. Groundwater flows and SPZ zone of influence potentially impacted upon. Potential impact upon Leathes' Ham nature reserve and Brook Yachts and Jeld Wen Mosaic county wildlife site through highways runoff, loss of green space and hydro morphological character. Floodplain loss and loss of green floodplain at Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic key issue.	N/A	Route option T3 has potentially significant impacts to floodplain and significant impacts with regards to groundwater and abstractions. The loss of important strategic/functional floodplain at Leathes' Ham and Brooke Yachts and Jeld-Wen Mosaic and their designations for important biodiversity value mean that significant measures would be required to mitigate impacts to these key water environment features.	N/A	Large Adverse

Appendices

Appendix A Plans



LEGEND

Option

REF	DATE	REVSIONS	INTITALS

CLIENT

Suffolk County Council

ENGINEERS

mouchel
building great relationships

PROJECT TITLE

LAKE LOTHING THIRD CROSSING

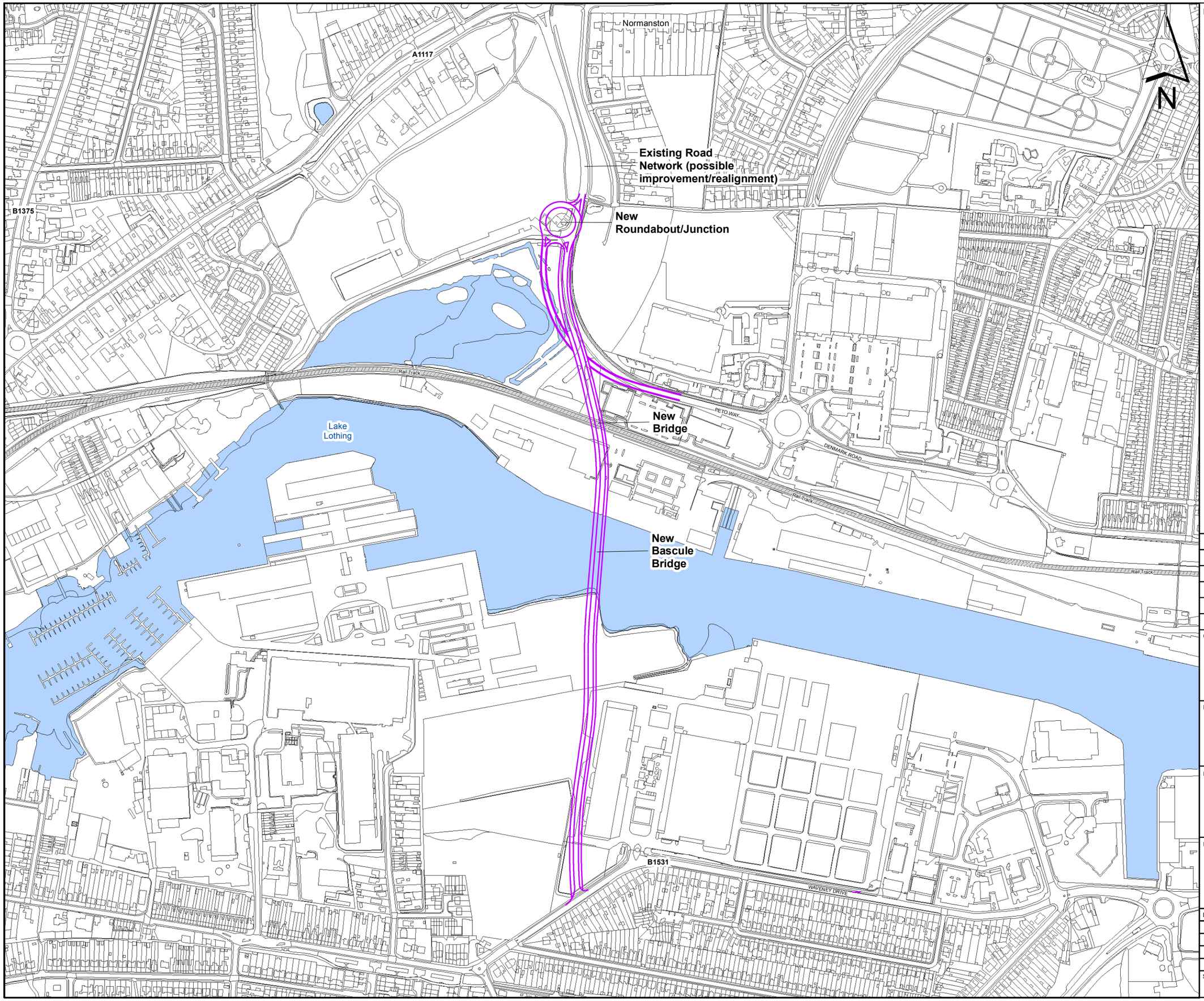
DRAWING TITLE

OPTION C11

DESIGN BY	DAW	CHECKED BY	MR
DATE	05/10/2015	DATE	05/10/2015
DRAWN BY	DAW	APPROVED BY	MR
DATE	05/10/2015	DATE	05/10/2015

DRAFT	X	PRELIMINARY		TENDER		CONTRACT

SCALE - A3	DRAWING NO	REV
1:5,000	1069948 FIGURE 1.1	A



LEGEND

Option

REF	DATE	REVSIONS	INTITALS

CLIENT

Suffolk County Council

ENGINEERS

mouchel
building great relationships

PROJECT TITLE

LAKE LOTHING THIRD CROSSING

DRAWING TITLE

OPTION W4

DESIGN BY	DAW	CHECKED BY	MR
DATE	05/10/2015	DATE	05/10/2015
DRAWN BY	DAW	APPROVED BY	MR
DATE	05/10/2015	DATE	05/10/2015

DRAFT	X	PRELIMINARY		TENDER		CONTRACT

SCALE - A3	DRAWING NO	REV
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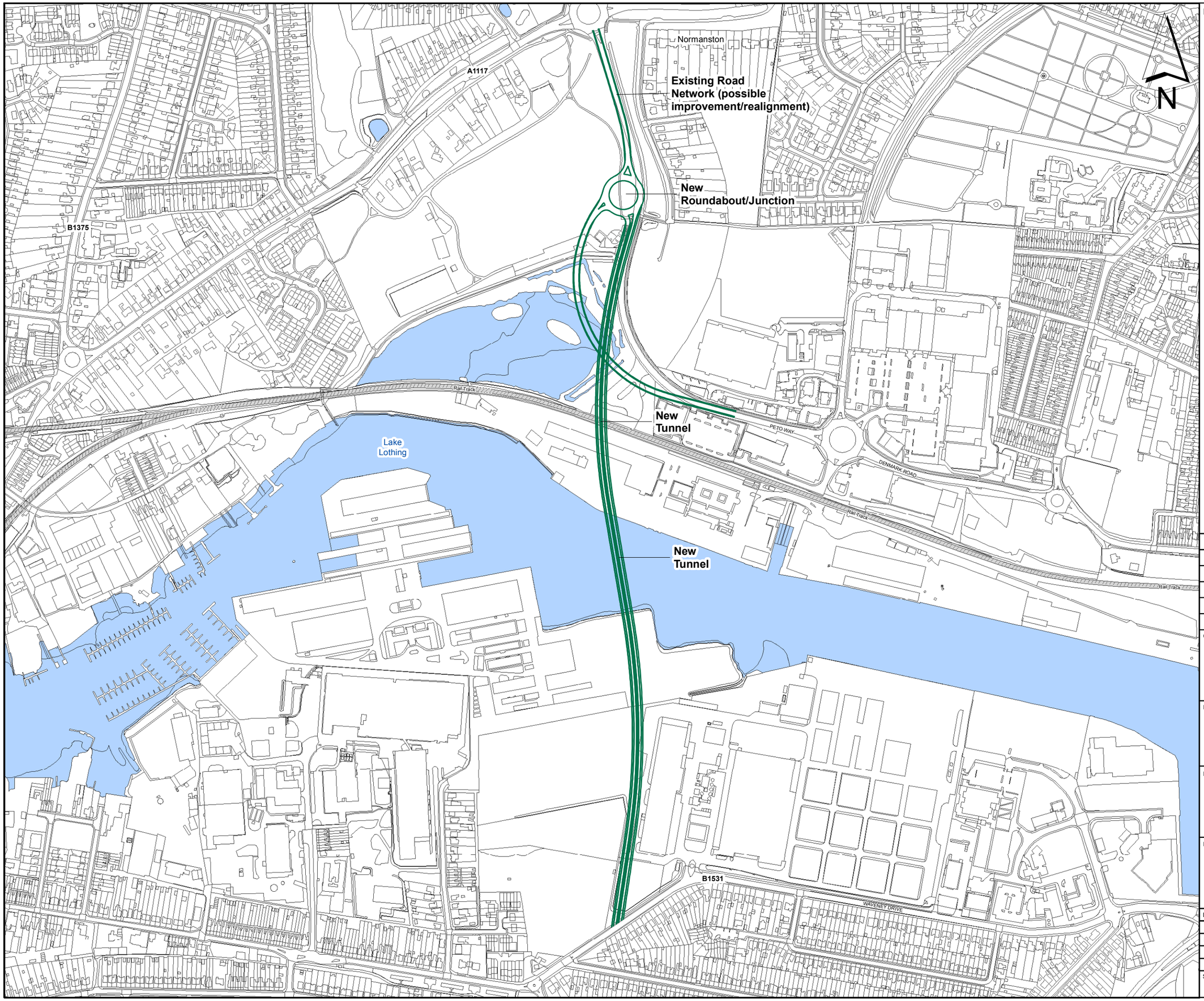

LEGEND

Option

REF	DATE	REVSIONS	INTITALS

CLIENT

Suffolk County Council

ENGINEERS

mouchel
building great relationships

PROJECT TITLE

LAKE LOTHING THIRD CROSSING

DRAWING TITLE

OPTION TUNNEL 3

DESIGN BY	DAW	CHECKED BY	MR
DATE	05/10/2015	DATE	05/10/2015
DRAWN BY	DAW	APPROVED BY	MR
DATE	05/10/2015	DATE	05/10/2015

DRAFT	X	PRELIMINARY		TENDER		CONTRACT

SCALE - A3	DRAWING NO	REV
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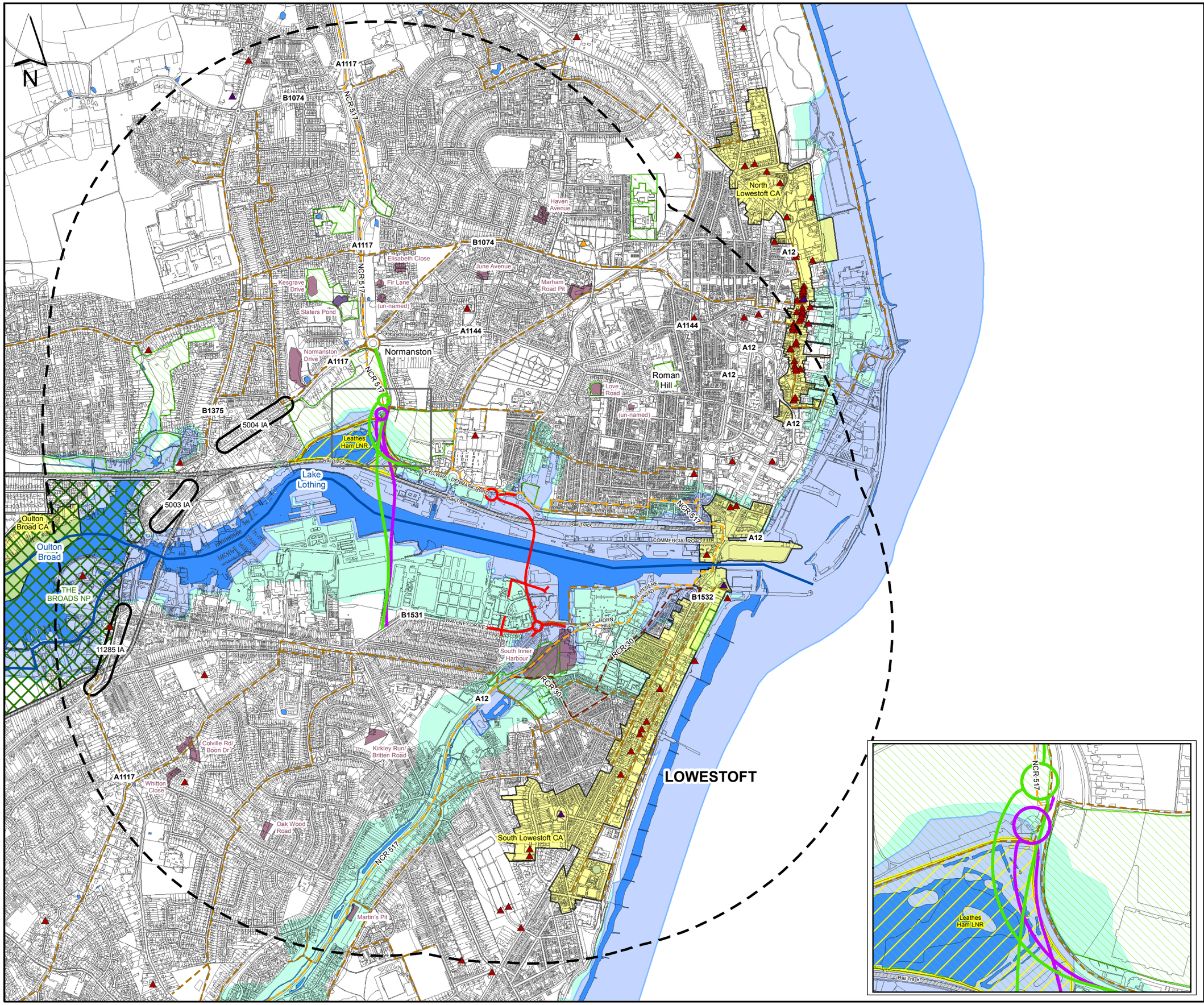

LEGEND

- 1500m Buffer
- Option C11
- Option T3
- Option W4

Listed Building

- I
- II
- II*

Public Rights of Way

- Cycle Route
- National Cycle Route (NCR)
- Regional Cycle Route (RCR)
- Defra Noise Important Area (IA)
- County Wildlife Site
- Main River
- Local Nature Reserve (LNR)
- National Park (NP)
- Historic Landfill
- Open Space
- Conservation Area (CA)
- Existing Rail Track
- Floodzone 3
- Floodzone 2

REF	DATE	REVSIONS	INTITALS

CLIENT

Suffolk County Council

ENGINEERS

mouchel
building great relationships

PROJECT TITLE

LAKE LOTHING THIRD CROSSING

DRAWING TITLE

ENVIRONMENTAL CONSTRAINTS

DESIGN BY	DAW	CHECKED BY	MR
DATE	05/10/2015	DATE	05/10/2015
DRAWN BY	DAW	APPROVED BY	MR
DATE	05/10/2015	DATE	05/10/2015

DRAFT	X PRELIMINARY	TENDER	CONTRACT

SCALE - A3	DRAWING NO	REV
1:16,000	1069948 FIGURE 1.4	A

Appendix B Phase I Habitat Survey Report

Lake Lothing Third Crossing

Phase I Survey Report

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Document Control Sheet

Project Title:	Lake Lothing Third Crossing
Report Title:	Phase I Survey Report
Document No:	1069948/ENV/02
Revision:	2
Status:	FINAL
Control Date:	December 2015

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
1	Draft	D. Weaver	26/10/15	A. Bascombe	3/11/15	P. Joyce	16/11/15
2	Final	D. Weaver	16/10/15	H. Roberts	17/11/15	A.Bascombe	2/12/15

Distribution

Organisation	Contact	Copies

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Contents

Appendices

Executive summary

As part of a project to alleviate traffic congestion through Lowestoft a third crossing over Lake Lothing has been proposed. Traffic travelling through Lowestoft on the A12 between Ipswich and Great Yarmouth can often cause congestion at peak times and alternative routes through residential roads can cause problems for the local residence. Therefore in 2009 a feasibility study for a third crossing was undertaken, it concluded that there was a potential four routes the new road could take, crossing Lake Lothing at two potential locations; the western (Grid Ref: TM532929), and the central (Grid Ref: TM538927).

The current study aims to assess potential ecological constraints that may affect the proposed routes, and offer recommendations for further study and potential mitigation.

The desk study showed that there was a total of one statutory protected area and 4 non-statutory protected sites, offering a constraint to works. There was also suitable habitat for breeding birds, reptiles and bats found within the study area.

Recommendation to avoid offences being committed were:

- Avoiding works during the breeding bird season, or the presence of a qualified ecologist during works to advise if active bird nests are encountered;
- Reptile survey to inform potential mitigation; and
- Bat roost surveys to inform potential mitigation.

1 Introduction

1.1 Background

1.1.1 in order to alleviate traffic congestion through Lowestoft, a third crossing over Lake Lothing has been proposed. Traffic travelling through Lowestoft on the A12 between Ipswich and Great Yarmouth can often cause congestion at peak times and alternative routes through residential roads can cause problems for local residents. It is also intended that a third crossing will provide better access to the lake area, support regeneration and provide an improved environment in Lowestoft, as well as remove through traffic from the currently congested Bascule bridge. This makes it possible to improve the pedestrian environment in the town centre, and meet expectations for ease of movement and journey reliability against a background of increasing traffic levels.

1.1.2 In 2009 a feasibility study for a third crossing was commissioned. This concluded that the new road could take one of four routes, with two possible crossing points of Lake Lothing: west (Grid Ref: TM532929), and the central (Grid Ref: TM538927).

1.2 Site location

1.2.1 Lake Lothing is situated in the centre of Lowestoft, Suffolk (Grid Ref: TM540927). It once housed a thriving boat building and repair industry which has declined in use over recent decades. It is classed as a salt water lake and lies east of the Broads National Park, opening into the North Sea at its eastern end.

1.3 Study rationale and objectives

1.3.1 The aim of the study was to appraise the ecological value of the study area, identify habitats and their likelihood of supporting protected species.

2 Methods

2.1 Desk Study

2.1.1 Information about the locations of any protected species records, and statutory protected nature conservation sites (e.g. Natura 2000 sites and Sites of Special Scientific Interest - SSSI) and non-statutory nature conservation sites (e.g. county wildlife sites including Sites of Nature Conservation Importance - SINCs) within a radius of 2 km of the proposed route were sought from the following sources.

- Multi Agency Geographic Information Centre website (www.magic.gov.uk).
- Suffolk Biological Records Centre (SBRC).
- Ordnance Survey Maps.

2.1.2 The desk study set out to identify any statutory or non-statutory designated sites, priority species and habitats or other ecological receptors.

2.2 Field Survey

2.2.1 A field survey of the site and its immediate environs was undertaken to:

- Appraise the ecological value of the Main Study Area, identify habitats and their suitability to support protected species.
- Map habitat types within the Main Study Area and provide a baseline assessment of the ecological value of these habitats in accordance with CIEEM (2006) “Guidelines for ecological impact assessments in the United Kingdom”;
- Identify habitat types which are suitable to support species that are protected by law or otherwise of particular nature conservation importance and review existing information regarding the likely presence of such species within the Broad Study Area;
- Determine whether ecological features are likely to constrain the proposed works; and
- Make recommendations for further work to progress the scheme, including further surveys, mitigation measures or ecological enhancements.

2.2.2 The map of habitat types is provided in Appendix 1.

2.3 Field Survey Limitations

2.3.1 The survey was completed in early October, therefore species of plants flowering earlier in the season may have been undetected. At the time of survey no access was available to private property; however, habitat areas were generally small and identification of species was possible from the boundaries. We were also unable to gain access to an industrial area with woodland scrub behind it (Grid Ref: TM 53023 92859), therefore no assessment was made of this area. The desk study identified that this area of scrub woodland is a County Wildlife Site and that ecological reports for it are available.

2.4 Assessment Methodology

2.4.1 The assessment methodology used to evaluate possible ecological receptors within the site follows published guidance CIEEM (2006). Ecological receptors have been evaluated based on specific criteria, which include:

- Habitat size, shape, diversity (e.g. mosaics, mono-cultures) and connectivity;
- Physical conditions (e.g. natural, semi-natural, buildings/hard standing);
- Biodiversity, including species richness, range and populations of plant and animals communities;
- Rarity and typicalness of plant and animal communities;
- Stage/stability of ecological succession and habitat development trajectory;
- Typicalness of the physical environment;
- Position in an ecological or geographical unit; and
- Potential and intrinsic value, ease of re-creation.

2.4.2 In addition, consideration has also been given to the possible occurrence of S41 species and habitats (referring to priority species and habitats listed under section 41 of the Natural Environment and Rural Communities Act 2006 (as amended)), inclusion on national or county Red Data Books, and to conservation status (such as nationally notable/scarce species, etc.). However, the inclusion within a priority species or habitat reflects the fact that the population of the habitat concerned is in a sub-optimal state (and hence that conservation action is required) and does not necessarily imply any specific level of value.

3 Results and Evaluation

3.1 Desk Study Results

Statutory protected sites

3.1.1 1.8 km west of the site is The Broads Special Area of Conservation (SAC) (Grid Ref: TM 51270 92474) which is also designated as a Ramsar site (Broadland Ramsar Site), and Site of Special Scientific Interest (Sprat's Water and Marshes, Carlton Coville SSSI). The significant barriers between the site and this area, including numerous residential areas, the A1117 and a train line, mean that adverse effects would not occur, and therefore Appropriate Assessment under the Habitats Regulations is not required.

3.1.2 Leathes Ham is a Local Nature Reserve (LNR) and County Wildlife Site adjacent to Peto Way (Grid Ref: TM 53011 93232). This site comprises a large water body with fringing reedbeds, wet woodland and rough grassland. The site supports a diversity of habitats and is important for breeding birds.

Non-statutory protected sites

3.1.3 There are twelve County Wildlife Sites within 2km of the proposed site. Of these, four are located within areas where the proposed works might affect them.

3.1.4 Brooke Yachts and Jeld-Wen Mosaic (Grid Ref: TM532962) is situated on the southern bank of Lake Lothing. It has an open mosaic of habitats on previously developed land and a small area of intertidal mudflat. This site supports a large population of common lizards and a diverse assemblage of breeding birds.

3.1.5 Kirkley Ham (Grid Ref: TM539922) lies adjacent to the A12 south of Lake Lothing. It comprises two distinct habitat types dissected by disused railway lines. The southern part contains two areas of reedbed fringed by willow scrub. These are drying out in places with encroachment of scrub and willowherb. They are fed by surrounding run-off and water from ponds in the adjacent Kirkley Fen Park. The site forms part of the flood control system. There are small areas of open water. The higher northern part consists of dry neutral and acidic grassland with gorse and scattered hawthorn scrub. A dyke running along the north western edge contains a few specimens of greater spearwort which is a nationally rare plant. Common lizard have been recently recorded at this site and it contains habitats suitable to support breeding birds.

3.1.6 Harbour Kittiwake Colony (Grid Ref: TM552927) is an important sea bird colony present near the Outer Lowestoft Harbour. This site contains an artificial cliff built on the north pier extension which was provided to replace an original nest site.

3.1.7 A plan showing the statutory and non-statutory sites that could be affected by the proposed scheme is provided in Appendix 2.

Protected species

3.1.8 Records of brown long-eared bat *Plecotus auritus*, pipistrelle *Pipistrellus sp*., water

vole *Arvicola amphibious*, grey seal *Halichoerus grypus* and common lizard *Zootoca vivipara* exist within 2km of the final alignments. Approximately 150 species of birds have been recorded within 2km of the site, including notable species such as barn owl Tyto alba, black redstart *Phoenicurus ochruros*, green sandpiper *Tringa ochropus*, hen harrier *Circus cyaneus*, kingfisher *Alcedo atthis*, little tern *Sternula albifrons*, peregrine *Falco peregrinus* and red throated diver *Gavia stellate*. A full list of all bird species recorded within 2km of the site is provided in Appendix 3.

Priority species

3.1.9 Biological records show several priority species (S41 NERC Act as amended) that have been recorded within 2km. Species recorded include hedgehog *Erinaceus europaeus*, common toad *Bufo bufo*, common frog *Rana temporatia* and smooth newt *Lissotriton vulgaris*. These species are afforded no formal protection within the UK, but must be taken into consideration during the planning phase.

3.2 Field survey results

3.2.1 The area surveyed was an urban landscape with a mixture of new retail and leisure developments, abandoned industrial units, and active industrial units. There are small remnant patches of woodland, scrub and tall ruderal around the industrial areas, with Leathes Ham LNR to the west of the site.

Habitats

3.2.2 **Semi-natural broadleaved woodland** – this is a small area situated either side of Peto Way. On the east side of the road the habitat contains a mixture of mature species with a complex scrub like understorey. Mature species include English oak *Quercus robur*, elm *Ulmus minor*, sycamore *Acer pseudoplatanus*, ash *Fraxinus excelsior*, maple *Acer campestre*, willow sp. *Salix sp.,* silver birch *Betula pendula*, horse chestnut *Aesculus hippocastanum*, elder *Sambucus nigra*, holly *Ilex aquifolium* and hawthorn Crataegus monogyna. The understorey consisted of bramble Robus fruticosus, common nettle *Urtica dioica*, gorse *Ulex euroaeus*, male fern *Dryopteris filix-mas* and ground ivy *Hedera helix*.

3.2.3 To the west of Peto Way the woodland is dominated by willow sp. with poplar *Populus tremula*, alder *Alnus glutinosa* and silver birch. The understorey has common reed *Phragmites australis*, ladies mantle *Alchemilla mollis* and rosebay willowherb *Chamerion angustifolium*. The dominances of willow trees and close proximity of this habitat to a lake mean that this is wet woodland. Wet woodland is a nationally important habitat type that has been in decline in the UK over recent decades, however, this habitat is locally abundant in East Anglia because of the abundance of wetlands within the area.

3.2.4 **Tall ruderal** – Small isolated areas of this habitat were present to the north of the railway line adjacent to Denmark Road. These areas were dominated by bramble, with willow herb, common nettle, ragwort *Jacobaea vulgaris*, common hogweed *Heracleum sphondylium*, ivy, bindweed Convolvulus arvensis, broom *Cytisus*

scoparius and dog rose *Rosa canina*.

3.2.5 Small areas of grasses were interspersed within the tall ruderal, and these consisted of perennial rye grass *Lolium perenne*, timothy-grass *Phleum pratense*, false oat grass *Arrthenatherum elatius* and willow herb. There were also some woody species within the tall ruderal, including elm, hawthorn and sycamore. This habitat is found throughout the UK and is not an ecological constraint to the works.

3.2.6 **Unimproved neutral grassland** –areas of this habitat type were present south of Lake Lothing in former industrial areas which have been left unmanaged. Species present included soft rush *Juncus effusus*, bramble, greater plantain *Plantaga major*, yarrow *Achillea millefolium*, broom, gorse, silverweed Argentina *anserina*, willowherb and ragwort. These areas if left unmanaged can be expected to succeed to tall ruderal within the next few years. Unimproved neutral grassland is widespread throughout the UK and is not an ecological constraint to the works.

3.2.7 **Amenity grassland** – there are two large areas of amenity grassland north of the lake, east and west of Peto Way, both of which are playing fields and recreational areas. This habitat is of low ecological value and is not an ecological constraint to the proposed works.

3.2.8 **Freshwater lake** – This is an LNR and is a large fresh water lake surrounded by reedbeds composed of common reed and bull rush *Typha latifolia*, adjacent to wet woodland. Several bird species were seen to be using the lake, including cormorant *Phalacrocorax carbo*, herring gull *Larus argentatus*, mallard duck *Anas platyrhynchos* and American Pekin duck *Anas pltyrhynchos domestica*. This is a UK statutory protected site and will need to be taken into consideration during the planning stage.

3.2.9 **Hard Standing** – several areas of old hard standing are present, containing numerous cracks within which vegetation has become established. Species present include buddleia *Buddleja globose*, gorse, willow herb and several species of grasses. This habitat is of little ecological value and is not a constraint to the proposed works.

Protected and priority species

3.2.10 **Breeding birds** – Many habitats present are suitable to support breeding birds, in particular, woodland and tall ruderal habitats. All UK birds are protected by law when breeding.

3.2.11 The breeding bird season typically occurs between mid-March and mid-August and therefore measures should be put in place to minimise the risk of adverse effects occurring on breeding birds at this time.

3.2.12 **Reptiles** – The site contains habitat suitable for use by reptiles, and records of reptiles exist for the wider area. Consequently, it is possible that reptiles may be present within the final alignment routes. Further investigation of reptiles is therefore recommended to inform the scheme design and assessment.

3.2.13 **Bats** – Records exist of bats west of the proposed site within the Broads National

Park. Buildings within the Main Study Area may be suitable to support roosting bats. Further investigation of bats is therefore recommended to inform the scheme design and assessment.

4 Discussion

4.1 Description of baseline ecology and constraints

4.1.1 The proposed alignments of the third crossing of Lake Lothing will pass through an urban landscape with interspersed pockets of semi-natural landscape and industrial buildings.

4.1.2 Leathes Ham LNR and the Brooke Yachts and Jeld-Wen Mosaic CWS support populations of common lizards, breeding birds, and contain valuable habitats including wet woodland and mudflats.

4.1.3 The natural and semi-natural habitats listed in the results section are relatively widespread in the UK (although some may be locally rare), however, due to their proximity to the two aforementioned sites, may also hold ecological value. The area holds suitable habitat for both reptiles and breeding birds. These species will inhabit woodland, tall ruderal, grassland and use decaying hardstanding making these habitats significant ecological receptors.

4.1.4 The large number of old industrial buildings offer suitable roosting sites for bats. Two species of bat have been recorded in the area therefore further surveys are recommended to establish if bats are using these buildings to roost and associated natural habitats for foraging and commuting.

4.2 Recommendations for further work

4.2.1 The following surveys are recommended to further investigate the likely effects of the proposals on ecological resources, and advise the need for and extent of any mitigation.

4.2.2 **Reptile Surveys** –surveys should be carried out within areas of suitable habitat. Surveys should seek to confirm presence/absence, identify species present and estimate population sizes. The survey findings will inform the scheme assessment and the need for and extent of any mitigation.

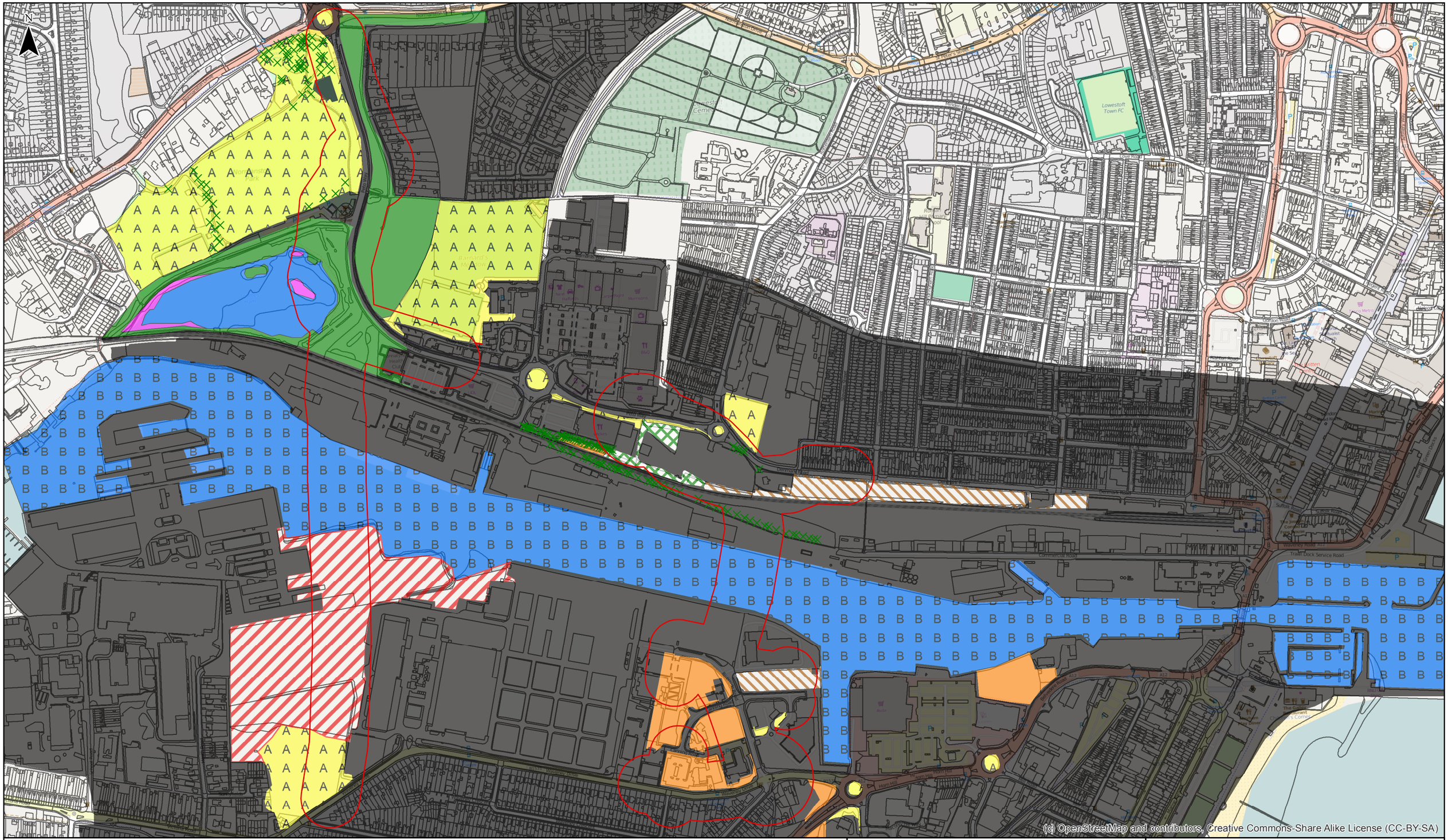
4.2.3 **Bat surveys** – surveys are recommended to identify possible roost sites within 50m of the proposed routes. Any possible roosts should be subject to emergence surveys to confirm whether roosting bats are present. The findings of these surveys would inform the scheme assessment and design, and the need for and extent of mitigation, as well as providing information that may be necessary should a protected species licence application need to be made.

4.2.4 **Breeding birds** - It is recommended that vegetation clearance takes place outside of the typical bird breeding season of mid-March to mid-August. If this is not possible then a suitably experienced ecologist should supervise vegetation clearance works, advising as appropriate should breeding birds be present.

4.2.5 We have used our reasonable endeavours to provide information that is correct and accurate and have discussed above the reasonable conclusions that can be reached on the basis of the information available. We would recommend that in order to obtain more secure results, the additional work outlined above should be commissioned.

Appendices

Appendix A Phase I Habitat Map



Legend

- Proposed Route
- Standing Tree
- Amenity Grassland J1.2
- Brackish Water
- Buildings and Hardstanding J3.6
- Dense and Continuous Scrub A2.1
- Inundation Vegetation F2.2
- No Access
- Scattered Scrub A2.2
- Semi-natural Broadleaved Woodland A1.1.1
- Standing Water G1
- Tall Ruderal C3.1
- Unimproved Neutral Grassland B2.1

Version	Amendment	Drawing Date	Review Date	Approved Date
A	First Issue	03/12/15 DW	03/12/15 PJ	03/12/15 AB

Client: Suffolk County Council

Project: Lowestoft Third Crossing

Drawing Title: Phase 1 Survey

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building great relationships

Office: Blackfriars

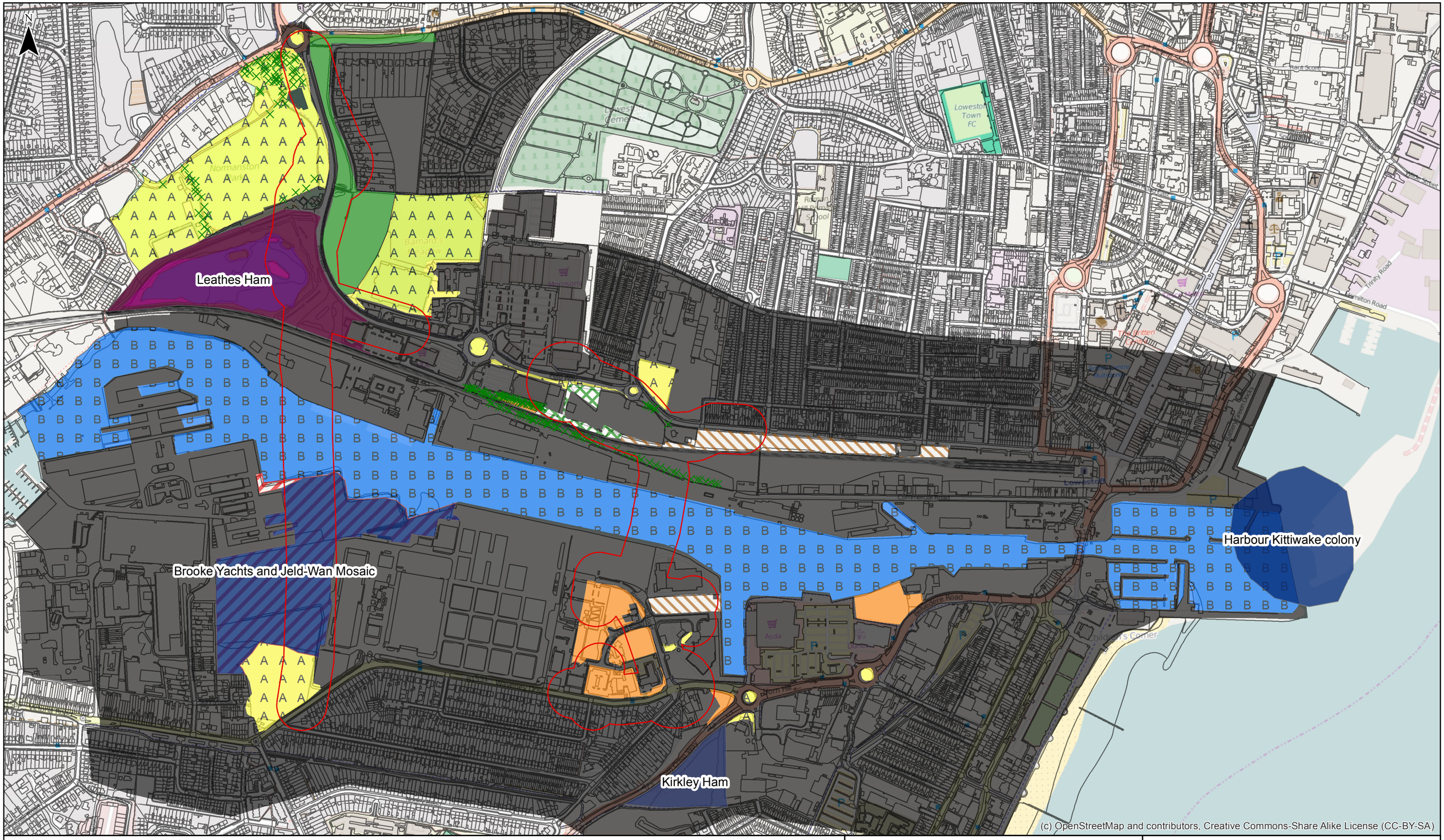
Tel: 020 7822 2497

Scale (at A3 size): 1:6,000

Purpose of Issue: Information

Drawing Number:

Appendix B Constraints Map



Legend

- Proposed Routes
- County Wildlife Site
- Local Nature Reserve
- Standing Tree
- Amenity Grassland J1.2
- Brackish Water
- Buildings and Hardstanding J3.6
- Dense and Continuous Scrub A2.1
- Inundation Vegetation F2.2
- No Access
- Scattered Scrub A2.2
- Semi-natural Broadleaved Woodland A1.1.1
- Standing Water G1
- Tall Ruderal C3.1
- Unimproved Neutral Grassland B2.1

Version	Amendment	Drawing Date	Review Date	Approved Date
A	First Issue	03/12/15 DW	03/12/15 PJ	03/12/15 AB

Client: Suffolk County Council

Project: Lowestoft Third Crossing

Drawing Title: Local Protected Sites - Constraints

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Office: Blackfriars

Tel: 020 7822 2497

Scale (at A3 size): 1:7,000

Purpose of Issue: Information

Drawing Number:

Appendix C Bird Records

Common Name	Latin Name
Alpine Swift	*Apus melba*
Arctic Tern	*Sterna paradisaea*
Ardea alba subsp. alba	*Ardea alba subsp. alba*
Avocet	*Recurvirostra avosetta*
Balearic Shearwater	*Puffinus mauretanicus*
Barn Owl	*Tyto alba*
Barnacle Goose	*Branta bernicla*
Bearded Tit	*Panurus biarmicus*
Bewick's Swan	*Cygnus columbianus*
Bittern	*Botaurus stellaris*
Black Redstart	*Phoenicurus ochruros*
Black Tern	*Chlidonias niger*
Black-necked Grebe	*Podiceps nigricollis*
Black-tailed Godwit	*Limosa limosa*
Black-throated Diver	*Gavia arctica*
Blue Tit	*Cyanistes caeruleus*
Brambling	*Fringilla montifringilla*
Brent Goose	*Branta bernicla*
Bullfinch	*Pyrrhula pyrrhula*
Cetti's Warbler	*Cettia cetti*
Coal Tit	*Periparus ater*
Common (Mealy) Redpoll	*Acanthis flammea*
Common Crossbill	*Loxia curvirostra*
Common Scoter	*Melanitta nigra*
Common Tern	*Sterna hirundo*
Crane	*Grus grus*
Cuckoo	*Cuculus canorus*
Curlew	*Numenius arquata*
Dark-bellied Brent Goose	*Branta bernicla subsp. bernicla*
Dartford Warbler	*Sylvia undata*
Dunlin	*Calidris alpina*
Dunnock	*Prunella modularis*
Fieldfare	*Turdus pilaris*
Firecrest	*Regulus ignicapilla*
Garganey	*Anas querquedula*
Goldcrest	*Regulus regulus*
Goldeneye	*Bucephala clangula*
Goldfinch	*Carduelis carduelis*
Goshawk	*Accipiter gentilis*
Grasshopper Warbler	*Locustella naevia*

Common Name	Latin Name
Great Grey Shrike	*Lanius excubitor*
Great Northern Diver	*Gavia immer*
Great Spotted Woodpecker	*Dendrocopos major*
Great Tit	*Parus major*
Great White Egret	*Ardea alba*
Green Sandpiper	*Tringa ochropus*
Green Woodpecker	*Picus viridis*
Greenfinch	*Carduelis chloris*
Greenshank	*Tringa nebularia*
Grey Partridge	*Perdix perdix*
Grey Phalarope	*Phalaropus fulicarius*
Grey Wagtail	*Motacilla cinerea*
Greylag Goose	*Anser anser*
Hawfinch	*Coccothraustes coccothraustes*
Hen Harrier	*Circus cyaneus*
Herring Gull	*Larus argentatus*
Hobby	*Falco subbuteo*
Honey-buzzard	*Pernis apivorus*
Hoopoe	*Upupa epops*
House Martin	*Delichon urbicum*
House Sparrow	*Passer domesticus*
Kestrel	*Falco tinnunculus*
Kingfisher	*Alcedo atthis*
Lapland Bunting	*Calcarius lapponicus*
Lapwing	*Vanellus vanellus*
Leach's Petrel	*Oceanodroma leucorhoa*
Lesser Redpoll	*Acanthis cabaret*
Light-bellied Brent Goose	*Branta bernicla subsp. hrota*
Linnet	*Linaria cannabina*
Little Egret	*Egretta garzetta*
Little Gull	*Hydrocoloeus minutus*
Little Owl	*Athene noctua*
Little Ringed Plover	*Charadrius dubius*
Little Stint	*Calidris minuta*
Little Tern	*Sternula albifrons*
Long-eared Owl	*Asio otus*
Long-tailed Duck	*Clangula hyemalis*
Manx Shearwater	*Puffinus puffinus*
Marsh Harrier	*Circus aeruginosus*
Marsh Tit	*Poecile palustris*
Meadow Pipit	*Anthus pratensis*
Mediterranean Gull	*Larus melanocephalus*

Common Name	Latin Name
Merlin	*Falco columbarius*
Nightingale	*Luscinia megarhynchos*
Olive-backed Pipit	*Anthus hodgsoni*
Osprey	*Pandion haliaetus*
Peregrine	*Falco peregrinus*
Pied Wagtail	*Motacilla alba subsp. yarrellii*
Pintail	*Anas acuta*
Purple Sandpiper	*Calidris maritima*
Red Kite	*Milvus milvus*
Red-backed Shrike	*Lanius collurio*
Red-flanked Bluetail	*Tarsiger cyanurus*
Redstart	*Phoenicurus phoenicurus*
Red-throated Diver	*Gavia stellata*
Redwing	*Turdus iliacus*
Reed Bunting	*Emberiza schoeniclus*
Ring Ouzel	*Turdus torquatus*
Ringed Plover	*Charadrius hiaticula*
Robin	*Erithacus rubecula*
Rock Pipit	*Anthus petrosus*
Roseate Tern	*Sterna dougallii*
Ruddy Shelduck	*Tadorna ferruginea*
Ruff	*Calidris pugnax*
Sabine's Gull	*Xema sabini*
Sand Martin	*Riparia riparia*
Sanderling	*Calidris alba*
Sandwich Tern	*Sterna sandvicensis*
Scaup	*Aythya marila*
Serin	*Serinus serinus*
Shag	*Phalacrocorax aristotelis*
Shelduck	*Tadorna tadorna*
Shore Lark	*Eremophila alpestris*
Short-eared Owl	*Asio flammeus*
Siskin	*Spinus spinus*
Skylark	*Alauda arvensis*
Slavonian Grebe	*Podiceps auritus*
Smew	*Mergellus albellus*
Snow Bunting	*Plectrophenax nivalis*
Song Thrush	*Turdus philomelos*
Sooty Shearwater	*Puffinus griseus*
Spoonbill	*Platalea leucorodia*
Spotted Flycatcher	*Muscicapa striata*
Starling	*Sturnus vulgaris*

Common Name	Latin Name
Stonechat	*Saxicola rubicola*
Swallow	*Hirundo rustica*
Swift	*Apus apus*
Tawny Owl	*Strix aluco*
Tree Pipit	*Anthus trivialis*
Tree Sparrow	*Passer montanus*
Treecreeper	*Certhia familiaris*
Turnstone	*Arenaria interpres*
Turtle Dove	*Streptopelia turtur*
Twite	*Linaria flavirostris*
Velvet Scoter	*Melanitta fusca*
Water Pipit	*Anthus spinoletta*
Waxwing	*Bombycilla garrulus*
Wheatear	*Oenanthe oenanthe*
Whimbrel	*Numenius phaeopus*
Whinchat	*Saxicola rubetra*
White Wagtail	*Motacilla alba subsp. alba*
White-fronted Goose	*Anser albifrons*
White-spotted Bluethroat	*Luscinia svecica subsp. cyanecula*
White-tailed Eagle	*Haliaeetus albicilla*
Whooper Swan	*Cygnus cygnus*
Wood Warbler	*Phylloscopus sibilatrix*
Woodchat Shrike	*Lanius senator*
Woodlark	*Lullula arborea*
Wren	*Troglodytes troglodytes*
Wryneck	*Jynx torquilla*
Yellow Wagtail	*Motacilla flava*
Yellowhammer	*Emberiza citrinella*

Appendix C Archaeological Desk Based Assessment

Lake Lothing, Lowestoft: Third Crossing

Cultural Heritage Assessment

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Document Control Sheet

Project Title	Lake Lothing, Lowestoft: Third Crossing
Report Title	Cultural Heritage Assessment
Report ref no.	10699948/Heritage
Version	0.3
Status	Final
Report Date	15th December 2015

Record of Issue

Version	Status	Author	Date	Checked by	Date	Approved by	Date
0.1	Draft	A Hancock	03/12/2015	M Roberts	03/12/2015		
0.2	Draft	A Hancock	10/12/2015	S Hales	10/12/2015		
0.3	Final	A Hancock	11/12/2015	S Hales	15/12/2015	S Hales	15/12/2015

Distribution

Date	Organisation	Contact	Format	Copies

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Contents

1 Introduction

1.1 Project background

1.1.1 The third crossing of Lake Lothing ('the Proposed Scheme') comprises construction of a new road crossing at Lake Lothing, a large saltwater lake which opens into the North Sea. The lake measures c.180m at its widest point, and forms the inner harbour of the Port of Lowestoft. Three option alignments for the new crossing have been identified, they are described in Section 7 of this document and are referred to as options C11, W4 and T3.

1.1.2 The project is at early stages of development and detail of the design and construction methods of the proposed crossings is not currently available.

1.1.3 In recent years the area bordering Lake Lothing has suffered greatly from the decline of shipbuilding and other heavy industry, and it has been identified as a key area for regeneration. The Proposed Scheme would support this regeneration by improving access between the south and north of the town and by relieving congestion in, and around the town centre.

1.2 Site location

1.2.1 Lake Lothing separates the north and south of Lowestoft. The A12 forms a north-south route on the eastern (seaward) side, crossing Lake Lothing by means of a bascule bridge. Another north-south route is provided by the A146 and A1177, which crosses Lake Lothing to the west near Oulton Broad by means of a lifting bridge at Mutford Lock.

1.2.2 The two north-south routes are linked by the A1144 and Denmark Road (north of Lake Lothing) and a section of the A146 (south of Lake Lothing).

1.3 Topography and Geology

1.3.1 Lake Lothing is an artificial channel which connects the River Waveney to the North Sea; it is located at the base of a broad, shallow, east-west aligned valley.

1.3.2 The area of the Proposed Scheme lies broadly level at c.3.6m AOD. However, this height is largely artificial, resulting from reclamation and levelling which was completed in the 19th and 20th centuries to form dockside. The levelling deposits overlie deep deposits of Holocene alluvium, including remnants of peat, which was laid down over Pleistocene river sands and gravels.

1.3.3 The solid geology of the Lowestoft area is Jurassic Chalk. A thick deposit of Tertiary London Clay lies above the chalk, the clay is capped by Pliocene and Early Pleistocene sands of the Crag Group, which is capped in turn by a succession of glacigenic tills comprising the Happisburgh Formation (formerly Corton Formation) and the Lowestoft Formation. In the immediate environs of Lake Lothing the till is overlain by marine deposits, river sands and gravels, and peat of Holocene age.

2 Aims and Objectives

2.1 The principal aims and objectives of this report are to:

- Establish the historical and archaeological background of the study area as far as possible through desk based research;
- Map any previously unrecorded features and areas of archaeological potential which may be identified through desk based research or site walkover;
- Assess the archaeological significance of the site, where possible;
- Understand the impact of the proposed scheme upon heritage assets;
- Make recommendations for further archaeological mitigation, where necessary.

2.2 The cultural heritage assessment forms the first stage of an iterative process, which will consider cultural heritage alongside wider scheme issues during development of the Proposed Scheme design. As part of the detailed design process, further archaeological investigations may be required to assess the extent, character and significance of buried remains.

3 Legislative Context

3.1 National and Regional Planning Policy

3.1.1 The requirement for an assessment of heritage is outlined in Policy 128 of the National Planning Policy Framework (NPPF) which outlines the need to identify and assess all heritage assets, their significance and the impact the proposals may have upon them (where possible). The following national and regional legislation, policies, plans and guidelines have been taken into account as part of this study.

Ancient Monuments and Archaeological Areas Act, 1979

3.1.2 This legislation sets out guidance and policy for protecting nationally important monuments through scheduled status. Consent must be obtained from English Heritage for all works on Scheduled Ancient Monuments.

Planning (Listed Building and Conservation Areas) Act 1990

3.1.3 This Act makes provision for the protection and conservation of historic buildings and areas by way of a process of listing and designation. Identified buildings are classified as being Grade I, Grade II* or Grade II by English Heritage and historic areas are designated Conservation Areas by the Secretary of State upon recommendation from the local authority. Once listed, Listed Building consent must be obtained from the local planning authority before works to demolish, alter or extend a Listed Building can be carried out. Similarly, consent must be obtained for the demolition of buildings in a Conservation Area. New developments in a Conservation Area are also expected to adhere to strict design criteria to ensure the character of the area is maintained or enhanced. Developments within proximity of a Conservation Area should also reflect the character of the area.

National Planning Policy Framework (NPPF) 2012

3.1.4 Section 12 of the NPPF sets out policies relating to the conservation and enhancement of the historic environment. Policies include the requirement to assess heritage assets as part of development schemes and to record assets that cannot be conserved as part of the works. This includes both designated and undesignated assets.

Suffolk County Council Environment Policy

3.1.5 Suffolk County Council is committed to the sustainable management of the local and global environment to support Suffolk's communities and growth in the local economy. The Council will strive to achieve the ambition to create the greenest county by tackling the issue of a changing climate, reducing our carbon emissions, and protecting and enhancing the natural and historic environment. In delivering services, the Council is committed to meeting all relevant regulatory, legislative and other requirements, and to the continual improvement of environmental performance

3.2 Local Planning Policy

Waveney Local Development Framework

3.2.1 Waveney District Council adopted the Waveney Local Development Framework in 2009; the framework contains the following policies which address cultural heritage assets:

Core Strategy: Built and Historic Environment. Policy CS 17

3.2.2 The District Council will work with partners and the community to protect and enhance the built and historic environment in the District. Proposals for development are expected to conserve or enhance the character and setting of the following:

- Conservation Areas:- Lowestoft (North and South), Beccles, Bungay, Halesworth, Southwold, Southwold Harbour, Holton, Homersfield, Somerleyton, Wangford, Wissett, Wrentham, and Walberswick (part);
- Listed buildings and locally listed buildings;
- Scheduled ancient monuments;
- Sites of archaeological interest and their settings; and
- The local distinctiveness of existing non-designated built environments.

3.2.3 In particular, proposals in conservation areas will be assessed against the relevant Conservation Area Appraisals and Management Plans.

Lowestoft Lake Lothing and Outer Harbour Action Plan: Heritage Assets. Policy EHC2

3.2.4 New development will reflect, protect and enhance the historic character of Lowestoft as illustrated in Figure

3.2.5 Development within the Lowestoft North and South Conservation Areas will be required to be of high standards of urban design that is complementary to the heritage environment. The character and setting of listed buildings within the Area Action Plan (AAP) will be enhanced and protected by development.

3.2.6 Development proposals should seek to retain and re-use existing listed or locally listed buildings unless it can be demonstrated that demolition would produce substantial benefits for the community in accordance with policy guidance set out in Planning Policy Statement 5 (PPS5: since superseded by the National Planning Policy Framework, NPPF). A historic building appraisal conducted by an individual with appropriate expertise should inform development proposals which potentially affect the setting or appearance of heritage assets.

3.2.7 Proposals involving the demolition of non-listed buildings within the Conservation Areas will be considered if proposals will enhance the overall quality of the Conservation Areas and bring about positive socio-economic benefits.

3.2.8 The redevelopment of the Strategic Sites identified within the Action Plan will require archaeological desk-based assessment, trial trenching and palaeo-environmental assessment, in order to establish the full archaeological implications of any proposals prior to the determination of planning applications. The results of this work will enable the archaeological resource (both in quality and extent) to be accurately quantified.

3.3 Standards and Guidance

3.3.1 The archaeological assessment has been undertaken in accordance with the Standards and Guidance for Historic Environment Desk Based Assessments set by the Chartered Institute for Archaeologists (CIfA) (rev 2014).

3.3.2 The assessment has been undertaken using appropriate methods and practices to satisfy the stated aims of the project, which comply with the Code of Conduct, Code of Approved Practice for the Regulation of Contractual Arrangements in Field Archaeology, and other relevant by-laws of the CIfA.

4 Methodology

4.1 The desk-based study was undertaken to investigate, as far as is reasonable and practical, the nature and extent of any known or potential archaeological and historical assets within a study area encompassing a 500m buffer from the Proposed Scheme alignments. For designated assets, such as Listed Buildings, the study area was also 500m.

4.2 The following were consulted during preparation of this document:

- Historic England (Inspector of Historic Buildings and Areas);
- Suffolk County Council (Senior Archaeological Officer); and
- Waveney District Council (Design and Conservation Officer).

4.3 The assessment has been informed by a review of all available archaeological records; historical documentary evidence; cartographic evidence and photographic material. This has involved a consultation of the following sources:

- Suffolk Historic Environment Record (HER) – for all records relating to known heritage assets and secondary source material including archaeological reports;
- Suffolk Record Office – for all historic maps, and other documentary evidence; and
- Historic England Archive.

4.4 Ordnance Survey (OS) maps from the 1st edition to the present, and any additional relevant historic maps such as tithe and enclosure maps have been examined.

4.5 The solid and drift geology for the site has been identified based on that recorded by the British Geological Survey/Geological Survey of Great Britain Maps.

4.6 A site walkover was conducted, where access and health and safety allowed, to allow for a consideration of the study area, the possible identification of landscape and archaeological features and factors that may have had an impact on buried remains. The site walkover was undertaken on 20th November 2015. Photographs were taken using a digital camera.

4.7 A brief appraisal of designated built heritage assets present within the study area was also undertaken. This involved a visual inspection of the exterior of the buildings.

4.8 All features identified through the research have been located on a site plan in GIS (Figure 1, Appendix B). The site numbers shown on the plan correspond with the reference numbers allocated in the gazetteer (Appendix A).

4.9 An Online Access to Index of Archaeological Investigations (OASIS) project record will be composed following approval of the final report.

5 Historical and Archaeological Background

5.1 Introduction

5.1.1 The study area examines Heritage Assets recorded by the Suffolk Historic Environment Record (HER) within 500m of the Proposed Scheme alignments and designated assets recorded by the Historic England Archive (HEA) within a 500m radius of the Proposed Scheme alignments. A small number of designated and undesignated heritage assets outside the study area have been included in the following sections if they enable better understanding of the heritage context.

5.1.2 The heritage asset data is supplemented with information derived from the Lowestoft URC Area, Cultural Heritage Assessment (Scott Wilson, 2006), the South Lowestoft Conservation Area Character Appraisal (Waveney District Council 2007) and other readily available documentary sources.

5.1.3 A total of 55 heritage assets and 9 previous archaeological investigations have been identified within the study area. Numbers in bold within the report text refer to the heritage assets and events. The assets and events are tabulated in a gazetteer presented in Appendix A and shown on Figure 1 (Appendix B).

5.2 Designated Heritage Assets

5.2.1 There are no World Heritage Sites, Scheduled Monuments, Registered Battlefields or Registered Park and Gardens within the study area.

5.2.2 There is one Listed Building within the study area

- The Beeches: Grade II

5.2.3 One Conservation Areas area is located within the study area:

- Lowestoft South.

5.2.4 Two other Conservation Areas are located in relatively close proximity to the study area:

- Lowestoft North, c.600m northeast;
- Oulton Broad, c.850m west.

Both of the above conservation areas are screened from the Proposed Scheme by the existing built environment and topography and neither is considered in this report.

5.3 Historic Landscape Characterisation

5.3.1 Historic Landscape Characterisation (HLC) has been completed for Suffolk (Suffolk County Council, 2008 V3).

5.3.2 The broad character immediately adjacent to Lake Lothing is current industrial.

5.3.3 Areas of modern leisure and a small parcel of unimproved land are located at the west of the study area. The remaining character comprises the built up area of the post medieval and modern town.

5.4 History and Archaeology

5.4.1 Heritage assets within the study area are described in the context of a timeline of archaeological periods from prehistoric through to modern.

The time periods discussed can be broadly divided as follows:

- Prehistoric:
    - Palaeolithic c.800,000 – 10,000 BC
    - Mesolithic 10,000 – 4,000 BC
    - Neolithic 4,000 – 2,500 BC
    - Bronze Age 2,500 – 700 BC
    - Iron Age 800 BC – AD 43
- Roman AD 43 – 410
- Early Medieval AD 410 – 1066
- Medieval AD 1066 – 1540
- Post-Medieval AD 1540 – 1900
- Modern AD 1900 – present

Palaeolithic

5.4.2 The Palaeolithic era was a period of cold glaciations interspersed with warm interstadials and interglacials. The successive glaciations have removed all archaeological evidence of this period in many parts of Britain, but rare scatters of flint tools and isolated finds of the early part of the period (Lower Palaeolithic) have been discovered in East Anglia.

5.4.3 Investigations of the Cromer Forest Bed Formation (part of the Crag Group) at Pakefield, c.2.5km to the south of the centre of Lowestoft, recovered Lower Palaeolithic worked flints, associated palaeoenvironmental material and animal bone, dated to c.700,000 years BP (Parfitt et al.2005). Other significant sites in East Anglia include Hoxne (c.400,000BP; Stringer et al. 1993), High Lodge, Mildenhall (c. 500,000 years BP; Ashton et al. 1992) and c.800,000 BP human footprints discovered in 2013 at Happisburgh Beach, Norfolk.

5.4.4 One Lower Palaeolithic findspot is recorded in the study area; in the 19th century five early Palaeolithic flints, including one possible handaxe (**63**), were recovered from 'Cannon-shot' gravels at Normanston.

5.5.5 Britain was connected to the rest of Europe by a land bridge in the latter part of this period. Relatively few Upper Palaeolithic sites have been identified in Suffolk although Late Upper Palaeolithic artefacts dated to between c.8,800 and 8,300 BC have been found at Sproughton near Ipswich, (Wymer and Rose 1976)

5.4.6 There is no recorded Upper Palaeolithic evidence within the study area.

Mesolithic

5.4.7 Temperature increased after the end of the last glaciation and the environment gradually changed from tundra to temperate grassland, then open woodland and finally mixed deciduous oak forest. Mesolithic people had a hunting, gathering and fishing economy; their former presence is usually evidenced by scatters of flint tools. The remains of the ephemeral types of structure used by Mesolithic hunter-gatherers are very rarely discovered.

5.4.8 The Mesolithic landscape of the study area is poorly understood, but much of it may have been fen or marshland, an environment suitable for wildfowling and seasonal gathering of other resources. The study area was subject to two episodes of marine transgression during later periods and evidence of transient Mesolithic activity may have been preserved

within or under marine, alluvial and peat deposits, which lie at c.3m-15m below ground level.

5.4.9 However, the study area was subject to extensive medieval and post medieval peat cutting and this may have removed any Mesolithic evidence that was present in the vicinity of Lake Lothing. No evidence of this period is recorded within the study area.

Neolithic

5.4.10 The Neolithic saw the development of agriculture and a more sedentary society. Areas of woodland were cleared for growing crops, animals were domesticated, pottery began to be used, ceremonial and communal funerary monuments were constructed.

5.4.11 Evidence for human activity remains relatively sparse, often comprising scatters of flint tools, such as those found within the study area at Victoria Road, Lowestoft (**2**) and Heath Road, Oulton (**55**). Isolated pits are sometimes found, such as an example found at Walton Road, Lowestoft (**11**), and evidence of small scale burning and woodland clearance is sometimes identified during palaeoenvironmental studies.

5.4.12 The study area saw an episode of marine transgression during the latter part of this period and any early Neolithic evidence located at the lower lying areas will have been buried by marine, alluvial and peat deposits.

5.4.13 Neolithic activity during the marine transgression may have been limited to exploitation of marine and wetland resources at the majority of the study area, This activity may have involved the construction of wooden trackways, use of dugout canoes and fish traps, but medieval and post medieval peat cutting and recent land reclamation may have adversely affected the survival of remains of this period at the majority of the study area.

Bronze Age

5.4.14 The Bronze Age marks the beginning of metallurgy in Britain. Woodland clearance intensified while pastoral and arable farming became the mainstay of the economy. A hierarchical society developed and this is reflected in the construction of individual funerary monuments such as round barrows and cairns. Many lowland barrows have been ploughed out, but they remain the most visible monument of this period.

5.4.15 Bronze Age human activity is often represented by isolated worked flints or flint scatters, but none has been discovered in the study area. Settlement evidence remains relatively rare nationally, but undated cropmarks which may locate Bronze Age features have been identified at slightly higher ground within the study area to the north of Lake Lothing (**38**) and immediately to the south (**45**) of the study area. The southern area of cropmarks includes a possible ring ditch of a Bronze Age burial mound and Bronze Age worked flint has been recovered at this location.

5.4.16 A marine transgression continued to affect the study area during the earlier part of the Bronze Age and human activity at much of the study area was probably limited to exploitation of marine, estuarine and subsequent wetland resources.

5.4.17 A marine transgression during the late Iron Age and Roman periods may have buried and preserved any Bronze Age evidence located at lower lying parts of the study area, but extensive medieval and later peat cutting will have adversely affected its survival.

Iron Age

5.4.18 The study area lay within the tribal territory of the Iceni during the Iron Age. Prevalent monument types include small, sometimes enclosed farmsteads and large hillforts.

5.4.19 A few small towns or "Oppida" developed in the latter part of the period and East Anglian examples are present at Saham Toney, Thetford and Caistor St Edmund.

5.4.20 The majority of the study area probably remained as wet, marginal land until the end of this period when a second marine transgression began. The use of the majority of the study area was probably limited to exploitation of wetland, estuarine and marine resources.

5.4.21 Archaeological remains of the period could be preserved under and within marine and alluvial deposits, but extensive medieval and post medieval peat cutting will have adversely impacted their survival.

5.4.22 No Iron Age features or find spots are recorded at the study area.

Roman

5.4.23 The Romano-British era began with the invasion of the south east of Britain in AD 43. The following four centuries saw the establishment of roads, forts, villa estates, and towns, all supporting a central administration which cemented the Roman occupation of Britain.

5.4.24 A marine transgression affected the study area throughout this period and activity at the majority of the study area may have been limited to exploitation of marine and estuarine resources with some use of marginal drier land at the north and south.

5.4.25 The River Waveney is known to have been used as a communication and trade route, but it is unclear whether the river could be reached from the study area during this period. A possible Roman road from Colchester to Burgh Castle is said to have passed through Lowestoft and archaeological remains tentatively interpreted as part of this road, or an associated bridge, were found during 19th century excavation of peat in the vicinity of the current Bascule Bridge. The evidence comprised several large tree trunks, 10-12 feet in length, laid out parallel and approximately two feet apart.

5.4.26 Five find spots of coins (**1**, **3**, **4**, **53**, **64**) are recorded within or very close to the study area. A coin hoard, a possible cremation urn and the skeletons of a number of horses was found during the 19th century c.200m north east of the study area, at a part of Lowestoft now known as "Roman Hill".

Early Medieval

5.4.27 The Early Medieval period began as the Romans left Britain in AD 410. The early part of the period is often difficult to detect as the prevailing Anglo Saxon settlement pattern was dispersed, short-lived and unenclosed farmsteads, which often focussed on river valleys.

5.4.28 The middle part of the period saw the establishment of longer lived settlements and the latter part saw the establishment of many historic English villages. The majority of the villages surrounding the study area, including Lowestoft and Kirkley, are recorded in the Domesday survey of 1086 (Williams and Martin 2003) and will have been founded by the latter part of this period.

5.4.29 The early focus of Lowestoft is thought to have been located some distance away from the present town centre, perhaps c.900m north of the study area in the vicinity of St Margaret's church. Limited agricultural activity may have been carried out at the north and south of the study area but it is probable that the majority will have remained as marginal land exploited for estuarine and wetland resources

5.4.30 No archaeological evidence of this period is recorded in the study area.

Medieval

5.4.31 Until the latter part of this period the core of Lowestoft may have retained its focus around St Margaret's church, approximately 900m north of the study area. The Domesday Survey of 1086 records rent for land being paid in herrings, which suggests that fishing already formed a significant part of the village economy.

5.4.32 Lowestoft was granted markets in 1308 and 1445 and by the end of the medieval period Lowestoft was a significant fishing port and the most important settlement in the area. The core of the town had moved east by this time to the area of the modern High Street. The southern edge of the medieval town (**5**) was located c.700m to the northeast of the study area.

5.4.33 Lake Lothing is a remnant of a turbary (**13**) - an extensive area of medieval peat cuttings. The speed of the peat cutting and the development of Lake Lothing is currently uncertain, but the eastern end of Lake Lothing including Kirkley Ham inlet was open to the sea by the 14th century (Oppenheim 1907). The northern side of this end of Lake Lothing was known as the Inner Harbour by this time and ships were being constructed on the southern side to the east of Kirkley Ham inlet.

5.4.34 Kirkley Ham inlet and its immediate environs may have been the most important harbour at this part of the coast for a brief part of the 14th century, but the inlet began to silt during the 15th century and by the end of the medieval period the importance of the port at Kirkley had been superseded by that of Lowestoft (Morely 1928).

5.4.35 Archaeological investigations at land located in the vicinity of Kirkley Ham inlet (**12, 15, 16, 57, 59**) have not revealed evidence of medieval activity in the study area and medieval evidence has not been discovered elsewhere.

Post-Medieval

5.4.36 In the post medieval period the port and town of Lowestoft continued to expand and in 1679 the town was granted Port Status, with certain specified rights of export and import. By the beginning of the 18th century up to 25% of men were involved in the fishing industry. The main catch of the fishing fleet comprised herring.

5.4.37 At the end of the 18th century Lowestoft was a moderately sized market town and fishing port with a population of about 2,300. Lowestoft had doubled in size by 1841 and by 1871 the population was over 13,000.

5.4.38 The focus of the port moved to the seaward beaches from 1712 when the mouth of Lake Lothing was closed to the sea by drifting sand. Occasional flood tides broke through the sand bar until 1717, but the lake then remained separated from the sea until harbour works including construction of a customs office known as The Port House (**60**) were completed in 1832.

5.4.39 The government forced the sale of the harbour in 1842 after the harbour works proved ineffective and a loan could not be repaid. The harbour was eventually sold to Sir Samuel Morton Peto in 1844 after which further harbour works were carried out. Mooring for 1000 boats was provided at the outer harbour and permanent access to the Inner Harbour at Lake Lothing was established.

5.4.40 In the latter half of the 19th century Sir Samuel Morton Peto played a leading role in the expansion of the town. He opened a rail link between Lowestoft and Norwich in 1847, with the station located just to the north of the Bascule Bridge. He subsequently built several other railways linking Norwich and Lowestoft to Ipswich and is credited with establishing

Lowestoft as a holiday resort. The investment in the town stimulated the expansion of the town to the south of Lake Lothing and the construction of many grand Victorian buildings including the Grade II* listed Royal Norfolk and Suffolk Yacht Club (**61**).

5.4.41 The study area contained dispersed farms and remained agricultural land until the latter part of the 19th century when the expanding town, port, industry and infrastructure of Lowestoft began to encroach. A manorial survey of 1618 (Butcher 1997) illustrates that the majority of the arable, meadow and heathland had been enclosed by the early 17th century.

5.4.42 A great house surrounded by parkland (**54**) was built at Normanston during this period. It is first shown on 18th century mapping and is named "Normanston Court" on 19th century Ordnance Survey maps. The house and surrounding parkland appear to have remained intact during the first half of the 20th century, but the area of its grounds fronting Normanston Drive began to be developed after the Second World War and the parkland was put to recreational use. The great house may have survived until the late 1960s or early 1970s when it was demolished to make way for housing development.

Modern

5.4.42 Lowestoft continued to see success and expansion into the early part of the 20th century with the fishing fleet, boat building and associated trades being the mainstay of its economy. By 1911 the population had reached 37,886, which reflects the peak in production for the British fishing industry.

5.4.43 Three bulwarks equipped with batteries of cannon had been constructed along the coastline to defend Lowestoft in the early 16th century, but it was 20th century which saw the zenith of military activity at the town.

5.4.44 The First World War saw some of the more capable local boats requisitioned by the Admiralty for patrolling and minesweeping. The town was bombed on a number of occasions, and on 25th April 1916, the German High Sea Fleet shelled the town and harbour leaving forty houses destroyed, two hundred damaged and four people killed.

5.4.45 During the inter war period the fishing industry and the town suffered a decline, but the start of the Second World War saw the town transformed into an important naval base with an all-round defensive perimeter of trenches, pillboxes and dense belts of barbed wire (e.g. **6-10, 18-37, 48**). None of the defences now survive but many of their locations have been recorded by the HER and the Defence of Britain project.

5.4.46 Lowestoft was extensively bombed during the Second World War and much redevelopment was necessary during the post war period.

5.4.47 During the latter part of the 20th century the port remained a focus of shipbuilding and developed as a focal point for operations of the oil and gas industries in the southern North Sea.

6 Archaeological Potential

6.1 Palaeoenvironmental

6.1.1 Very little palaeoenvironmental work has been undertaken within the study area, but limited evidence (GgMS 2013) suggests that peat deposits may survive at either side of Lake Lothing.

6.1.2 Any surviving areas of peat may have been truncated by medieval peat cutting and where preserved it will be located beneath levelling and alluvial deposits at depths of between 3m and 15m below ground level. The peat is likely to preserve evidence of the environment, and could preserve archaeological remains, of the later prehistoric periods.

6.2 Palaeolithic

6.2.1 There is limited evidence of Palaeolithic activity within the study area. However, well preserved evidence of the period (c.700,000 BP) has been discovered at Pakefield c.2.5km to the south within the Cromer Forest Bed Formation. This formation is likely to be present beneath the study area, but will be deeply buried beneath alluvial, marine and glacial deposits.

6.2.2 The proposed development could impact Palaeolithic archaeological remains at spatially constrained areas where deep excavations would be necessary, e.g. where bridge piers would be constructed, but this is unclear with the current level of geological information. The potential for the presence of archaeological remains of this period is **uncertain**.

6.3 Mesolithic to Iron Age

6.3.1 The only definitive evidence for the Mesolithic, Neolithic, Bronze Age or Iron Age periods within the study area are two find spots of Neolithic worked flint and one Neolithic pit. However, activity associated with the exploitation of marine, estuarine and marginal drier environments is likely to have occurred within the study area during all of these periods.

6.3.2 Any evidence may have been destroyed by subsequent extensive medieval peat cutting, or by recent construction of quay sides, industrial buildings and infrastructure. The potential for the presence of archaeological remains of the prehistoric periods is **low**.

6.4 Roman

6.4.1 Roman settlement activity is evident in the wider area and it has been suggested that a Roman Road crossed the eastern end of Lake Lothing in the vicinity of the current Bascule bridge. The River Waveney is known to have been used as a communication and trade route, but it is uncertain if the river could be reached from the vicinity of Lowestoft. Three find spots of Roman coins are recorded within the study area, but other types of evidence have not been identified.

6.4.2 The area was subject to a marine incursion during this period and activity in the vicinity of the alignment options may have been limited to exploitation of marine, estuarine and marginal drier environments. Any such evidence may have been destroyed by medieval peat cutting; recent construction of quay sides, industrial buildings and infrastructure. The potential for the presence of archaeological remains of the Roman period is **low**.

6.5 Early Medieval

6.5.1 Archaeological remains of this period have not been identified within the study area, but the villages of Lowestoft and Kirkley are mentioned in the Domesday Book and evidence

associated with exploitation of marine, estuarine and marginal drier environments could survive at the proposed crossing alignments.

6.5.2 However, any such evidence may have been destroyed by medieval peat cutting, by construction of quay sides, modern industrial buildings and infrastructure. The potential for the presence of archaeological remains of the early medieval period is **low**.

6.6 Medieval

6.6.1 The evidence for this period is limited. The eastern end of Lake Lothing was in use as a harbour by the end of the period, in particular the area near Kirkley Ham may have been the focus of a port and settlement during the 14th century. The majority of the study area was agricultural land and the central part of the study area was subject to extensive peat cutting. The lower lying land is also likely to have been exploited for freshwater fish, shellfish, wildfowl, reeds and pasture / water meadow.

6.6.2 The construction of quay sides, modern industrial buildings, infrastructure and housing will have adversely impacted archaeological remains of this period, and the potential for the survival of medieval remains in the vicinity of the proposed crossing alignments is **low**.

6.7 Post-medieval

6.7.1 The town and port of Lowestoft saw significant growth during the 19th century and the conurbation eventually expanded to the south of Lake Lothing. The eastern end of the lake was used as a harbour, with boat and ship building yards, fish processing, ancillary and manufacturing industries located along each side.

6.7.2 The majority of the study area remained agricultural land, although the great house, “Normanston Court” was built c.250m to the north west of the area where alignments W4 and T3 tie in to Peto Way. The historic parkland and agricultural character of the study area suggests that the potential for the presence of post medieval remains is **low**.

6.8 Modern

6.8.1 Interest in this period relates mainly to the Second World War when Lowestoft was transformed into a naval base with a surrounding defensive perimeter. The above ground evidence for the defences has been removed, but truncated subsurface remnants may survive. The proposed alignments avoid the majority of recorded defences and the potential for the discovery of Second World War archaeological remains is **moderate**.

7 Site Visit

7.1 Introduction

The following is a description of the areas of the alignment options as determined from a site walkover.

7.2 Option C11

7.3.1 The option ties into an existing roundabout on Waveney Drive then extends northward to cross modern commercial and industrial development located to the south of Lake Lothing. At the northern side of the lake it traverses dockside, a railway line and a modern commercial area before tying in to a new roundabout at Denmark Road. Short sections of new road are proposed within the modern development to the south of the lake and upgrades to existing sections of road would also occur.

7.3.2 The area of this option is predominantly industrial, transport and commercial in character (Plate 1, Appendix C) although limited residential buildings are located to the north and south.

7.4 Option W4

7.4.1 The option ties into the existing road network to the south of Lake Lothing at Waveney Drive. From here it traverses land located between a large industrial development and a playing field, then crosses an area of undeveloped reclaimed ground (Plate 2, Appendix C) situated at the southern side of Lake Lothing.

7.4.2 To the north of Lake Lothing it crosses an area of dockside containing late 20th century office and industrial buildings (Plate 3, Appendix C), the railway line, and then enters an area of undeveloped land located at the side of an artificial lake known as Leathes' Ham before tying in to Peto Way at a new roundabout located partly on Normanston Park Sports Ground (Plate 4, Appendix C: formerly parkland of Normanston Court).

7.5 Option T3

7.5.1 The option has a very similar alignment to W4. It ties into the existing road network to the south of Lake Lothing at Waveney Drive. From here it traverses land located between a large industrial development and a playing field, then crosses an area of undeveloped reclaimed ground at the southern side of Lake Lothing.

7.5.2 To the north of Lake Lothing it crosses an area of dockside containing late 20th century office and industrial buildings, the railway line, and then enters an area of undeveloped land before crossing the north east side of an artificial lake known as Leathes' Ham, and subsequently tying in to Peto Way at a new roundabout located on Normanston Park Sports Ground (formerly parkland of Normanston Court)..

8 Cartographic Evidence

8.1 Early Mapping

Early mapping of the Lowestoft area such as Hodskinson's Map of 1783 and Robert Barnes Map of 1830 (Figure 2, Appendix B) show the focus of the town located to the north of the study area and provide some detail of the road layout and villages surrounding Lowestoft. With the exception of the presence of the great house and parkland at Normanston Court, little detail is illustrated at the study area, which suggests that it was undeveloped agricultural, common or marginal land. The Lowestoft (1841), Carlton Colville (1842) and Kirkley Ham (1841) tithe maps show much of the study area as enclosed agricultural fields bisected by two railway lines.

8.2 1885 Ordnance Survey map

The town expanded slightly to the west and to the south across Lake Lothing during the early - mid 19th century. However the study area remained mostly agricultural land; the central option (C11) is situated at an area of enclosed fields located slightly to the west of industrial development at the edge of the town. The eastern options (W4 and T3) are located in the agricultural hinterland of the town except at the north where they are located in the parkland of "Normanston Court" (Figure 3, Appendix B).

8.3 1886 - 1960 Ordnance Survey maps

An additional railway line was constructed to the west of Lowestoft during the late 19th century. The northern part of Lowestoft remained little changed, but Normanston, Mutford Lock and the southern half of the town saw housing and industrial development during the first half of the 20th century (Figure 4, Appendix B). The area of the alignment options remained mostly agricultural land.

8.4 1961 - Modern Ordnance Survey maps

The 1960s mapping (Figure 5, Appendix B) shows that the area between Lowestoft and Normanston had almost completely infilled with housing. Industrial development had also expanded along the southern side of Lake Lothing. "Normanston Court" had been demolished and Lowestoft had reached its modern size by the mid-1970s although limited infill development and regeneration has subsequently occurred.

9 Built Heritage

9.1 Introduction

The following sections use Historic England list entry information, observations made during the site visit, and the South Lowestoft Conservation Area character appraisal (Waveney District Council 2007) to summarise the built heritage situated in proximity to the alignment options and to enable assessment of setting.

9.2 South Lowestoft Conservation Area

The south east of the study area includes a part of the South Lowestoft Conservation Area which encompasses the part of the town which was constructed during its 19th century expansion. The area developed following the establishment of a harbour and river access through Lake Lothing in the early 19th century and grew into a pleasure resort from the mid-19th century onwards. The buildings of the conservation area comprise commercial premises which are focussed at the north around Lake Lothing, large townhouses and villas to the south along the seafront, with areas of lower status terraced housing to the west. The area has a largely linear street plan, laid out parallel to the shore.

9.3 Listed Buildings

9.3.1 There is one Listed Building within the study area:

- The Beeches: Grade II (Plate 5, Appendix C)

It is screened from the alignment options by the existing built environment.

9.3.2 The setting of two other listed buildings would be affected by alignment option C11 and these are:

- The Royal Norfolk and Suffolk Yacht Club: Grade II* (Plate 6, Appendix C); and
- The Port House: Grade II (Plate 7, Appendix C).

9.3.3 The Royal Norfolk and Suffolk Yacht Club was built in 1903 by G & F Skipper, influenced by the arts and crafts style, with rendered and asymmetrical elevations, establishing a high level of architectural quality to the open space (Royal Plain) to its south. The views of the option alignments from the Yacht Club would be limited by the three storey Pier Terrace located slightly to its west, but it is probable that alignment C11 would be clearly visible from its upper floors.

9.3.3 The Port House was constructed in 1831 as the port customs house. Built in gault brick, with slate roofs. It comprises a long south facing two storey range containing sash windows, with a central transept.

9.4 Undesignated Buildings

9.4.1 The setting of a small number of historic buildings of local interest located on the northern side of Lake Lothing would be affected by alignment option C11:

- 3 – 11 Station Square (Plate 8, Appendix C);
- Terraced Houses fronting the north side of Commercial Road from its junction with Station Square (Plate 9, Appendix C);
- A two storey brick built 20th century industrial building located on the north side of Commercial Road (Plate 10, Appendix C); and

- A one storey brick built 20th century industrial building and an iron railway footbridge located on the north side of Commercial Road at the entrance to Associated British Ports land (Plate 11, Appendix C).

9.4.2 The setting of one historic building of local interest located south of the bascule bridge and to the west of the Royal Norfolk and Suffolk Yacht Club would be affected by alignment option C11:

- Pier Terrace (Plate 12, Appendix C).

10 Statement of Significance

10.1 Palaeoenvironmental

There has been limited work on palaeoenvironmental deposits in the study area, which has suggested that there is potential for encountering palaeoenvironmental deposits beneath or within estuarine, marine sands, alluvial or reclamation deposits. The ability to determine the formation processes, sequence and date of such deposits would be of **local** or **regional** importance. Palaeoenvironmental deposits associated with occupation sites would be of particular significance.

10.2 Early Prehistoric

The geology of East Anglia favours the presence and survival of in situ early prehistoric archaeology. Any deposits associated with the Palaeolithic period could be of national or international significance.

10.3 Later Prehistoric

There is limited evidence for the prehistoric periods in the study area. However, peat, marine and alluvial sediments may cover well preserved prehistoric sites. The remains of wooden trackways, platforms, and inter-tidal sites and features, such as boats, fish-traps and salterns could be present. Sites or finds of this nature are likely to be of regional significance.

10.4 Roman

Limited evidence for Roman activity has been discovered within the study area. The discovery of settlement evidence of this period would be of **local** or **regional** significance. The River Waveney was used for river transport in the Roman period and it is possible that evidence for Roman river and sea trade, or military naval activity may be located within the study area. The discovery of such remains would be of **regional** or **national** significance.

10.5 Early Medieval

Lowestoft is mentioned in the Domesday Book but there is no archaeological evidence of this period within the study area. Discovery of remains of this period would be of **local** or **regional** significance.

10.6 Medieval

Evidence related to medieval port activity would be of **regional** or **national** significance, and answer key questions within the regional research agenda regarding the chronological development of the medieval ports of Lowestoft and Kirkley Ham. Recovery of significant assemblages of pottery would contribute to the development of a regional pottery typology (Brown and Glazebrook 2000, 27-29).

10.6 Post-medieval

Evidence related to river and sea transport, the port and railways and discovery of industrial archaeological deposits within the study area would be of **local** or **regional** significance. Archaeological evidence for the chronological development and expansion of the town and agrarian practice would be of **local** significance.

10.7 Modern

Evidence relating to defences of the two World Wars would be of **regional** significance according to the regional research agenda (Brown and Glazebrook 2000, 34).

11 Statement of Impact

11.1 Introduction

The assessment has identified a number of heritage assets close to the alignment options including scattered Neolithic and Roman find spots, commercial and industrial buildings of the late post medieval period and demolished defensive structures of Second World War date. The examination of impact in the following sections is based on the known cultural heritage of the study area.

11.2 Early Prehistoric

There is remote potential for the presence of Lower Palaeolithic evidence. The evidence would be deeply buried and the majority of groundwork during construction of the Proposed Scheme would have no impact on remains of this period. However, areas of deep excavation into or through the Cromer Forest Bed Formation, which may lie above the London Clay, could have a major adverse impact on remains of this period.

11.3 Later Prehistoric

The later prehistoric periods are poorly represented at the study area with only two find spots of Neolithic worked flint and discovery of one Neolithic pit recorded. Remnants of peat containing palaeoenvironmental evidence and archaeological remains of the periods may be present, but is likely to have been removed or have been heavily truncated across much of the area during the medieval period. The limited later prehistoric evidence suggests that the options are unlikely to cause significant adverse impact to sub-surface heritage assets of this period.

11.4 Roman

Known evidence is restricted to a few find spots of coins, which suggests that the options are unlikely to cause significant adverse impact to sub-surface heritage assets of this period.

11.5 Early Medieval

There is no evidence for the early medieval period in the study area. The options are unlikely to cause significant adverse impact to sub-surface heritage assets of this period.

11.6 Medieval

There is no securely dated evidence of this period in the study area and the options are unlikely to cause significant adverse impact to sub-surface heritage assets of this period.

11.7 Post-medieval

Little post medieval evidence has been discovered in the study area and the options are unlikely to cause significant adverse impact to heritage assets of this period.

11.8 Modern

Significant evidence of the modern period would be restricted to the structural remains of Second World War defences and naval bases. The majority of the defensive positions and structures were demolished during the second half of the twentieth century. Any truncated remnants of these features would probably be relatively shallow and groundwork which encountered such remains would have a major adverse impact.

11.9 Built Heritage

Option C11 would impact the setting of The Royal Norfolk and Suffolk Yacht Club (Grade II*), The Port House (Grade II) and a small number of historic buildings of local interest

focussed along Commercial Road and around the bascule bridge. A moderate adverse impact would occur to the setting of the Port House and minor adverse impact to the setting of the Yacht Club. The impact on the setting of some buildings of local interest would be minor adverse although slight beneficial impact could occur where traffic would be diverted away from the eastern end of Commercial Road and the current bascule bridge.

12 Recommendations

12.1 A geoarchaeological deposit model should be compiled to determine the presence or absence and depth of any surviving Cromer Forest Bed Formation deposits, and of peat, marine and alluvial sediments at the option alignments. The results of the deposit modelling should inform the selection of a preferred option

12.2 The impact of the options on the setting of designated and undesignated built heritage should be considered during the option selection and design process.

12.3 Mitigation of the impact of the proposed development would be required in advance of and during construction of a selected option. The scope of the mitigation should be informed by the geoarchaeological deposit model and consideration of the impact on setting and significance of designated and undesignated built heritage.

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Appendix A - Gazetteer of Cultural Heritage Assets

The following table lists the sites and monuments listed in the Suffolk Historic Environment Record and the National Monuments Record as identified through historical references, archaeological investigation, cartographic evidence and aerial photographs. The gazetteer includes all designated and undesignated sites within 500m buffer around the proposed alignments.

* Primary Record Number (PRN) – Suffolk Historic Environment Record

** NMR Reference – National Monuments Record Reference

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
1.	Roman Coin. The Fairfield. Roman Hill	LWT007		TM 5415 9335	Findspot		Third brass of Constantine I (AD307-337)	Low
2.	Neolithic flint. Victoria Road.	LWT016		TM 5285 9225	Findspot		Scatter of small flakes, scrapers and flake from chipped axe	Low
3.	Roman Coins. 108 Bevan Street.	LWT024		TM 5475 9305	Findspot		Four Roman Coins	Low
4.	Roman Coins. Roman Road	LWT027		TM 5450 9327	Findspot		Roman coins found 1877	Low
5.	Lowestoft Medieval Town Core	LWT040		TM 5515 9375	Settlement		Area of archaeological importance defining area of medieval and post medieval town core	High
6.	WWII Anti tank Defences	LWT045		TM 5214 94	Military		The site of an extensive World War Two anti-tank defensive system, consisting of anti-tank	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							cubes, barbed wire obstructions and scaffolding, is visible on aerial photographs surrounding the northern perimeter of Lowestoft, from the Lowestoft Denes to Lake Lothing and Oulton Broad. Now demolished.	
7.	Three WWII road blocks	LWT103		TM 5447 9294	Military		Three World War II road blocks to the north of Lowestoft Docks	Low
8.	WWII road block	LWT104		TM 5400 9296	Military		A road block of World War II date is visible in Hervey Street, Lowestoft on aerial photographs from 1944 (S1). The roadblock is visible as 2 rows of 'dots' which represent the caps covering holes/slots into which posts were slotted to block	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
9.	WWII air raid shelter	LWT105		TM 5403 9293	Civil Defence		Air raid shelter of World War II date, south of Denmark Road, near Lowestoft Docks	Low
10.	WWII air raid shelter	LWT106		TM 5440 9290	Civil Defence		Air raid shelters of World War II date,located south of Denmark Road, close to Lowestoft Docks	Low
11.	Walton Road Neolithic pit	LWT137		TM 5451 9321	Ritual / domestic		Neolithic pit revealed in evaluation in 2002	Low
12.	Former Crown Works shipbuilding and engineering site	LWT151		TM 5424 9254	Event		Photographic survey of extant structures undertaken of the former Crown Works shipbuilding and engineering site in Lowestoft, followed by monitoring, no significant archaeological remains	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							were revealed.	
13.	Lake Lothing	LWT154		TM 5272 9296	Turbary		Lake Lothing, possible remnant of Medieval turbary.	Low
14.	Barnard's Meadow eval	LWT166		TM 5344 9329	Event		Negative evaluation trenching	Low
15.	Land off Clifton Road, Lowestoft; St Matthews Church	LWT176		TM 5436 9216	Event		Site of windmill, buildings and large Mission church (St Matthew's). Evaluation revealed three early modern ditches, one undated ditch associated with site drainage, area of desiccated peat and several large modern pits.	Low
16.	Horn Hill, Lowestoft/Kirkley Drive	LWT180		TM 5429 9238	Event		Negative evaluation trenching	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
17.	St Mary's Water treatment works evaluation	LWT190		TM 5384 9249	Event		Negative evaluation trenching	Low
18.	Site of WWII barrage balloon, air raid shelters and a possible operational building	LWT210		TM 5445 9303	Military		The site of World War Two barrage balloon, earthen-covered air raid shelters and a possible operational building are visible on aerial photographs.	Low
19.	Site of WWII emergency water tank and air raid shelter	LWT211		TM 5414 9297	Military		The site of World War Two emergency water tank and an earthen-covered air raid shelter are visible on aerial photographs.	Low
20.	WWII emergency water tank and road blocks	LWT214		TM 5397 9325	Military		The site of World War Two emergency water tank and road block	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
21.	WWII military buildings and shelters	LWT220		TM 5422 9336	Military		The site of a group of World War Two military buildings, possibly largely accommodation, but potentially also operational buildings are visible on aerial photographs. Large numbers of entrances to sub-surface air raid shelters are also visible.	Low
22.	WWII barrage balloon site	LWT230		TM 5396 9266	Military		The site of World War Two barrage balloon mooring and associated structures is visible on aerial photographs.	Low
23.	WWII barrage balloon site and public air raid shelters	LWT231		TM 5342 9206	Military		The site of a World War Two barrage balloon mooring and public air raid shelters in the grounds of Kirkley High School is visible on	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							aerial photographs	
24.	WWII emergency water tank	LWT232		TM 5336 9222	Civil Defence		The site of a World War Two emergency water tank is visible on aerial photographs	Low
25.	WWII civil defence	LWT233		TM 5309 9231	Civil Defence		The site of a possible World War Two ARP warden's post	Low
26.	WWII pillbox	LWT234		TM 5350 9270	Military		The site of a World War Two a type 22 MSX27408 pillbox is visible on aerial photographs.	Low
27.	WWII defended fuel store	LWT235		TM 5361 9255	Military		The site of a probable fuel storage tank, surrounded by World War Two structures and barbed wire defences, is visible on aerial photographs from 1944-45. Earlier wartime	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							photography indicates that a pillbox and/or gun emplacement stood on this site and a number of slit trenches were visible within this area.	
28.	WWII pillbox	LWT236		TM 5289 9301	Military		The site of a World War Two a type 22 pillbox is visible on aerial photographs.	Low
29.	WWII pillbox and slit trench	LWT237		TM 5308 9284	Military		The site of a World War Two a type 22 pillbox and slit trench is visible on aerial photographs	Low
30.	WWII gun battery	LWT245		TM 5272 9326	Military		The site of World War Two gun battery is visible on aerial photographs camouflaged within a quarry. The rear two gun houses are disguised as huts in 1945. The site	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							consists of four angular 'lozenge' shaped gun emplacements that may have contained field guns. Alongside the battery is large range of buildings, which appear to be largely pre-World War Two in date, with some military structures in amongst them, suggesting that the site is being used for wartime purposes. A raised platform of land, in front of the main building range, has either a trench shelter or an entrance to a sub-surface shelter leading into it. See LWT 280 and LWT 306-307 for similar arrangements of guns protecting Lowestoft.	

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
31.	WWII air raid shelters	LWT246		TM 5346 9315	Civil Defence		The site two World War Two earthen covered air raid shelters, partially camouflaged within allotments, is visible on aerial photographs	Low
32.	WWII barrage balloon site, camouflaged factories and air raid shelters	LWT247		TM 5369 9327	Military		The site of a World War Two barrage balloon mooring, substantial earthen covered communal air raid shelters and an extensive area of camouflaged factories at the Nobel Chemical Finishes Eastern Coach Works are visible on aerial photographs on the site of the North Quay retail park. An unusually long curved profile hut is located along the western side of the factory complex. It	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							is assumed that this has a specialised function, potentially to do with the manufacturing and finishing items or equipment associated with the war effort.	
33.	Probable WWII gun emplacements alongside railway	LWT248		TM 5361 9347	Military		The site of probable World War Two gun emplacements or similar features are visible on aerial photographs alongside railway line.	Low
34.	WWII pillbox and other defensive structures	LWT249		TM 5358 9362	Military		The site of a former World War Two type 22 pillbox and other defensive structures and temporary training activity are on aerial photographs. These formed part ofthe wider system of defences recorded under LWT	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							045.	
35.	WWII pillbox	LWT250		TM 5345 9355	Military		The site of a former World War Two a type 22 pillbox is visible on aerial photographs. The pillbox is located near to the barbed wire system to the north of Lowestoft (LWT 045) and forms part of this defensive system (LWT 309	Low
36.	WWII huts and camouflaged buildings	LWT252		TM 5268 9307	Military		The site of an area of World War Two huts, potentially nissen huts, and camouflaged buildings are visible on aerial photographs near the slipways and quayside alongside Lake Lothing. Although the camouflaged buildings may be industrial or associated	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							with the workings of the port and shipping, it is possible that they be serving a military or naval function.	
37.	Possible WWII pillbox	LWT255		TM 5394 9338	Military		The site of a World War Two a type 22 pillbox is visible on aerial photographs	Low
38.	Cropmarks of multi-phase ditches and boundaries	LWT285		TM 5342 9340	Cropmarks		The cropmarks of a fragmentary and multiphase ditches and boundaries of unknown date, but potentially including elements of late prehistoric, Roman and medieval to post medieval date, are visible on aerial photographs. Although it must be noted that some of the cropmarks could feasibly relate to	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							non-archaeological subsurface features such as geology and/or drainage	
39.	WWII bomb craters	LWT292		TM 5315 9322	Military		The site of a pair of probable World War Two bomb craters are visible on aerial photographs within Leathes' Ham	Low
40.	WWII Naval Base, HMS Myloden	LWT297		TM 5289 9265	Military		The site of World War Two Naval Base, HMS Myloden, to the south of Lake Lothing Lowestoft, is visible on aerial photographs. The base, which undertook Landing Craft Training for RM Commandos and Combined Operations, was located within the site of the old Silk Factory which is located	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							alongside the waterfront. Practical training was carried out at sea with craft regularly in transit on exercise between the base, Great Yarmouth and HMS Wolverstone, another landing craft training establishment on the Orwell	
41.	WWII bomb craters	LWT298		TM 5305 9267	Military		The site of a probable World War Two bomb craters is visible on aerial photographs. These may relate to aerial bombardment of the docks or the Naval site to the immediate west (LWT 297).	Low
42.	WWII bomb craters	LWT299		TM 5357 9184	Military		A line of World War Two bomb craters is visible on aerial photographs.	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
43.	World War Two pillbox and possible civil defence site	LWT300		TM 5394 9243	Military		The site of a World War Two type 22 pillbox and another structure is visible on aerial photographs. The second structure is square with a possible associated blast wall and may have been in use as a defensive structure or a check point. It is however visible on an oblique aerial photograph taken in 1928, indicating that it pre-dates the Second World War, but may have been added to during this period.	Low
44.	World War Two air raid shelters and other possible military/civil	LWT301		TM 5398 9195	Military		The site of a World War Two air raid shelters, and other possible military/civil defence structures, is visible on	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
	defence structures						aerial photographs	
45.	Cropmarks of multi phase ditches	LWT304		TM 5280 9176	Cropmarks		The cropmarks of a dispersed group of multiphase ditches and field boundaries are visible on aerial photographs. The date of these features could potentially range from the later prehistoric to medieval to post medieval period. See LWT 308 for possible Bronze Age round barrow within area of the site.	Low
46.	WWII gun battery	LWT306		TM 5282 9217	Military		The site of World War Two gun battery is visible on aerial photographs, partially camouflaged within a quarry and area of	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							rough ground. The site consists of two angular 'lozenge' shaped gun emplacements that are likely to have contained field guns. Similar sites in other parts of the country were constructed out of sandbags filled with concrete and with a concrete roof placed on the top). It is impossible to tell from the aerial photographs whether these are of a comparable construction. This site, along with the nearby LWT 307, formed a line of defence on the south side of Lowestoft. Another two arrangements of guns (LWT 245, LWT 280)	

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							protect the north.	
47.	WWII gun battery	LWT307		TM 5303 9191	Military		The site of World War Two gun battery is visible on aerial photographs, partially camouflaged within areas of rough ground, cultivation and extraction. The site consists of at least two angular 'lozenge' shaped gun emplacements that are likely to have contained field guns. An additional three rectangular structures are suggested by the aerial photographs, although they are not as conclusive, as the more characteristic gun houses, and may be temporary shelters.	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							Similar batteries in other parts of the country were constructed out of sandbags filled with concrete and with a concrete roof placed on the top. It is impossible to tell from the aerial photographs whether these are of a comparable construction, although they do appear to be of fairly temporary construction, judging by the appearance of the site immediately post-war. This site, along with the nearby LWT 306, formed a line of defence on the south side of Lowestoft. Another two arrangements of guns (LWT 245, LWT 280) protect the north.	

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
48.	WWII defensive system	LWT309		TM 5278 9295	Military		A major World War Two defensive system, consisting of anti-tank ditch system, barbed wire obstructions, antitank scaffolding and lines of anti-tank cubes, and associated defences, including pillboxes, gun emplacements, slit trenches and weapons pits, is visible on aerial photographs encircling Lowestoft and running along this section of the East Coast from Corton to Pakefield. The defence is split into two sections, with Lake Lothing and Oulton Broad forming a natural break in the defensive line. The northern section surrounds the	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							northern perimeter of Lowestoft, from the Lowestoft Denes to Lake Lothing and Oulton Broad (LWT 045) and then runs south from Oulton Broad Lowestoft to Pakefield (LWT 284).	
49.	Possible post medieval remains	LWT318		TM 5356 9307	Settlement		The slight earthworks and possibly low structural remains and/ or exposed foundations of probable post medieval date may be visible on aerial photographs. The Ordnance Survey First Edition map indicates possible structures in this vicinity and it was therefore decided that these features probably related to ephemeral post medieval	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							structures, perhaps relating to industrial or horticultural activity and were therefore not mapped	
50.	WWII bunker	LWT319		TM 5386 9304	Military		The site of a World War two structure surrounded by a substantial blast wall, and some other structures and trenches, are visible on aerial photographs to the north of North Quay. Although it is possible that this is a large, well protected air raid shelter, it seems more likely that this represented an important operational building for either military or civil defence.	Low
51.	Land at the	LWT330		TM 5280 9260	Event		Negative evaluation	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
	former Sanyo site, School Road						trenching	
52.	Polished flint axe	LWT333		TM 5296 9245	Findspot		-	Low
53.	Roman coins	LWT334		TM 5442 9312	Findspot		-	Low
54.	Normanston	LWTMisc		TM 5315 9355	Domestic: Manor House		Great House shown on Bowen's 1755 (S1) and Hodskinson's 1783 maps (S2)	Low
55.	Heath Road, Oulton	OUL013		TM 5296 9245	Findspot		Probably related to Mouchel Ref No: 52. Drawing of butt half of a Neolithic polished axehead with description. Found in 1996. (S1).	Low
56.	Former Brook Marine Site	ESF21504		TM 5304 9288	Event		Desk based assessment	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
57.	Marstons Pub, Horn Hill	ESF21518		TM 5428 9238	Event		Negative monitoring	Low
58.	Land off Canning Road	ESF22240		TM 5376 9257	Event		Negative evaluation	Low
59.	Southern Relief Road. SCCAS Monitoring	ESF19727		TM 533 914	Event		Negative monitoring of southern relief road	Low
60.	Port House, North Quay		1292511	TM 5472 9275		Grade II	Offices, formerly Customs house. 1831. Gault brick. Slate roofs. 2 storeys. Long range facing south with a central transept. Transept lit through one 6/6 sash each floor to south and similar fenestration to east and west returns. Hipped roof. To right of transept are 5 ground-floor 6/6 sashes, two C20 ones in blocked doorways.	Medium

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							Three 6/6 sashes to first floor. All sashes have gauged skewback arches. Three 6/6 sashes to first floor left of transept, some replaced. Central doorway flanked by one 6/6 sash either side to ground floor. Shallow hipped roof with 5 stacks, all set to the left. The east return forms the entrance: 4 bays. Late C20 gabled porch in second bay (from left), with a pediment. One 6/6 sash left, 2 right, all with gauged skewback arches. 4 identical first-floor sashes. INTERIOR. Open well staircase at the west end: 2 turned balusters to each tread,	

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							moulded handrail and heavy turned newels with ball finials. Interior otherwise modernised for office use.	
61.	Royal Norfolk And Suffolk Yacht Club, Royal Plain		1207043	TM 5480 9261		Grade II*	Purpose-built yacht club. 1902-3 by G & F Skipper of Norwich. Rendered and whitewashed brick under plaintile roofs. Very advanced design for its date. L-shaped, with an engaged tower in the inner angle opposing a square observation room at the top of the outer angle. 2-3 storeys. The south front is composed of a 3-storey, 3-bay square block with the observation room at the top. In the centre is a	High

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							low entrance porch with a panelled and glazed door flanked by a 3-light semi-circular window with glazing bars either side. The windows above are casements of varying design. At the first floor is a moulded brick panel with a sailing ship moulded in high relief brick. The observation room is glazed all round under a copper dome. To the right is a 2-storey wing under a half-hipped roof with a further semi-circular-headed casement to the ground floor and three windows to the first floor: 2 round-headed casements with balconies and, to the left, a canted bay	

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							window. The east elevation is lit through a large segmental sash with 18/18 glazing bars, and the upper storey through 3 circular windows with casements. The hip of the roof is pierced by a triangular sash with glazing bars. The north side has, between the arms of the L, a curved and glazed single-storey bow. Behind it rises the 3-storey engaged round tower illuminated through casements to the first floor and a band of brick-dressed lights at the second floor. The hipped northern arm of the L has casements with glazing bars. INTERIOR. The	

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							entrance leads into a square central hall partly top-lit from an open ceiling well into the first floor. A concave wall separates the hall from the bar to the north-east, which is entered through bowed double doors with glazing. The restaurant in the north-west corner has double muntin doors with leaded and glazed upper panels and a segmental overlight. The closed-string staircase has tall square newels tapering above the handrail and terminating in saucer finials, in a style being developed by Voysey. Reeded balusters. The first floor has an octagonal open	

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							well looking into the ground-floor hall and protected by a reeded balustrade. The doors to the 2 principal rooms are of muntin type with stained glass panels. The north room also has a fireplace with a 3-panel overmantel. (Goodey C: 120 Years of Sailing: Beccles: 1980-: P.12).	
62.	The Beeches, 16 High Beech		1207021	TM 5362 9388		Grade II	Formerly known as: The Beccles Normanston Drive. House, now flats. Early C19. Gault brick, rendered to returns and rear. Double-depth plan with slate to the front range and pantiles to the rear. Facade is to the south. 2 storeys in 3 bays. Central full-height	Medium

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							bow opened to the ground floor to form a porch defined by a pair of fluted Greek Doric columns. The door is C20 half-glazed under a rectangular overlight. Above the door is a 6/6 curved sash under a gauged skewback arch. One similar, though flat, sash to each floor either side of the bow. Projecting eaves. Gabled roof over which shows a pair of gault-brick stacks set in the valley between the 2 piles. The left-hand (west) stack reduced in height following gale damage 1987. Against the east and west returns are C20 single-storey extensions. The	

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							rear elevation is irregular: C20 glazed door right of centre, one early C19 6/6 sash ground-floor left, another first-floor right, remainder are C20 sashes or casements. Dentil eaves cornice. INTERIOR. Open string stick-baluster staircase with a ramped and wreathed handrail. The rear section has chamfered bridging beams.	
63.	Palaeolithic handaxes from Cannon Shot gravels	MSF15299		TM 53 93	FIndspot		Normanston: In his review of Palaeolithic implements of East Suffolk, W A Dutt (1908) illustrates five flints from `Cannon-shot' gravels at 27m OD, found in a pit a few 100m north of the	Low

Mouchel Reference Number	Site Name	PRN*	NMR Reference**	Grid Reference	Site Type	Designation	Description	Value
							main road from Lowestoft to Oulton Broad. These have not been traced, but form the drawing they appear genuine, one possibly a hand-axe. Some were rejected, but others were accepted by W G Clarke and A S Kennard	
64.	Roman coin found at Normanston Park	-	-	-	Findspot	-	Findspot of Roman coin recorded in Proceedings of the Suffolk Institute of Archaeology 1975 (33)	Low

Appendix B – Figures

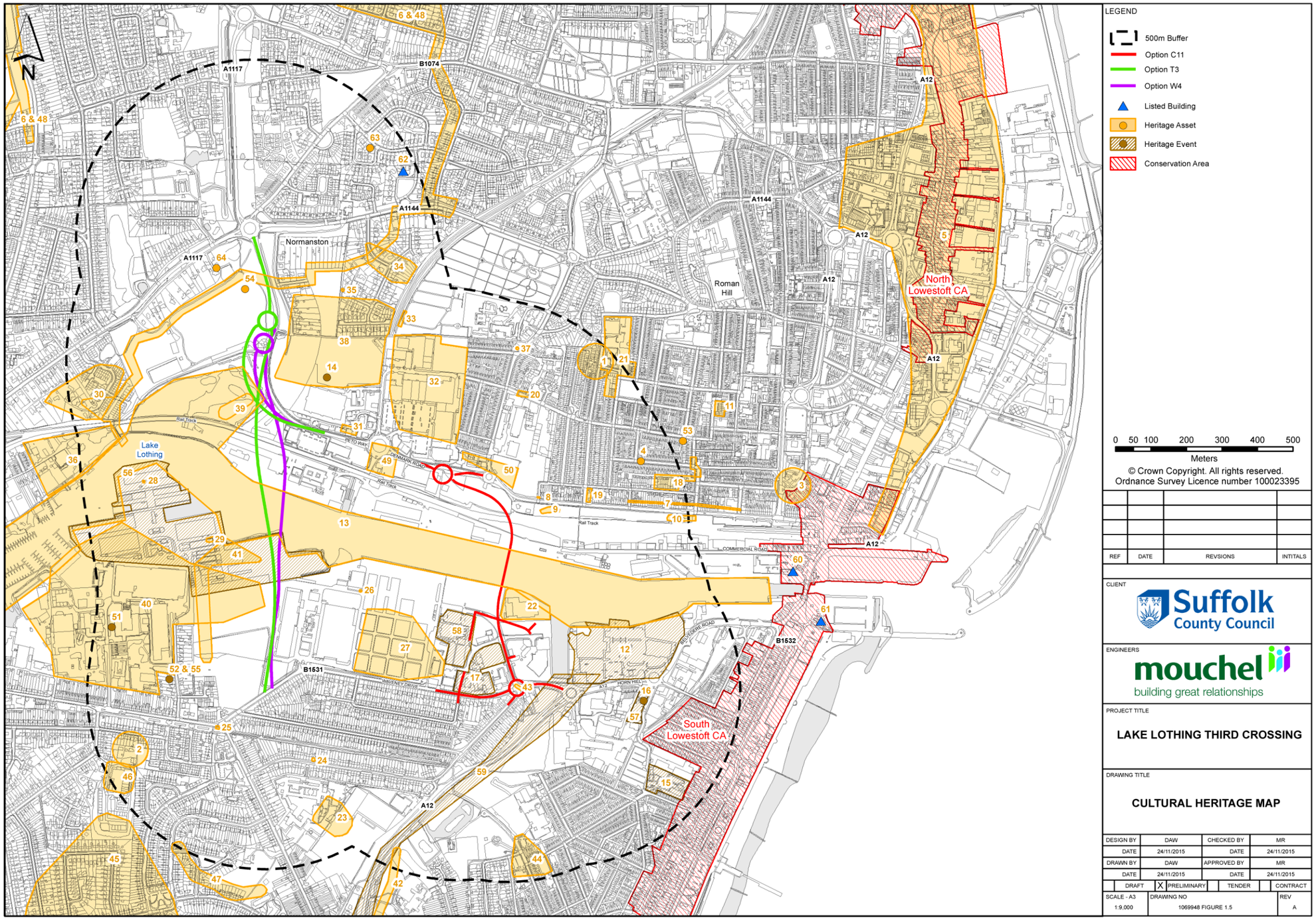

Figure 1: Location of heritage assets and events

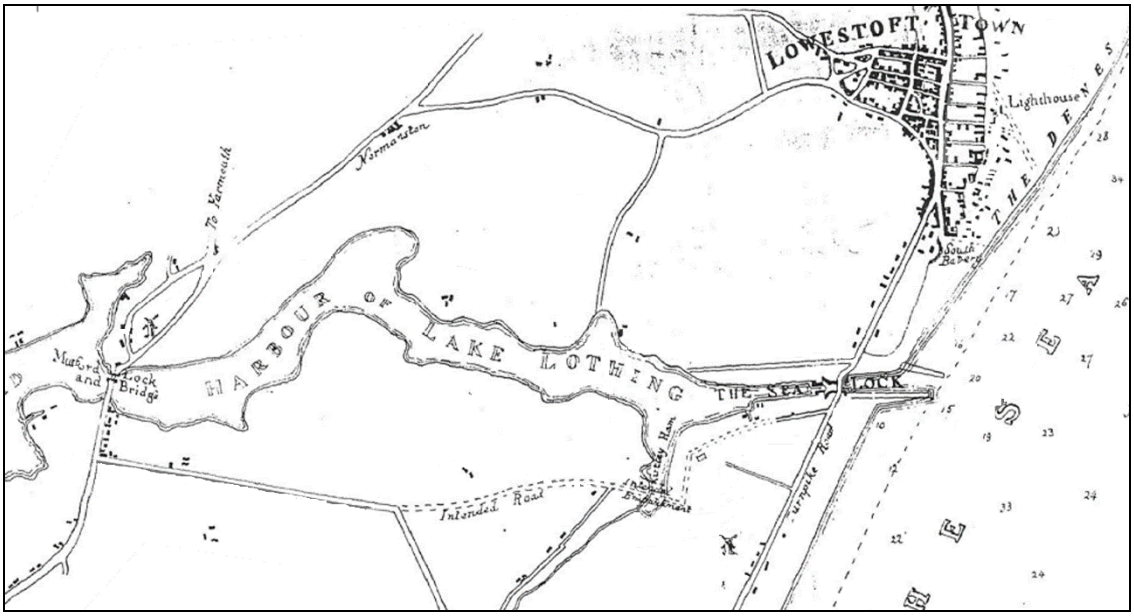

Figure 2: Extract from Map of 1830 by Robert Barnes

Figure 3: Extract from 1885 Ordnance Survey Map

Figure 4: Extract from 1906 Ordnance Survey map

Figure 5: Extract from 1964 Ordnance Survey map

Appendix C - Plates

Plate 1: Lake Lothing, looking west from vicinity of option C11

Plate 2: Lake Lothing, looking south west to reclaimed ground from area of option W4 and T3

Plate 3: Lake Lothing, looking north from vicinity of option W4 and T3

Plate 4: Lake Lothing, looking north west to Normanston Park from area of option W4 and T3

Plate 5: The Beeches: Grade II

Plate 6: The Royal Norfolk and Suffolk Yacht Club: Grade II*

Plate 7: The Port House: Grade II

Plate 8: 3 – 11 Station Square

Plate 9: Terrace at north side of Commercial Road

Plate 10: Two storey 20th century industrial building on north side of Commercial Road

Plate 11: One storey 20th century industrial building on north side of Commercial Road

Plate 12: Pier Terrace