A1 in Northumberland: Morpeth to Ellingham

Scheme Number: TR010041

6.7 Environmental Statement – Appendix 11.1 Preliminary Sources Study Report

Part A

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

June 2020

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

The A1 in Northumberland: Morpeth to Ellingham
Development Consent Order 20[xx]

Environmental Statement - Appendix

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Preliminary Sources Study Report

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1 Introduction

In 2016, Jacobs were employed by Highways England (HE) to take the design of the Upgrade to the A1 to a continuous dual carriageway between Morpeth and Ellingham, Northumberland according to the Project Control Framework (PCF) Stage 2 Option development.

The A1 Northumberland is the main link road through Northumberland to the North East of Newcastle, connecting England to Scotland and forms part of the Department for Transport's (DfT) Roads Investment Strategy (RIS). The purpose of the scheme is to address key issues with the existing arrangements that affect the performance of the A1 north of Newcastle Upon Tyne and its ability to perform as a 'Route of Strategic National Importance'.

Figure 1-1 Northumberland location

As part of the DfT First Roads Investment Strategy, options are being considered and developed for the following programme of improvements:

- **A1 Morpeth to Ellingham** – thirteen miles of upgrade to dual the carriageway linking the Morpeth and Alnwick bypasses with the dual carriageway near Ellingham, to create a continuous, high-quality dual carriageway from Newcastle to Ellingham. This involves:
  - Morpeth to Felton offline and online dualling options.
  - Alnwick to Ellingham online dualling option.
- **A1 North of Ellingham enhancements** – a set of measures to enhance the performance and safety of the A1 north of Ellingham, including:
  - Three stretches of climbing lanes totalling 2.5 miles.
  - Five junctions enhanced with right turning refuges.
  - Better crossing facilities for pedestrians and cyclists.

This programme will involve the preparation of three 'Preliminary Sources Study Reports' (PSSR). These are in accordance with HD22/08, as described in the Statement of Intent, as follows;

- **Section A – Morpeth to Felton.**
- Section B – Alnwick to Ellingham.
- Section C – North of Ellingham.

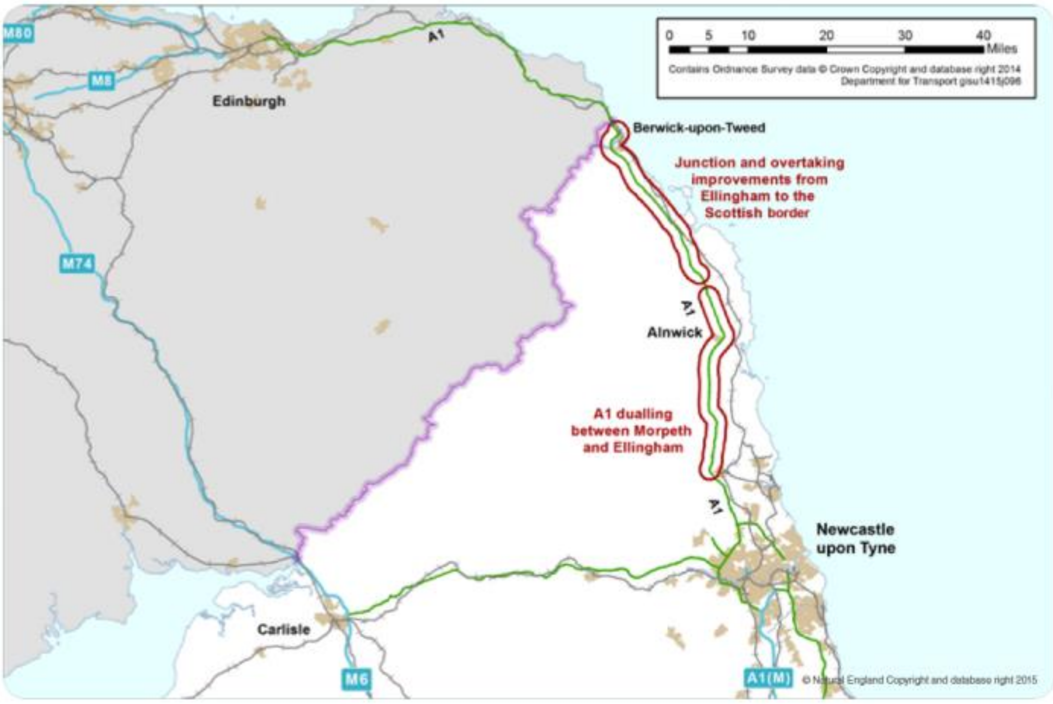

Plate 1-2 Location of improvements From Newcastle to Berwick (DFT)

This PSSR is for the southern section **Morpeth to Felton, Section A**.

Sections B and C are reported separately. This report is concerned with:

- Section A – Orange online option
- Section A – Blue Route hybrid (mainly online with some offline) option
- Section A – Green offline option

An overview of the scheme is provided in Appendix A including site location maps for each section, Figure A1, A26, A27 and A28.

The route passes through predominantly agricultural land with significant past mining activity to the east of the options. This project aims to increase capacity, reduce journey times, improve safety, facilitate future economic growth in Northumberland and improve local access junctions and interchanges along the A1.

1.1. Document Purpose and Structure

This report presents the PSSR for Section A - A1 in Northumberland, Morpeth to Felton improvements, and has been produced for HE in accordance with the Design Manual for Roads and Bridges Vol 4 Section 1 Part 2, HD22/08, Managing Geotechnical Risks.

The report contains a description of the site based upon site visits, historical mapping and published information followed by a description of the engineering proposals for the route options culminating in a ground model and risk register based upon published historical information.

Annex A to the PSSR is present separately to this document (HAGDMS No. 29387).

2 Sources of Information

Table 2-1 Sources of Information

Source	Description	Provenance
Online	DiGMapGB – 10, superficial and bedrock geological maps (Reference 3)	Unverified
Online	DiGMapGB – 50, superficial and bedrock geological maps (Reference 3)	Unverified
British Geological Survey	Solid Geology 1:63,360 scale Map 9 – Rothbury (1966) (Reference 4)	BGS publication
	Solid and Drift Geology 1:50,000 scale Map 9 – Rothbury (2003) (Reference 5)	BGS Revision
	Geology of the Country around Rothbury, Amble and Ashington (1935). Geological Memoir. (Reference 6)	BGS publication
Environment Agency On line	What's in my backyard? – Online database and mapping (Accessed October 2016). (Reference 7)	EA free to view
Zetica Ltd.	Pre Desk Study Assessment Ordnance database – October 2016. (Reference 8)	Commercial Database
Zetica Ltd.	Detailed Desk Study Assessment Ordnance Report – November 2016. (Reference 8)	Commercial Assessment
Coal Authority	Mine Risk Assessment Coal Authority desk study (CON 29M). (Appendix I)	Statutory Authority Report
Groundsure Ltd	Digital Mapping and reporting GIS data obtained for Figures in Appendix A and Appendix B.	Commercial mapping
Highways Agency Geotechnical Data Management System (HAGDMS)	Bullen Consultants PSSR A1 Morpeth to Felton (2004). (Reference 9) (HAGDMS No. 19699)	Geotechnical Certification
	Laing O Rourke / WYG PSSR A1 Morpeth to Felton Dualling (2006). (Reference 10) (HAGDMS No. 20917)	Geotechnical Certification
	Halcrow (2007) A1 Alnwick to Morpeth Defect report. (HAGDMS No. 21674)	Independent Report
	Halcrow (2008) Geotechnical Asset Management Plan. (HAGDMS 21876)	Independent Report
	Norwest Holst (NHSED) (2006) Stage 1 Ground Investigation NOTE: Detailed in Table 3.1. (HAGDMS No. 20918)	Geotechnical Certification
	Halcrow (2010) Statement of Intent, A1(T) Morpeth Bypass, Detailed in Table 3.1. (HAGDMS No. 25181)	Unknown
	AOne+ Integrated Highway Services (2014) Geotechnical Report, A1 Morpeth to Alnwick PTI Phase 2 – Tritlington SB Lay-by Improvements. (HAGDMS No. 28140) (Reference 14)	Geotechnical Report
AOne+ Integrated Highway Services	Asset Management Data (see Table 4.1)	Work in progress
Scott Doherty Associates	A1 South-East Northumberland Link Road, A1 Interchange to How Burn Crossing, Interpretive Report (1997).	Geotechnical Certification
Jacobs	Jacobs, A1 in Northumberland Statement of Intent (2015). (Reference 2) (HAGDMS No. 28835)	Geotechnical Certification
Site Investigation River Coquet, Felton	Tarmac Construction Limited Central, 1974. Detailed in Table 3.1. (HAGDMS No. 3378). (Reference 13)	Pre-Geotechnical Certification
Google	Google Earth satellite view for current conditions from 2002 to 2015 (Accessed 2016). (Reference 14)	Photograph Free to view

3 Field Studies

3.1 Site Walkover

A site walkover of the A1 Section A, Morpeth to Felton route was conducted on Tuesday 25th October 2016. The aims of the visit were to observe the local topography and geomorphology, the ground conditions and the existing structures and assess site constraints that may influence the geotechnical risks identified in the Geotechnical Risk Register from Statement of Intent, PCF Stage 1. The walkover considered the site constraints for the online and offline options.

For health and safety reasons the site was accessed by car to drive between 16No. stopping points located on the northbound and southbound sides of the A1 and on side roads between Morpeth and Felton. Stopping points positions are shown in Figure 3-1. A summary is present here with a more detailed observation in Appendix H.

3.2 Site Observations

Land adjacent to the carriageway is arable farmland for most of the route. Where residential, educational and commercial properties occur, they are commonly at junctions with side roads. The carriageway follows the undulating topography and the alignment is at grade with the adjacent land (Plate 3-1) as far as can be discerned on account of thick vegetation including mature trees.

Plate 3.1 Stop 1 (approx. Ch. 1500m) looking south from a lay-by on the west of the road.

Hedgerows and crops with occasional trees line the road. All options pass through woodland near Floodgate Burn (Stop 3, Plate 3.2), Long dike Burn and the River Coquet (Stop 11, Plate 3.3).

Plate 3.2 Stop 3 (approx. Ch. 3600m) looking south the lay-by on the west on the carriageway.

Plate 3.3 Stop 11 (approx. Ch. 12800m) View from the footpath north bank, River Coquet looking south underneath the bridge.

Stop 5 is located on Fenrother Lane at the location of the proposed offline option, approximately 0.5km west of the A1. The topography is undulating and falls to the south (Plate 3.4). The proposed junction between the offline option and Fenrother Lane will require earthworks to accommodate the overbridge.

Plate 3.4 Stop 5 (approx. Ch. 5000m) looking east on Fenrother Lane. Topography is undulating and falls to the south.

The River Coquet is in a steep sided valley and a new bridge is required to accommodate the dualling of the A1. All options are online at this location. A visual inspection of the valley slopes was made from the footpath on the northern slope of the river between Felton and the A1.

Slopes are densely vegetated which limits the inspection area to the slopes close to the footpath. Several slips were observed parallel to the footpath at the top of the valley in the superficial glacial deposits. Scarp features and slumped blocks are observed on the southern edge of the footpath (Plate 3.5).

The gradient of the northern slope is approximately 1V:2H about 100m east of the River Coquet Bridge, as shown in Plate 3.6.

Plate 3.5 Stop 11 (approx. Ch. 12800m) View from the footpath on the north side of the River Coquet looking south east.

Plate 3.6 Stop 11 (approx. Ch. 12800m) View from the footpath on the north side of the River Coquet looking west to the River Coquet bridge.

Slopes have been re-graded and dense vegetation has been removed to accommodate the existing bridge piers and abutments (Plate 3.7). No signs of instability were observed on the slopes next to the bridge.

Plate 3.7 Stop 11 (approx. Ch. 12800m) View of the east side of River Coquet Bridge abutment on the north slope.

Plate 3.8 Stop 11 (approx. Ch. 12800m) View south of the River Coquet Bridge piers from the footpath on the North Slope.

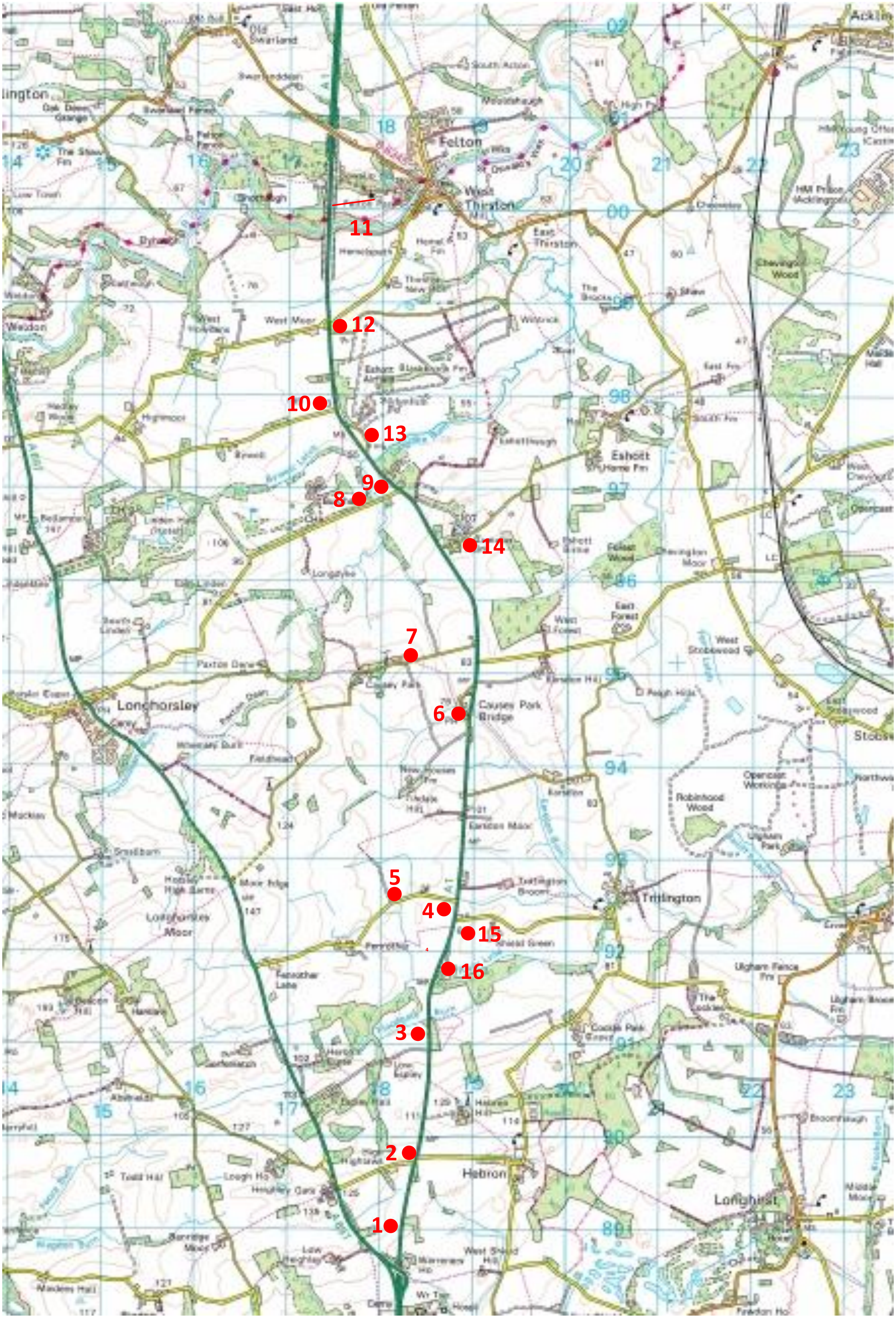

Figure 3-1 Site walkover stopping locations. Ordnance Survey ©.

Limited geomorphological observations were noted within the site walkover survey.

Geomorphological mapping was completed as part of the 2006 PSSR. A review has been undertaken and particular account is taken to the section considering the risks identified in relation to the northern bank-seat of the River Coquet Bridge. The geomorphological map is presented as Appendix D.

No drainage studies have been completed as part of the fieldwork for this PSSR.

No geophysical surveys have been completed as part of the fieldwork for this PSSR. As part of previous investigations magnetic gradiometer surveys have been completed by Durham University Archaeological Services. These totalled 37 hectares completed to identify archaeological features. The locations of these features form part of a different report that has not been available.

Photographs were taken as part of the walkover survey to emphasise particular features relevant to the geotechnical aspects of the scheme. These are presented for completeness in Appendix H) and may be of value, e.g. visual record of field access and routes required to undertake ground investigation fieldwork, in the future.

Aerial photographs have not been obtained directly for this PSSR. Satellite imagery from Google Earth has been used to inspect the area and note any changes evident between the dates of the most recent OS published plan and the imagery.

No significant discernible geo-hazards are identified although thick vegetation along the route makes such observation difficult.

4 Site Description

4.1 Scheme Description

The Morpeth to Felton improvement, Section A, consists of upgrading the single carriageway to a two lane dual carriageway. The options presented at PCF Stage 2 consist of three alternative alignments as follows:

- Online widening, Orange route
- Offline widening, Green route
- A combination of both online and offline widening, Blue route.

The options are shown in Appendix A on Figures A1 – A3 with summaries of the routes shown on the geotechnical aspects plan in Figure A4. Detailed engineering description of the options is presented in the PCF Phase 1, Technical Appraisal Report. Within the confines of the existing route the majority of the road is at grade consisting of minor earthworks. There are a number of stream crossings including the deeply incised River Coquet (Ch. 12750m).

The existing highway asset categorisation follows the guidance presented in HMRB HD 41/15 defining earthworks as minor to a maximum vertical height of less than 2.5m and major earthworks are to a height greater than or equal to 2.5m.

The scheme is within the Highways Maintenance Area 14, currently managed by AOne+ plus on behalf of the HE. Part of their role is to inspect, categorise in terms of asset condition and maintain the earthworks (cuttings and embankments).

The risk rating methodology is described within Plate 4-1.

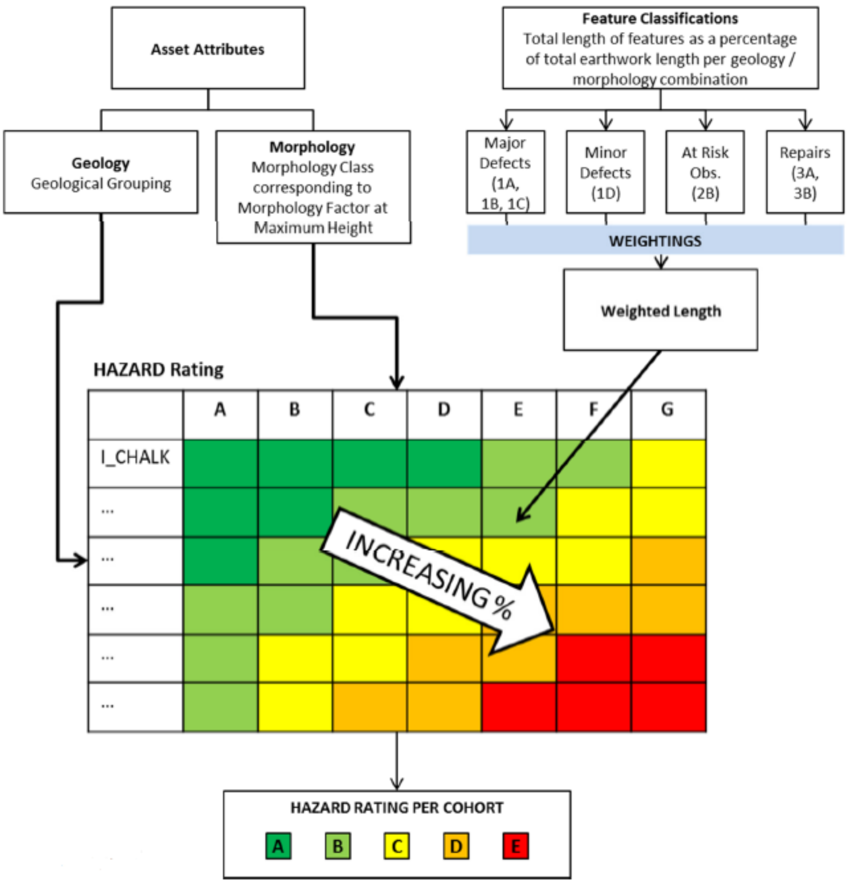

Plate 4-1 - Risk classification for earthworks within Highways England

The current category (obtained from HAGDMS) is summarised in Table 4-1.

The scheme extends from Chainage 0m, at National Grid Reference (NGR) 418198E, 587649N to Chainage 13700m, at NGR 417480E, 600753N.

Table 4-1 Current Earthwork condition relating to defined hazard scores from HAGDMS

Chainage from (m)	Chainage to (m)	Hazard Rating	Location and type of earthworks
0	1000	N/A	Outside proposed design
1000	2000	A	Minor, Northbound & Southbound
2000	3000	A	Minor, Northbound & Southbound
3000	4000	A	Minor, Northbound & Southbound
4000	5000	A	Minor, Northbound & Southbound
5000	6000	A	Minor, Northbound & Southbound
6000	6800	A	Minor, Northbound & Southbound
6800	7000	Bridge	Cutting Northbound & Southbound
7000	8000	A	Minor, Northbound & Southbound
8000	9000	A	Minor, Northbound & Southbound
9000	10000	A	Minor, Northbound & Southbound
10000	11000	A	Minor, Northbound & Southbound
11000	12000	A	Minor, Northbound & Southbound
12000	12650	B/C	Cutting Northbound / Southbound
12650	12720	Bridge	Minor, Northbound & Southbound
12720	13200	C/B	Cutting Northbound / Southbound
13200	13500	A/B	Embankment Northbound / Southbound
13500	13800	B/C	Cutting Northbound / Southbound

The north and south sides of the River Coquet Bridge are the poorest quality earthworks within the whole route but are themselves of moderate concern (Class C).

A geotechnical aspects plan showing the alignment of the three route options is provided in Appendix A.

4.2 Topography

The route traverses the gently undulating coastal plateau of eastern Northumberland with the southern section, at the Morpeth Bypass, at an approximate elevation of 105mAOD. Extending northwards the route falls to attain an elevation in the order of 50mAOD to the north of the River Coquet valley. The steeply incised river is at an elevation of approximately 30m AOD at river bed. Minor watercourses identified in Section 4.4 create steep sided incised slopes that trend east –west and flow generally perpendicular to the route. Minor bridges and culverts are present where the watercourses cross the existing road.

The coastal plateau extending to the North Sea to the east is designated an area of outstanding natural beauty (AONB). A significant intrusion of igneous rock traverses the route in the area of Causey Park. This feature forms a south-west by north- east trending hill.

The Coquet Valley is a biological SSSI (salmon, lamprey, otter, flowing waters and woodland) and requires special consideration.

To the east of the route and especially north east of Morpeth, local topographical expression is influenced by abandoned colliery waste tips and opencast coal mining restoration profiles, see Section 4.9 for further detail.

4.3 Geology

4.3.1 Top Soil and Subsoil

A review of the top/sub soil properties within the study area has been undertaken using the Cranfield University Soilscapes map (Reference 18), a summary of which is presented in Table 4-2 below.

Table 4-2 Soil properties within the study area

Chainage	240-12550	13300-13980	12550-13300
Soil Description	Soilscape 18: Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils.		Soilscape 6: Freely draining slightly acid loamy soils.
Drainage	Impeded drainage.		Freely draining.
Fertility	Moderate.		Low.
Habitats	Seasonally wet pastures and woodlands.		Neutral and acid pastures and deciduous woodlands; acid communities such as bracken and gorse in the uplands
Land Cover	Grassland and arable; some woodland.		Arable and grassland.
Water Protection	Main risks are associated with overland flow from compacted or poached fields. Organic slurry, dirty water, fertiliser, pathogens and fine sediment can all move in suspension or solution with overland flow or drain water.		Groundwater contamination with nitrate; siltation and nutrient enrichment of streams from soil erosion is certain from these soils.

4.3.2 Made Ground

Made ground present at the surface and often above a clearly defined former top soil layer, formed as a result of localised road building, mining and quarrying, can be expected as a thin to moderate layer of broken mudstone, sandstone in isolated areas. A more intensive area of industrial activity is in the Causey Park area where mining, quarrying and aggregate preparation continue to this day.

Existing current and superseded OS mapping and Groundsure data shows that there have been a number of ponds in the vicinity of the proposed route options that are no longer present. This could be due to natural sedimentation or infilling with soil or waste material. The composition of made ground is further elaborated upon in Section 5.2.

4.3.3 Recent and Glacial Deposits

The geological sequence between Morpeth and Felton comprises localised deposits of Recent alluvium (sand, silt, clay, peat), river terrace sands and gravels adjacent to the River Coquet in the extreme northern part of the route, above extensive deposits of Devensian, glacial till (stoney clay), glacio-lacustrine (laminated clays) and glacio-fluvial (sand and gravel). The glacial deposits are encountered extensively at the surface and attain, in places, thicknesses in excess of 25m. Glacial till is sandy or gravelly clay and clayey silt. Cobbles are frequently observed. Gravel and cobbles are sub-angular to sub-rounded clasts of sandstone, mudstone and quartzite. The strength of the unit is variable, with deposits less than 4m below ground level ranging from soft (as a result of reworking) to firm, and deposits deeper than 4m below ground level firm to very stiff. Northumberland Till has been divided into Upper and Lower units characterised, amongst other things, by colour. The Upper Till being light brown and mottled blue/grey and the Lower Till dark grey. This is thought to be a feature of post-depositional weathering of lodgement tills deposited during the Devensian period and not a stratigraphic boundary.

Laminated clays occur within the glacial deposits along the route. These are observed around Low Espley at local Ch.2000m where all options are online; Causey Park at local Ch. 7500-8000m of Offline Option A; and west of Eshott around local Ch. 9500-10000m of Online Option A and Online Option C.

Granular glacial deposits within the glacial till form layers of loose to medium dense, silty sand with gravel. Material is noted as well graded, with sand grains dominant over gravel. The thickness of these layers varies from 1m to 5m.

The fabric and composition of the main glacial units controls engineering performance and is a significant defining factor. Glacial deposits are known to have experienced rotational failures north of the River Coquet between local Ch. 13000-13500m of Online Option A and Online Option C, and between local Ch. 12700-13200m of Offline Option A.

4.3.4 Bedrock Geology

Underlying superficial deposits is a succession of Carboniferous rocks that were deposited in a coastal and shallow marine environment. Rock head elevation is variable along the route and coincides with changes in the thickness of glacial till. The Stainmore Formation underlies the superficial deposits for the majority of the route. This Formation comprises an interbedded sequence of mudstones, siltstones and sandstones. Mudstones are carbonaceous and form thinly laminated beds. Siltstones are light grey to brown, with some beds containing discontinuities that are planar and undulating and very close to medium-spaced. Sandstones are light grey to dark grey. The Corbridge Limestone is a shelly unit within the Stainmore Formation that occurs in the vicinity of the River Coquet. Minor coal seams occur within the sequence.

Coal Measures occur above the Stainmore Formation cropping into the base of the glacial till to the east of the route. Lower Coal Measures and are a sequence of mudstones, shales, siltstones, sandstones and coal. The Victoria Seam was worked at Causey Park Mine. Seatearth associated with coal seams are known to have been worked in the region for use as refractory brick manufacturing. Section 4.9 expands on the known mining activity and an assessment of the mining risk is made in the risk register in Section 7.

Coal seams up to 0.5m thick occur between 13m to 17m below ground level (bgl) at Offline Option A at Causey Park.

Thin coal seams (less than 0.1m) are observed between 30-35m bgl south of Felton at local Ch. 10900m of Online Option A and Online Option C, and local Ch. 10700m of Offline Option A where all options are online.

The Causey Park Dyke is a tholeiitic discordant intrusion crossing the route, west to east, at approximate Ch. 8000m. This has not been intersected in any boreholes available on the BGS website but consists of dark green, fine grained very strong quartz-micro-gabbro and is quarried as a road stone (wearing course) at Causey Park.

The regional stratigraphy is presented in Table 4.3 and the units highlighted have been identified between Morpeth and Felton.

Table 4-3 - Geological Succession (Adapted from Reference 5 and http://www.bgs.ac.uk)

Quaternary	**Holocene**	Peat		South Charlton
		Alluvium		
		River Terrace Deposits		
	Devensian	Glacio-fluvial Deposits		
		Till		Morpeth to Berwick-upon-Tweed
Palaeo-gene		Northern England Late Carboniferous Tholeiitic Dyke-swarm	Quartz-microgabbro formed approximately 299 to 326 million years ago in the Carboniferous Period.	Causey Park (Morpeth to Felton)
Early Permian		Great Whin Sill	Quartz-microgabbro formed approximately 271 to 326 million years ago in the Permian and Carboniferous Periods.	Occurs around Middleston, south of Alnwick.
Upper Carboniferous	**Pennine Coal Measures Group**	Pennine Middle Coal Measures Formation	Mudstone and siltstone with locally thick sandstone beds and coal seams up to 375m thick. Thickest Coal below Maltby (High Main) Marine Band (MTMG).	
		Pennine Lower Coal Measures Formation	Mudstone, siltstone and sandstone 175-205m thick formed approximately 312 to 313 million years ago. Local environment previously dominated by swamps, estuaries and deltas.	North of Causey Park (Morpeth to Felton)
	Yoredale Group	Stainmore Formation (formerly Millstone Grit and Upper Limestone)	Mudstone, sandstone and limestone 390-530m thick formed approximately 313 to 326 million years ago. Local environment previously dominated by swamps, estuaries and deltas.	Occurs south of Newton-on-the-Moor ie Morpeth to Felton, Haggerston
			Great Limestone Member Limestone formed approximately 322 to 326 million years ago. Local environment previously dominated by shallow carbonate seas.	
Lower Carboniferous		Alston Formation	Limestone, sandstone, siltstone and mudstone400-415m thick formed approximately 322 to 335 million years ago. Local environment previously dominated by shallow carbonate seas.	Scremerston to Newton on the Moor
		Tyne Limestone Formation	Limestone, sandstone, siltstone and mudstone up to 550m thick formed approximately 331 to 339 million years ago. Local environment previously dominated by shallow carbonate seas.	Scremerston to Newton on the Moor
		Scremerston Coal Member	Sandstone, siltstone and mudstone formed approximately 331 to 339 million years ago. Local environment previously dominated by swamps, estuaries and deltas.	Forms rock head beneath A1 in Nothern half of Alnwich to Ellingham route at South Charton, North Charlton, Brownieside. North of Ellingham beneath Climbing Lane Option 0 1250M North-bound
	Border Group	Fell Sandstone Formation	Sandstone. Sedimentary bedrock formed approximately 335 to 352 million years ago in the Carboniferous period. Local environment previously dominated by rivers.	

4.4 Hydrology

A number of watercourses are present within the study area, some of which cross the alignment of the current carriageway and proposed future route options. These watercourses (from south to north) are described in Table 4-4, while their locations are indicated on Figure 5 in Appendix B. It should be noted, however, that existing unmapped watercourses could be present within the study area. Watercourses greater than 100m from a proposed route option have not been included in Table 4-4.

Table 4-4 Watercourses within the study area

Name	Route Option Intersection Chainages (m)			Existing A1 Carriageway Crossing Type	Tributary of
	Green	Blue	Orange		
Unnamed watercourse	350	350	350	Culvert	Benridge Burn
Cotting Burn	20m E of 775	20m E of 775	20m E of 775	N/A	Shieldhill Burn
Shieldhill Burn	1800	1800	1800	Culvert	Cotting Burn
Floodgate Burn	3665	3665	3665	Culvert	River Lyne
River Lyne	4045	4010	4010	Bridge	N/A
Unnamed watercourse	N/A	30m E of 5000	30m E of 5000	N/A	Earsdon Burn
Fenrother Burn	4955 and 5400	N/A	N/A	N/A	Earsdon Burn
Unnamed watercourse	N/A	20m E of 5540	20m E of 5540	N/A	Earsdon Burn
Earsdon Burn	7050	6950	7000	Bridge	River Lyne
Unnamed watercourse	7280	N/A	N/A	N/A	Earsdon Burn
Unnamed watercourse	N/A	70m E of 7850	N/A	N/A	Eshott Burn
Eshott Burn	N/A	5m E of 8280	30m E of 8235	N/A	Thirston Burn
Unnamed watercourse	3100m NE of 9600	60m NE of 9850	30m NE of 9820	N/A	Longdike Burn
Longdike Burn	9980	1210	1170	Bridge	Thirston Burn
Bywell Letch	70m W of 9960	90m W of 10150	100 W of 10180	N/A	Longdike Burn
Unnamed watercourse	10850	11100	11050	Culvert	Unknown
Unnamed watercourse	11850	12090	12050	Culvert	Thirston Burn
River Coquet	12545	12780	12745	Bridge	N/A
Unnamed watercourse	13140	13380	13340	Culvert	Back Burn
Minto’s Dean	13680	13930	13880	Culvert	Back Burn

Of the watercourses listed above, there are currently three being monitored as part of the EU Water Framework Directive (WFD) (Reference 19). The latest information on quality from these is summarised in Table 4-5 below.

Table 4-5 WFD classification for watercourses in the study area

Water body	Category	2015 Classification
River Coquet	Overall	Good
	Ecological	Good
	Chemical	Good
Longdike Burn	Overall	Moderate
	Ecological	Moderate
	Chemical	Good
River Lyne	Overall	Poor
	Ecological	Poor
	Chemical	Good

There are a number of ponds located within the study area. These are summarised in Table 4-6 below and shown in Figure 8A in Appendix B. Historical ponds are summarised in Section 4.6.2.

Table 4-6 Ponds in the Study Area

Chainage	Type	Code	Further Information
30m E of 2320	Ephemeral Pond	P15	Appears on 2012 and 2013 aerial imagery
170m W of 3910	Pond	P14	First shown on 1974 map
40m E of 9890	Pond	P16	Constructed between 1978 and 2002
180m W of 9900	Pond	P17	First shown on aerial imagery from 2012
160m NE of 10030	Pond	P18	Constructed between 1978 and 2002

The risk to the proposed scheme associated with flooding from rivers is summarised in Table 4-7 below and shown on Figure 5A in Appendix B.

Table 4-7 Risk of flooding from rivers

Classification	Classification Definition	Route Option Chainages (m)			Associated Watercourse
		Green	Blue	Orange	
High	Every year the chance of this area flooding is greater than 3.3%	4030-4050	4010-4035	4010-4035	River Lyne
		N/A	6950-6955	7000-7005	Earsdon Burn
		9945-10015	10170-10240	10145-10205	Longdike Burn
		12505-12600	12740-12835	12700-12795	River Coquet
Medium	Every year the chance of this area flooding is between 1% and 3.3%	7020-7040	6955-6980	6985-7000	Earsdon Burn
				7005-7030	
Low	Every year the chance of this area flooding is between 0.1 and 1%	4020-4030	N/A	N/A	River Lyne
		9900-9940	10160-10170	10120-10145	Longdike Burn
			10240-10250	10200-10205	
		12600-12620	12850-12865	12795-12825	River Coquet

No surface water abstractions are located within the study area.

The area to the north of Causey Park Bridge (Ch. 7350 to 13980) is in a Surface Water Safeguard Zone for metaldehyde, a pesticide.

4.5 Hydrogeology - Resource

The classification of superficial and bedrock aquifers beneath the proposed scheme are summarised in Table 4-8 and Table 4-9 below. The distribution of aquifers within the superficial deposits is shown on Figures 6A and 7A in Appendix B respectively.

Table 4-8 Aquifer classification and extent – superficial deposits

Classification	Definition	Route Option Chainages (m)			Associated Strata
		Green	Blue	Orange	
Secondary A	Permeable layers capable of supporting water at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers	9910-10010	10160-10245	10120-10205	Alluvium
		12030-12475	12270-12715	12230-12675	Glaciofluvial Deposits
		12670-13100	12910-13340	12870-13300	
		13270-13550	13500-13800	13470-13750	
Secondary Undifferentiated	Assigned when it has not been possible to attribute either category A or B to a strata	240-6930	240-6930	240-6930	Glacial till (alluvium between 1820-1870m and 4010 - 4065m)
		7065-9910	7020-10160	7045-10120	
		10010-12030	10245-12270	10205-12230	
		13250-13270	13480-13500	13450-13470	
		13560-13780	13800-14020	13750-13980	

Table 4-9 Aquifer classification and extents - bedrock

Classification	Definition	Route Option Chainages (m)			Associated Strata
		Green	Blue	Orange	
Secondary A	Permeable layers capable of supporting water at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers	240-7815	240-8010	240-7950	Stainmore Formation
		7850-7980	8050-9200	7995-9190	Pennine Lower Coal Measures Formation
		8360-8780			
		7980-8360	9200-14020	9190-13980	Stainmore Formation
		8780-13780			
		12485-12530	12720-12765	12680-12725	Corbridge Limestone
		12610-12650	12845-12890	12805-12850	

Classification	Definition	Route Option Chainages (m)			Associated Strata
		Green	Blue	Orange	
Secondary B	Predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering	7810-7850	8010-8050	7950-7995	Northern England Late Carboniferous Tholeiitic Dyke Swarm

There is one groundwater abstraction within the study area, detailed in Table 4-10 below and shown on Figure 8A in Appendix B.

Table 4-10 Groundwater abstractions within the study area

Chainage	280m NE of Ch. 9600m
NGR	418408 597165
Licence Number	NE/022/0003/001
Name of Licence Holder	Felmoor Park Ltd
Purpose	Industrial, Commercial And Public Services - Holiday Sites, Camp Sites & Tourist Attractions
Usage	Drinking, cooking, sanitary and washing
Maximum Daily Abstraction (m^3)	130
Maximum Annual Abstraction (m^3)	25000

The far southern extent of the scheme (Ch. 240m to 1300m) is designated as a Total Catchment (Zone 3) Source Protection Zone. This is defined as ‘the area around a source within which all groundwater recharge is presumed to be discharged at the source’ (Reference 20).

4.5.1 Groundwater Aspects

The details of the groundwater instrumentation and monitoring carried out during the investigation in 2006 has been summarised at the time and reported here. Independent validation is not possible as raw data and the instruments themselves have not been recovered as part of this PSSR.

“Due to the predominantly cohesive nature of the drift material groundwater strikes encountered during drilling provide an unreliable picture of ground water levels across the scheme. In order to determine the groundwater levels across the scheme more reliably groundwater monitoring installations were installed in exploratory holes at various depths along the scheme route.

Groundwater monitoring instrumentation was installed in a total of 61 exploratory holes; 50mm gas monitoring standpipes were installed in 11 exploratory holes, 19mm diameter standpipe *piezometers were installed in 46 of the exploratory holes and 8 vibrating wire piezometers were installed in 4 of the exploratory holes (two instruments per hole). Installation details are shown on the relevant exploratory hole logs within the NWHSEL Factual report presented in Appendix F and the groundwater monitoring results are summarized in Appendix A.*

During the monitoring period, following a period of stabilisation, groundwater levels rarely varied by more than approximately 0.2m within each exploratory hole. However, fluctuations of between 1.28m and 4.40m were recorded in three exploratory holes (1011, 1018 and, 1034). This is thought to be due to the piezometer tip being located either within a granular horizon or at the soil-rock interface, where preferential flow paths may have established. All three instruments were installed at 4.50m bgl or shallower.

Piezometers installed at shallow depths (<3m) within Made Ground (B) recorded ground water at an average depth of 0.64m. The piezometer installed in BH1044 responding at a depth of 15m within the existing embankment fill recorded ground water at a depth of 11.36m or a level of 40.93m AOD. This corresponds to the approximate level of the water course passing beneath the embankment at this location.

Piezometers installed at shallow depths within the alluvium (C) near to the water courses of Floodgate Burn and the River Lyne typically recorded ground water levels at shallow depth (average depth of 0.56m).

Piezometers installed at an average depth of 4.45m within the Glacial Till (D) recorded ground water at an average depth of 2.15m. Piezometers installed within the bedrock at depths of greater than 10m below existing ground level typically recorded ground water levels at a lower level than instruments responding at shallower depth within drift material, suggesting perched water conditions within the drift under drained by the bedrock.

Notable exceptions to this picture are the instruments installed in BH1029 responding at 28.25m depth and BH1002R responding at 21.5m depth both within sandstone which recorded ground water at depths of 1.27m and 3.38m respectively.

Dual vibrating wire piezometers were installed in the BH1039, 1040, 1041 and 1042 to the east of the existing cutting north of the Coquet Valley. In all installations the upper piezometer was located at 5m depth within the Cohesive Glacial Till and the lower installation within bedrock at depths of 12.2m to 15m below ground level. With the exception of BH1041 the upper piezometer recorded ground water at depths of 2.67 to 3.92m. The reading from the upper piezometer in BH1041 is considered unreliable as suction was measured. The lower piezometers recorded ground water at depths of 9.04m to 12.15m below ground level. The results of the ground water monitoring indicate perched ground water in the drift deposits under drained by the bedrock as has been indicated elsewhere along the scheme.

Chemical testing was carried out on 7 samples of ground water and recorded a pH range of 5.3 to 8.2 with an average value of 7.5 and a range of soluble sulphate levels between 0.072 and 0.156 g/l with an average value of 0.115 g/l."

4.6 Land Use

4.6.1 Current Land Use

The land use within the study area is largely agricultural, with the town of Morpeth to the south of the southern end of the study area and the village of Felton to the east of the northern end of the study area. There are a number of small, scattered settlements throughout the study area.

There are a number of recreational land uses within the study area, such as Felmoor Park Holiday Park, Bockenfield Holiday Park, Burgham Park Golf and Leisure Club, and Eshott Airfield.

The current commercial / industrial land uses within the study area are summarised in Table 4-11 below, and shown on Figure 8A in Appendix B.

Table 4-11 Current commercial/industrial land uses

Type	Code	Chainage (m)	NGR
Wind Electricity Generator	C1	500m E of 2360	418942 589989
Pylon	C2	420m E of 2670	418909 590289
Telephone Mast	C3	420m E of 2670	418908 590289
Telephone Mast	C4	440m E of 2680	418933 590298
Pylon	C5	440m E of 2680	418933 590298
Vehicle Repair, Testing and Servicing	C6	90m E of 4090	418671 591691
Water Pumping Station	C7	40m E of 4790	418848 592364
Telephone Mast	C8	220m NE of 8870	418817 596453
Pipeline	C9	280m NE of 10100	418093 597454
Windsock	C10	180m NE of 10630	417743 597794
Agricultural Contractors	C11	470m W of 11560	416987 598616
Unspecified Works	C12	440m W of 11560	417009 598622

4.6.2 Historical Land Use

A summary of historical land use within the study area, based on a review of published historical OS mapping, is provided in Table 4-12 below and on Figure 8A in Appendix B. Published maps where no significant changes have been noted are not listed. Historical tanks in the study area are detailed separately in Table 4-13.

Table 4-12 Summary of historical land use and features within the study area

Map	Chainage (m)	Code	Feature	Higher Risk Feature		
				Green	Blue	Orange
1855 1:2,500	2130	P1	Small square pond			
	2130	P2	Rectangular pond			
	2470	P3	Pond to S of Hebron Hill Farm			
	2750	Q1	Old Quarry	Y	Y	Y
	4640	P4	Pond to W of Shield Green Farm			
	5260	L1	Portland Arms Inn			
	5350	P5	Pond	Y		
	5825	P6	Pond to S of Earsdon Moor Farm		Y	Y
	6100	L2	Earsdon Mill (corn mill) – Windmill			

Map	Chainage (m)	Code	Feature	Higher Risk Feature		
				Green	Blue	Orange
			shown			
	6150	P7	Pond			
	6900	Q2	Old Quarry		Y	Y
	6960	L3	Ogle Arms Inn			
	7600	P8	Pond			
	9300	Q3	Quarry, with two distinct lobes			
	12880	P9	Pond	Y	Y	Y
	12950	P10	Pond			
1866 1:10,560	920	P11	Pond to S of Warreners House			
	3650	L4	Tile Sheds - ‘Gins’ shown to N			
	3710	P12	Two rectangular ponds, likely associated with Tile Sheds	Y	Y	Y
	3870	P13	Three rectangular ponds, likely associated with Tile Sheds			
	7810	L5	Brick and Tile Yard		Y	
1897 1:2,500a	2130	P1	Small square pond no longer present – presumed infilled			
	3650	L4	Tile Sheds now shown as Tile Works			
	5260	L1	Portland Arms Inn no longer shown			
	6100	L2	Earsdon Mill no longer shown as corn mill			
	6900	Q2	Old quarry no longer shown – presumed infilled		Y	Y
	6960	L3	Ogle Arms Inn now shown as Oak Inn			
	6970	L6	Smithy - shown at Causey Park Bridge			
	7570	W1	Windpump			
	7600	P8	Pond no longer shown – presumed infilled			
	7790	Q4	Old Quarry	Y		
	7810	L5	Brick and Tile Yard no longer shown but buildings remain		Y	
	9300	Q3	Eastern lobe of quarry shown as ‘Old Quarry’			
	10870	Q5	Disused Colliery and Shaft			
1923 1:2,500	920	P11	Pond no longer present – presumed infilled	Y	Y	Y
	3630	L7	Sheepwash	Y	Y	Y
	3650	L4	Tile Works now shown as disused			
	3870	P13	Three rectangular ponds now absent – presumed infilled			

Map	Chainage (m)	Code	Feature	Higher Risk Feature		
				Green	Blue	Orange
	4200	W2	Pump shown at Priest's Bridge House			
	4640	P4	Pond no longer present at Shield Green Farm – presumed infilled			
	4800	W3	Pump shown at Tritlington School			
	5260	L1	Former Portland Arms Inn now shown as Portland Cottage			
	5770	W4	Pump marked to S of Earsdon Moor Farm			
	5900	W5	Pump marked to N of Earsdon Moor Farm			
	6970	L6	Smithy no longer shown at Causey Park Bridge			
	8900	Q6	Quarries shown at Helm Cottage			
	9300	Q3	Quarry now shown as 'Old Quarry'			
	10870	Q5	Colliery now shown as 'Old Coal Shaft'			
1947 1:10,560	6840-7350	H1	A1 straightened and new bridge at Causey Park Bridge			
	7820	Q7	Adit shown to N of Old Quarry	Y		
	8140-8330	H2	A1 realigned			
	9100	W6	Windpump			
	10190-10650	H3	A1 straightened			
1948-50 1:10:560	500	L8	St Andrews Colony			
	4050-4550	H4	Priest's Bridge bypass			
	4960-5350	H5	A1 straightened to run to the W of Portland House			
	6150-6600	H6	A1 straightened			
	8930	A1	Eight buildings and two trackways			
	9300	A3	23 temporary buildings and five trackways		Y	Y
	9260	A2	15 temporary buildings and one trackway			
	9250	A4	Five temporary buildings and two trackways shown within quarry footprint			
	9400	A5	43 temporary buildings and one trackway			
	9800	A6	27 temporary buildings and four trackways	Y	Y	Y
	10180	A7	9 temporary buildings and three trackways	Y	Y	Y

Map	Chainage (m)	Code	Feature	Higher Risk Feature		
				Green	Blue	Orange
	12880	P9	Pond no longer present – presumed infilled	Y	Y	Y
1974 1:2,500	500	L8	St Andrews Colony now shown as Northgate Hospital and more buildings present	Y	Y	Y
	870	H7	Improved A1-A697 junction constructed			
	3500	L9	Cattle Pens building			
	3650	L4	Tile Works no longer present			
	3710	P12	Two rectangular ponds no longer present – presumed infilled	Y	Y	Y
	3910	P14	Pond			
	4180	G1	Garage		Y	Y
	5825	P6	Pond to S of Earsdon Moor Farm no longer present		Y	Y
	5900	L10	Sheep Dip		Y	Y
	6840	G2	Filling Station		Y	Y
	8900	L11	Tumulus/Pillar			
	9300	A3	Water reservoir - Camp area now shown as disused.		Y	Y
	10700-11120	A8	Airfield (disused) - three runways shown and roads / buildings to W and S of airfield boundary	Y	Y	Y

*Features are classified as 'higher risk' if an infilled pond, infilled quarry, garage, tank or potentially infilled area of land is within 100m of a proposed scheme option, or if a landfill is within 250m of a proposed scheme option.

Table 4-13 Historical tanks within the study area

Chainage (m)	Code	NGR		Dates	Higher Risk Feature		
					Green	Blue	Orange
920	T1	418280	588572	1973, 1996	Y	Y	Y
2560	T2	419012	590203	1923			
2700	T3	418866	590332	1974, 1994			
4620	T4	419231	592196	1897			
5870	T5	418848	593437	1862		Y	Y
5940	T6	418669	593508	1922			
5940	T7	418710	593508	1922			
6090	T8	418855	593655	1897		Y	Y
11640	T9	417259	598688	1924			

4.6.2.1 Airfield Site

Eshott Airfield (NGR 417684 597792, east of Ch.10700-11120) was formerly known as RAF Eshott and was used by the RAF from November 1942 to 1948. The airfield reopened for leisure use around 1990 (Reference 31). Aerial imagery (Google Earth) and photographs taken on site, in 2008 show building footprints and buildings in a semi-demolished state to the west and south of the main airfield site. Historical OS mapping shows a number of ancillary sites associated with the main airfield, which appear to contain temporary buildings. When cross-referenced with modern aerial imagery (Google Earth), some of these ancillary sites have been fully converted to another use, such as arable land or holiday parks (Felmoor Park and Bockenfield Holiday Park), while others still contain derelict buildings. On the site walkover it was noted that the camp at Helm (A3 in Table 4-12) still had either complete buildings or upright walls present.

Historical BGS exploratory hole records associated with the above ancillary sites (BGS references NZ19NE142 and NZ19NE148) encountered fragments of road stone, concrete, tiles, glass and brick, which could be associated with the construction and/or demolition of the buildings. In one trial pit (NZ19NE148) asbestos was observed, although subsequent soil testing recorded a negative result. Information on these trial pits can be found in Table 4-15.

A Pre-Desk Study Assessment was requested from Zetica which recommended a detailed desk study assessment. The detailed assessment is included in Appendix F. In summary, the report found that during World War Two, strategic targets located within 5km of the proposed scheme included RAF Eshott, anti-aircraft defences, army camps, military convoy routes and public utilities and transport infrastructure. Morpeth rural district recorded 163 bombs at 2.1 bombs per 405 ha.

Page 13 of Appendix E identifies the location of recorded UXO across the site. Between CH.4000m and 4500m may be located within the vicinity of Incendiary devices. However, this is not anticipated to be intercepted by the proposed works and ground investigation. In total, it is estimated that there is the potential for up to six unexploded bombs, six incendiary bombs and seven high explosive bombs to have been dropped within the study area between 1940 and 1941.

Records show that at least 12 high explosive bombs were recorded in close proximity to the proposed scheme, and some of these were recorded as unexploded. RAF Eshott was bombed in May 1941.

The recommendation from the specialist UXO contractor relates to the risk acceptability of the client. Should a zero tolerance to risk be adopted a clearance certificate is likely to be required. Where this is not the case, it is considered prudent to hold workshops with the staff relating to the risks and the possible indicators on site (Appendix E). In line with this advice it is advised that all staff attending site through ground investigation and construction stages are briefed on the potential presence of unexploded ordnance. It is also recommended that site procedures are to detail appropriate action on encountering indicators of unexploded ordnance.

4.7 Archaeology

The Archaeology Data Service (Reference 22) has records for two archaeological investigations within the study area. A geophysical survey took place at NGR 418300 589650 in 2006 and a desk based assessment took place at 417500 600000 in 1999. There are no records of any discoveries from either of these investigations. The only map reference to archaeological features within the study area is of a Tumulus/Pillar, shown in Table 4-12. The archaeological impacts of the proposed options will be considered as part of the Environmental Impact Assessment, further detailed study of the archaeology is therefore considered to be outside the scope of this report.

4.8 Aerial Photographs

The following is observed from an inspection of available aerial photogrammetry:

- Google earth back to 2002, shows infilled open cast workings to the east of the site at Earsdon Moor.
- A number of buildings on the outline of the Airfield north of Causey Park and South of Felton are omitted on OS maps as related to the airbase during the war. Post war evidence that they have been removed and infilled, followed by tree plantation. This has now been removed and repaired due to issues with instability.
- Footprints of buildings still identified to the east of the A1 by the Eshott Airfield, may be areas of made ground requiring excavation and replacement should the dualling of the road be to the east of the current A1.
- A Caravan Park located at the waste due for a surface coal mining works and ponds visible.

4.9 Mining and Mineral Deposits

Coal mining enquiries have been obtained for parts of the route in the past, although the actual correspondence is not available through BGS or HAGDMS at the present time. A summary was provided in an earlier report (Reference 10) as follows:

> *"The Coal Authority provided a report of historical coal mining activity in the route corridor. Their report identified two areas of coal workings, one at Causey Park Hagg (approx. Ch. 6800) and the other adjacent to the airfield at the northern end of the site (Ch. 9600 to Ch. 10700).*
>
> *The Coal Authority provided a Mine Plan NC536 for the coal workings at Causey Park Hagg. The mine plan shows the location of adits and roadways at Causey Park Hagg.*
>
> *A geophysical survey carried out in the vicinity of the mine workings and dolerite dyke at Causey Park identified a large linear dipolar anomaly and a number of smaller discrete anomalies. The results of the geophysical survey are discussed in Section 4.5 [of the origin report].*
>
> *No mine plan is available for the workings at the northern end of the route, however, the location of a disused colliery is indicated on historical plan 54NE (1899)*

and an old coal shaft is indicated at the same location on the historical O.S. plan 51SW (1947).

Due to the fact that (a) shallow mine workings are present along the route corridor, (b) that poor coals and fireclays are present within the Upper Stainmore Group and (c) the strike of the strata is parallel to the scheme alignment,

The entire route corridor has been assessed to have a moderate risk associated with the presence of shallow mine workings."

A Mining Report CON 29 M has been obtained from the Coal Authority and is presented in Appendix I. The report indicates that.

- There are nine mine entries that are within or within 200m of the route boundary. Approximate shaft locations are shown on the Geotechnical Aspects Plan in Appendix A. The condition of these is by and large unknown. Unrecorded mine entries may occur in addition to these.
- In an area of past underground workings. There are no current or planned licenced underground or opencast mines.
- No mine gas emissions that the CA are aware of.
- The route is underlain by seams of coal for which no records are known, but which may contain unrecorded workings.
- A section of mine plan presented in the earlier report and reproduced here Appendix F, is from the Causey Park area. The geophysical survey data is also reproduced and presented in Appendix F also.

Proposed Bridge structures will be treated as areas where possible unrecorded workings would pose an unacceptable risk. Future investigations to cater for this risk are presented in Annex A.

A shallow mine workings risk zone between Ch. 4500 and Ch.9000m and Ch. 12000 and Ch.13500m is shown on the Geotechnical Aspects Plan presented as Figure A4 in Appendix A.

4.10 Contaminated Land

A summary of the potential contaminants within the study area is given in Table 4-14. This list is meant to be indicative and is not exhaustive of the contaminants that may be encountered.

Table 4-14 Potential contaminants that may be encountered within the study area

Source	Potential Contaminants
Existing Road Network (A1)	Embankment fill materials (PFA, ash), oils/hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), Benzene, Toluene, Ethyl benzene and Xylenes (BTEX), Methyl Tertiary Butyl Ether (MTBE), heavy metals, antifreeze, brake fluids, road salt.
Agriculture	Slurry (nitrate, ammonium, organics), pesticides, herbicides, fertilisers, pathogens, oils, fuels, PAHs.
WW2 Airfield and associated buildings	Aviation fuel (kerosene), gasoline, diesel, antifreeze, solvents, fire-fighting agents, lubricants, hydraulic fluids, Polychlorinated Biphenyls (PCBs), asbestos, PAHs, Volatile and Semi-Volatile Organic Compounds (VOCs and SVOCs), heavy metals.
Garage and historical filling station	Oils/hydrocarbons, PAHs, BTEX, MTBE, VOCs and SVOCs, heavy metals, antifreeze, brake fluids, solvents, asbestos.
Infilled Ponds / Quarries and historical landfills	Various unknown contaminants (including heavy metals, hydrocarbons, PAHs, ash, ground gas, asbestos).
Foot and mouth burial pits	Pathogens, heavy metals, oils/hydrocarbons.
Tanks	Oils, fuels (diesel, red diesel, gasoline), pesticides, herbicides, fertilisers, slurry (nitrate, ammonium, organics),

4.10.1 Historical Contamination Records

BGS exploratory borehole records within the study area were reviewed for visual/olfactory evidence of contamination, and these are summarised in Table 4.17. The locations of these boreholes are shown on Figure 9A in Appendix B.

Table 4-15 Summary of contamination encountered within the historical BGS exploratory holes

BGS Borehole Reference	WYG/Norwest Holst Report Reference	Chainage (m)	NGR	Contamination Encountered	Depth (mbgl)
NZ19NE142	TP1278	30m NE of 10200	417852 597364	Made ground: Dark grey/black clayey sand and gravel. Gravel sized fragments are fine to coarse angular to sub-angular of sandstone, coal, pottery and asphalt/tar. Strong hydrocarbon odour noted.	2.30-3.00
NZ19NE148	TP1284	10m E of 11075	417502 598134	Made ground: Dark grey brown slightly sandy gravelly clay. Gravel sized fragments are sub-angular fine to coarse of sandstone, brick and concrete. Asbestos, door locks and glass noted.	0.20-0.30

4.10.1.1 Historical Contamination Testing

Forty soil samples were tested as part of the Norwest Holst ground investigation in 2006, and the determinands tested for are detailed in Table 4-16.

Table 4-16 Determinands tested for as part of 2006 Norwest Holst GI

Metals and semi-metals	Organics and others
Boron (water soluble)	Acidity
Arsenic	Asbestos
Cadmium	Free Cyanide
Chromium (total)	Sulphate
Copper	TPH
Lead	PAH
Mercury	EPH
Nickel	GRO
Selenium	Phenols

The results of this analysis were compared to current generic assessment criteria (GAC) by Jacobs, and screened against the LQM/CIEH S4ULs for Human Health Risk Assessment for commercial/industrial end use. Only one of the samples tested (TP1278, BGS reference NZ19NE142, Appendix H) recorded exceedances of these levels. These exceedances were for benzo(b)fluoroanthene, benzo(a)pyrene and dibenzo(ah)anthracene. It is likely that these values are related to the strong hydrocarbon odour that was encountered in the trial pit, as detailed in Table 4-15.

4.10.2 Waste

Historical landfills located within the study area are summarised in Table 4-17 below and on Figure 8A in Appendix B. There are no active landfills within the study area.

Table 4-17 Historical landfills within the study area

Name	Chainage (m)	NGR	Accepted Waste	Dates	Licence no
Eshott	90m NE of 8400	418900 596000	Industrial, Commercial, Household, Liquids/Sludge	Unknown	Unknown
The Helm, Felton	0 - 20m NE of 9090 – 9475	418500 596700	Inert	7/10/1977-31/12/1979	67279

The previous PSSR for this section of the A1 (Reference 9) recorded the presence of a foot and mouth burial pit at High Highlaws Farm, located to the north of the farm lane (70m west of 2150, NGR 418327 589732). A cleanse and disinfect pit is located to the south of the farm (160m west of 1880, NGR 418162 589526), which contains farm material and equipment. The pits are estimated to have been excavated between March and April 2001.

A subsequent Preliminary Geotechnical Report (Reference 1) found no elevated biological or chemical contamination of water from two boreholes within the vicinity of these pits. The locations of the foot and mouth pits are shown on Figure 8A in Appendix B.

There are two historical waste transfer stations within the study area, which are summarised in Table 4-18 and on Figure 8A in Appendix B.

Table 4-18 Historical Waste Transfer Stations within the study area

Name	Chainage (m)	Code	NGR	Type	License Number	Active Dates
Shield Green Farm	420m E of 4620	WT1	419200 592200	Composting facility	DIX001	29/09/1993-15/08/2000
The Helm, Felton	150m NE of 9200	WT2	418600 596700	Landfill taking other wastes	NOR018	18/07/1977-12/02/1993

There are seven active discharge consents within the study, which are summarised in Table 4-19 and on Figure 8A in Appendix B.

Table 4-19 Active Discharge Consents within the study area

Location	Chainage (m)	Code	NGR	Type	Permit Number	Receiving Water
Tritlington C of E School	260m E of 4930	D1	419080 592500	Sewage Discharges – Final/Treated Effluent	224/0996	Tributary of Earsdon Burn
Oak Inn, Causey Park	120m W of 7030	D2	418860 594600	Sewage Discharges – Final/Treated Effluent	224/0946	Earsdon Burn
Four Gables, Causey Park Bridge	50m W of 7140	D3	418946 594703	Sewage Discharges – Final/Treated Effluent	EPRCP3423GU	Tributary of Earsdon Burn
Burgham Farm	100m SW of 9960	D4	417900 597090	Sewage Discharges – Final/Treated Effluent	223/0987	Longdike Burn
The Farmhouse, Burgham Park	100m SW of 10060	D5	417830 597180	Sewage Discharges – Final/Treated Effluent	223/1003	Longdike Burn
Burgham Park Golf and Leisure Club	100m SW of 10220	D6	417740 597300	Sewage Discharges – Final/Treated Effluent	223/0961	Longdike Burn
Felmoor Park Ltd	250m NE of 10100	D7	418080 597427	Sewage Discharges – Final/Treated Effluent	NPSWQD006231	Longdike Burn

4.11 Pollution

There is one recorded pollution incident within the study area, as detailed in Table 4-20 and on Figure 8A in Appendix B.

Table 4-20 Pollution incidents within the study area

Chainage	180m W of 1130m
NGR	418040 588780
Pollutant	Commercial Waste
Impact to Air	Category 4 (No Impact)
Impact to Land	Category 3 (Minor)
Impact to Water	Category 4 (No Impact)
Date First Added	01/06/2003
Date Last Added	07/01/2004
Number of Occurrences	3

4.12 Designated Sites

The River Coquet and Coquet Valley Woodland SSSI intersect the scheme at Ch.12670 to 12770m. It is designated due to being a relatively unmodified fast flowing river that supports a wide range of flora and fauna.

Scotch Gill Wood Local Nature Reserve, designated at local level by the local authority, is 1.2miles (2km) south of all options.

All options pass close to and through areas identified by the Castle Morpeth Local Plan as having "High Landscape Value".

There are two Noise Important Areas (IA) alongside the existing A1 between Morpeth and Felton (IA_ID 1003), at Warrener's House, adjacent to the southbound side of the A1 just north of Morpeth; (IA_ID 1002), also adjacent to the southbound side of the A1, at Causey Park Bridge.

Table 4-21 Listed cultural heritage sites in the study area

Chainage (m)	Code	NGR	Type	Grade
10m E of 2350	CH1	418456 589979	Milepost	Grade II
15m SE of 3980	CH2	418456 589979	Milepost	Grade II
On proposed carriageway at 5625	CH3	418901 593192	Milepost	Grade II
5m E of 7280	CH4	419024 594838	Milepost	Grade II
20m NE of 10495	CH5	417674 597598	Milepost	Grade II
210m E of 11860	CH6	417639 598913	Milepost	Grade II
120m W of 13175	CH7	417344 600232	Boundary Stones	Grade II
120m W of 13280	CH8	417339 600334	Longfield Cottage	Grade II

Details of designated cultural heritage sites within the study area are summarised in Table 4-21 and on Figure 8A in Appendix B. These will be considered in the Environmental Impact Assessment.

4.13 Services

Scheme drawings are presented as Appendix A include the locations of Statutory Utilities and Services. These are not comprehensive at this stage and no reliability is placed upon their location on these plans.

Attention however is drawn to two locations where current service information indicates an existing gas main running parallel to and west of the existing A1. The main is identified on the Geotechnical Aspects drawings (within Appendix A) at existing Ch.1000 to 4000 and Ch. 9600 to 10400. All options considered will interact with this service.

5 Ground Conditions

5.1 Previous Ground Investigations

Ground investigations have been undertaken along the route previously for the purpose of road improvement works including new alignment as described herein. A summary of the scope of the investigations, their date and originator is given in Table 5-1.

A borehole and trial pit location plan for the previous boreholes is presented in Appendix A (A4).

A geological longitudinal section that is representative of the options is presented in Appendix C.

Table 5-1 List of previous ground investigations relevant to proposals.

Title	Originator and year	Scope of GI
Stage 1 Ground Investigation NWH Soil Engineering Report (Reference 12) In general this investigation had exploratory bore holes every 250m, with trial pits and window samples in-between holes.	Norwest Holst (NHSED) 2006	42No. CP boreholes 17No. with Rotary Core follow on 11No. Rotary Core boreholes 38No. dynamic window sampler probe holes 113No. Trial Pits 18No. Concrete core holes 38No. Dynamic Cone Penetrometer testing in Trial Pits Hand Vane Shear Testing 4No. Permeability testing 1No. Downhole optical imaging using a tele viewer.
Site Investigation River Coquet, Felton on behalf of Northumberland County Council (Reference 13)	Tarmac Construction Limited Central Engineering Laboratories 1974	6No. CP boreholes 6No. Rotary Core Follow on 1No. Rotary Core borehole
A1(T) Morpeth Bypass preventative maintenance, Ground Investigation Report (Reference 11)	Halcrow 2010	2No. CP boreholes 24 No. Cone penetration tests To the south of the design proposal.

Across the site the superficial deposits generally comprise cohesive glacial till overlying the Stainmore Group (formerly the Millstone Grit / Upper Limestone Series). Pockets of made ground or alluvium are present in localities associated with watercourses and in areas where the A1 has been improved. Apart from the Causey Park area there is very little made ground arising from past mining or quarrying.

The ground model for the proposed alignments has been assessed using available existing factual data from a number of ground investigations including the 2006; Stage 1 Ground Investigation along the length of a similar proposal to the current Green Offline route.

An indicative model that can be applied to all route options is presented as Table 5-2 below.

Engineering Properties	Shear Strength	MC (mean)	LL (mean)	PL (mean)	PI (mean)	m_v (m^2/MN)
Made Ground Cohesive	c_u 20 to 40 kN/m^2	22%	-	-	20%	-
Alluvium	c_u 9 kN/m^2 SPTs 2-7 N	5-31	-	-	15	0.3-1.5
Glacial Sand and Gravel	ϕ 30 °	-	-	-	-	-
Glacio-lacustrine	c_u = 70 kN/m^2 ϕ' = 28° (triaxial compression)	23	-	-	20	0.1 – 0.30
Glacial Till	c_u =50 – 250 kN/m^2 ϕ' = 28°	23	-	-	15-30	0.05-0.2

Table 5-2 Engineering Ground model-strength and compressibility for the route

The general proven thicknesses of each material is shown in Table 5-3.

Table 5-3 Ground Units average thickness proven in boreholes

Unit	Depth Encountered (mbgl)	Thickness (m) (range)
A – Made Ground	0	1.2 (0.0 – 3.7)
B – Alluvium	0	0.5 (0.0 – 1.2)
C – Glacio Fluvial deposits	2	1 (0.0 – 7.1)
D – Glaciolacustrine Deposits	4	1.5 (0.0 – 4.1)
E – Glacial Till	1.5	7 (0.0 – 24.7)
F – Bedrock (Interbedded)	8.5	N/A unproven

5.2 Unit A – Made Ground

The made ground occurs sporadically and is variably described as summarised in Table 4-15.

Classification tests indicate moisture content ranging from 13 to 40% with a standard deviation of under 5 for a mean of 22%. Fourteen from 16 plasticity tests undertaken, plot above the A line and 12 out of 16 are representative of intermediate plasticity. The Plasticity Index (PI) of the material ranges from 12 to 26 with a standard deviation of 3.8 for a mean of 19.2%. These plots are shown in Figure B10 to B11 in Appendix B.

The undrained shear strength (c_u) has been obtained from 3 triaxial tests completed on made ground samples (BH1028, BH1044 and BH1041) which represents the material to the north of Ch. 10000m. Results of 21, 20 and 21 kN/m^2 respectively were obtained indicating a clay of soft consistency. This is confirmed by SPT 'N' values of 6 to 9 within the same deposit which can be correlated to undrained shear strength of between 25 kN/m^2 and 40kN/m^2. Higher values for undrained shear strength have been recorded where SPT 'N' values are N 50.

Contamination testing has been completed on samples of Made Ground, however, these were completed ten years ago, and natural processes may make the result invalid. The results indicated that only 4 out of 14 tests exceeded screening values set by the environmental specialist at that time[6]. Of these all but one were related to Total Petroleum hydrocarbons and Polyaromatic Hydrocarbons.

5.3 Unit B – Alluvium

Alluvium is evident within the River Wansbeck, River Lyne and the River Coquet catchment and flood plains. It has been encountered in 8 boreholes along the route directly within the watercourses of Floodgate Burn, Earsdon Burn, The River Lyne, Longdike Burn and the River Coquet during the investigation for the Offline Green route. All routes cross these watercourses and are expected to encounter localised alluvium at the proposed crossings.

At Longdike Burn (Ch.10180m), BH1028 (WYG 2006) the material was described as very soft dark grey very sandy clay underlain by glacial till.

Single moisture content at 5.5m depth is 13%. Plasticity Index tests result in 18% PI and a liquid limit of 33% and a plastic limit of 15%. SPT tests are summarised below. A summary of SPT'N' values within alluvium are given in Table 5.4.

Table 5-4 - Alluvium SPT results from BH1028

Depth	SPT 'N' Value	Description
4 – 4.5m	7	Top of layer overlain by made ground
5 – 5.45m	1	Base of soft clay

One triaxial test was completed on a recovered U100 sample in BH1010 (Ch.4050m). A moisture content of 31% and undrained shear strength of $9kN/m^2$ was derived.

There is limited data for alluvium along the route and a further investigation, in areas where it occurs, is required for the preferred option.

5.4 Unit C – Glacial Sands and Gravels

Extensive research (Reference 23-26) has been undertaken into the occurrence, formation and engineering properties of Northumberland glacial deposits on account of their major significance in the economic recovery of underlying coal. As a result comprehensive data is available to characterise the material in terms of its total and effective shear strength, elastic and consolidation characteristics, permeability and its remoulded properties for assessment of re-use potential as earthworks.

Glacial sand and gravel occurs directly below the alluvium or at depth interlayered with glacial till and laminated glacial clay. It occurs as beds or lenses and can vary significantly in particle size distribution, thickness and lateral extent.

Fluvio-glacial sand and gravel along the route are represented by slightly clayey slightly silty, slightly gravelly sand. From PSD tests the average sand and gravel content is 68%. From 22 tests, 3 tests from TP1277 and TP1298 indicated a clay and silt fraction greater than the combined sand and gravel.

The lenses of sands and gravel range from 0.2m to 7.1m thick and appear not to be largely represented within the glacial succession.

5.5 Unit D – Glacio-lacustrine deposits

The glacio-lacustrine deposits have been identified within the route and are located between an upper and lower glacial till (research has called these a lower ablation till and a basal glacial till[16]). The lacustrine deposits are clay and silt (often varved) having formed in lakes between periods of ice advancement and retreat. The material's absence of coarse particles such as gravels and cobbles with fine silt and fine sand partings is a noticeable feature.

Lacustrine deposits have been encountered within BH1030 and BH1031 between Ch. 10451m and 11570m for the green route, where they are described as stiff to firm thinly laminated dark grey / brown clay. Also, within BH1045 at Ch. 13390m, the material was described as thinly laminated dark grey brown sandy silt. It was encountered at 54.7mAOD, which is 4.2m bgl for a thickness of 4.1m.

A summary of laboratory derived plasticity and stiffness results are summarised in Table 5.5.

Table 5-5 - Glaciolacustrine deposits table of properties

Property	Range	Standard deviation	Characteristic Value	Most probable
Moisture Content (%)	18 – 34	4.94	29	23
Plasticity Index (%)	12 – 31	7.9	23	20
Undrained Shear Strength (Triaxial) (kN/m^2)	24 – 29	N/A	24	24
Undrained Shear Strength (SPT/ cu derived) (kN/m^2)	13.5 – 225	87.8	30	70
One dimensional volume compressibility (m^2/kN)	0.09	N/A	0.1	0.1

For this section the thickness of the material ranges from 0.5m to 4.1m. A moisture content of between 18 – 34% with a characteristic value of 29% is derived. The clay is of intermediate to high plasticity.

Effective stress parameters published for this material range from ϕ' values of 24° to 36° with a mean value of 28° (Reference 25).

5.6 Unit E – Glacial Till

A drawing showing the depth to bedrock (alternatively the total thickness of the glacial deposits) is presented as Figure 1 in the Statement of Intent and reproduced as Figure B17. The route extends from north Morpeth (Ch. 900m), where the till is moderately thin, in the order of 5m, however the first of two buried glacial channels become evident as the deposit gradually thickens, forming a flat 17m to 19m base depth for about 3km. At Tritlington the till is again of moderate thickness, in the order of 7m. Gradually as the route approaches Causey Park, it thins to be absent where the igneous intrusion surfaces. North of Causey Park the moderately thick till (circa 7m) extends to Helm (Ch.8900m). At Helm the deposit thickens rapidly to form a narrow buried valley with a base depth 25m bgl. This depth extends over about 2.5km northwards before again rapidly thinning just south of the Felton Bypass tie in. A third buried valley is evident almost immediately north of this section. Buried valleys are centred at approximate Ch4000m, Ch7000m and CH10500m.

The glacial till varies in thickness across the site from 0m at Causey Park and the River Coquet to an proven thickness of 25.5m at BH1027 (CH 9500m), although bedrock is not encountered at this depth. A total thickness of up to 45m, is locally possible.

The Preliminary geotechnical report (Reference 10) which investigated the glacial material Unit E along its full length (albeit the data was aligned for the off line option) evaluated a large volume of data and presented the following summary.

Table 5-6- Geotechnical Properties of Glacial Till (Reference 28)

Geotechnical Property	Typical Range	Preliminary Design Values
Natural Moisture Content (%)	10-30	20
Plasticity Index (%)	15-30	22
SPT		N=2z+4 (CCE) N=2.6z+9 (CMP)
Undrained Shear Strength (kN/m^2)		N=8.6z+10 (CCE) N=12.5z+50 (CMP)
Effective Angle of Shear Resistance		28°
Bulk Density (Mg/m^3)	1.95-2.25	2.15
Effective Cohesion (kN/m^2)		0
Equilibrium CBR		3%
Optimum Moisture Content (2.5kg rammer) (%)	12-18	15
Optimum Moisture Content (4.5kg rammer) (%)	10-15	12
Lime Consumption (%)	3.45-4.6	4
One dimensional volume compressibility, m_v (m²/MN)	0.1-0.2	0.15
Compression index, c_c	0.05-0.15	0.1
Swelling index, c_s	0.01-0.05	0.03
Coefficient of consolidation, cv (m²/year)	1-9	3

(CCE = Characteristic Cautious Estimate) (CMP= Characteristic Most Probable)

The mottled clay is a recently weathered upper zone. The red material is a weathered layer thought to result from weathering within the glacial and interglacial period. The unweathered grey clay (referred to as ablation till) has undergone no oxidation following deposition. The Grey basal till exhibits an identifiable reduction in moisture content and an increase in strength/ reduction in compressibility.

Extensive research into the glacial deposits in the area has been carried out and a number of sources have been identified assessing a significantly large data for the whole glacial till succession. At Acklington Opencast Site, to the south east of the route data has been summarised and presented in Table 5.7 below.

Table 5-7 - Classification and strength data for soils at Acklington mound (Reference 23)

Soil	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Undrained Shear Strength (kN/m2)	Effective Angle of Friction ϕ'(°)
Subsoil	19	40	17	90	(30)*
Mottled clay (unit 1)	18 (17)	39 (33)	17 (10)	124 (150)	(30)
Red brown till (Unit 2)	16 (14)	37 (34)	17 (14)	150 (180)	(28)
Grey till (Unit 3)	12 (12)	30 (32)	14 (15)	305 (200)	(31)

*The figures in brackets refer to typical values for those soils taken from an extensive database from the region.

Taken from an extract from Plate 5-1:

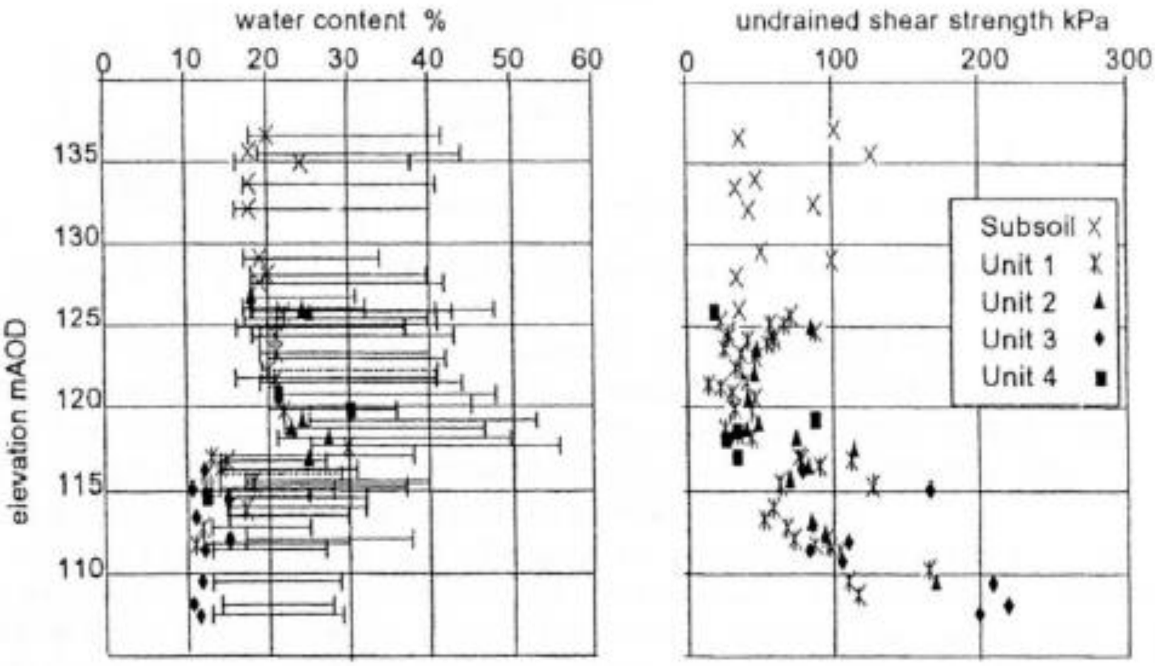

Plate 5-1 - Typical classification profile at Acklington Coal (Reference 23)

This is largely confirmatory of the values obtained from the site specific data. It does identify the undrained shear strength of the glacial till as high which has been recorded in the site specific data at shallow depth.

Compaction tests undertaken predominantly within the weathered glacial till indicate a range of values between m_{opt} = 10 % and 18 % with corresponding maximum dry density between 1.7 and 2.02Mg/m^3.

Moisture Condition Value tests have been undertaken on mottled brown clay and a range of values between 7 and 14 are derived at moistures ranging from 16 and 23%. Re-use value for all glacial till from weathered to fresh and very stiff is high.

California Bearing Ratio (CBR) determinations on the weathered till has shown that unsoaked values between 0.2% and 9% with a mean of approximately 4% are typical. Soaked tests, on samples from the weathered glacial till, return a mean value of approximately 3.5%.

5.7 Unit F – Bedrock units

The bedrock encountered across the site is the Stainmore Formation and the Upper Limestone series of the Yoredale Formation of the Carboniferous. The Causey Park Fault and discordant dykes cross the route at approximately Ch. 8000m

The Sandstone, siltstone, mudstone, shale, coal and fireclay of the Stainmore group have been intercepted between 2.3m bgl and unproven at 26m bgl across the site. The material is interbedded and from available laboratory testing on rotary cored samples, are characterised by a range of unconfined compressive strengths from 0.2 to 5.3 MN/m^2 within weakly laminated mudstone described as shale and Sandstone. A detailed geological section across the Coquet Valley dated 1978, at the existing A1 Bridge position is reproduced in Appendix C as Figure C3.

6 Preliminary Engineering Assessment

The dualling of this section of the A1 north of Newcastle requires adapting the current transport corridor. Three design options have been developed and the following sections outline the available information.

The options can be quickly summarised into the following sections where the proposed routes differ in underlying soil.

Table 6-1 - Sections of earthworks along the site

Section	Chainage from (m)	Chainage to (m)	Comments
1	0	3600	Online dualling for all options
2	3600	6238	Within glacial valley across the site, options diverge at the beginning of the chainage.
3	6238	8270	Offline option west of existing carriageway and within second glacial valley characterised by bedrock depth.
4	8270	9900	Options merge back to online options from offline and online options
5	9900	13740	Online dualling for all options and River Coquet Crossing

The following Sections outline the differences in the proposed earthworks for the proposed routes.

6.1 Earthworks Description

6.1.1 Cuttings

Along the length of the site, the cuttings required for the proposed route alignments are identified in Table 6-2. Cuttings to a depth of 10.5m bgl are required. The side slopes for the preliminary design have been based upon 1V in 3H. The effective angle of friction for the glacial till of 28° is expected to be stable at that design angle, however, the laminated clay and lenses of silt and sand within the glacial till may present areas where this design will not be suitable. Further ground investigation shall confirm the thickness and strength of these laminations throughout the material.

Cutting heights are based on preliminary values with a design slope of 1V:3H as shown on overview drawings, located in Appendix A. Ground conditions have been determined from existing ground investigation data from within close proximity of the earthworks structures.

Table 6-2 - Length of Cuttings along the proposed routes

Chainage from (m)	Chainage to (m)	Length (m)	Maximum height	North / southbound side of carriageway.	Orange Route	Blue Route	Green Route	Ground conditions
1290	1350	60	Circa 6.5m	Northbound	X	X	X	Very soft to very stiff glacial till to 19m bgl underlain by moderately strong Sandstone. Possible laminated clay at 6 to 10m bgl.
6470	6510	40	Circa3.5m	Northbound		X		Very stiff basal glacial till to 8m bgl underlain by weak to strong laminated sandstone. Proposed design of 1V in 3H.
6620	6820	200	Circa 5m	Northbound & Southbound		X		Very stiff basal glacial till to 8m bgl underlain by weak to strong laminated sandstone. Proposed design of 1V in 3H.
7580	7720	140	Circa 3m	Southbound			X	Firm laminated glacial till underlain by medium dense gravel at 3m – 4m further underlain by stiff glacial till to a depth of 16m bgl. The base within granular material may lead to seepage at the base of the cutting.
8500	8760	260	Circa 6.5m	Northbound & Southbound			X	Firm to very stiff glacial till to 6mbgl underlain by sandstone recovered as gravelly sand. Cutting expected to be based within the bedrock. Bedrock is expected to be weathered sandstone. Sandstone may require ripping.
8760	8930	170	Circa 5m	Southbound		X		Firm to very stiff glacial till to 6mbgl underlain by sandstone recovered as gravelly sand. Cutting expected to encounter weathered sandstone at the base. Weathered sandstone should not require ripping.
9470	9520	50	Circa 6m	Northbound & Southbound			X	Firm to stiff glacial till to a depth of 25m bgl. Depth of cutting within the glacial till. Preliminary batters of 1V in 3H side slope angles.
12180	12510	330	Circa 10.5m	Southbound	X	X	X	Stiff glacial till underlain by weak bedrock with shallow coal to a depth of 12m bgl. Mine workings unproven. Local dip of mudstone into excavation may lead to plane or wedge failure. Requires assessment. Additional coal band at 19m bgl.

Chainage from (m)	Chainage to (m)	Length (m)	Maximum height	North / southbound side of carriageway.	Orange Route	Blue Route	Green Route	Ground conditions
12510	12650	140	Circa 3.5m	Southbound	X	X	X	Stiff glacial till underlain by coal at 2.5m and the cutting base within sandstone. Coal bearing layer is expected. Coal and rock bedding and jointing to be clarified.
12900	13060	160	Circa 6m	Southbound	X	X	X	Firm to stiff glacial till with occasional lenses of sand to a depth of 10m bgl further underlain by very weak to weak mudstone and siltstone. Base of the cutting to be within glacial till. Boulders present and may present occasional variability in strength for the subgrade.
13060	13260	200	Circa 3.5m	Southbound	X	X	X	Made ground of reworked glacial till present across the site. The made ground has moderate strength but waste material throughout associated with the industrial history of the area. Likely to be classed as 'unsuitable' for re-use apart from 4F landscape fill.
13460	13700	240	Circa 5.5m	Southbound	X	X	X	Stiff glacial till interbedded with loose sand and laminated silt to a depth of 8.5mbgl. The cutting is expected to be based within the laminated silt which is likely to be weak and prone to sliding. Reduced side slope dimensions may be required to provide stability within the cutting.

6.1.2 Embankments

New or modified embankments are required up to 12m in height. The embankments are normally associated with the access roads approach embankments and watercourse crossing points which run generally west to east.

Table 6-3 identifies the embankments along the length of the route for the three route proposals. Embankment heights are based on preliminary values with a design slope of 1V:3H as shown on overview drawings, located in Appendix A. Ground conditions have been determined from existing ground investigation data from within close proximity of the earthworks structures.

Table 6-3 - Length of embankments along the proposed route

Chainage from (m)	Chainage to (m)	Maximum Height (m)	Length (m)	North / southbound side of carriageway.	Orange route	Blue Route	Green Route	Ground Conditions
1790	1880	Circa 3m	90	Northbound	X	X	X	Firm glacial till to a depth of 17m underlain by sandstone. There are no exceptional foundation or embankment slope issues envisaged. It is expected that site won glacial material will be used as Class 1 and 2 embankment fill. Indicative side slope angle of 1V:3H achievable subject to design confirmation.
2200	2270	Circa 7m	70	Overbridge both sides	X	X	X	Stiff glacial till to a depth of 4.4m bgl further underlain by a medium dense gravel proven to a depth of 6.2m. Conventional earthmoving equipment is envisaged within the cutting. Boulders present at formation to be removed.
3600	3670	Circa 3.5m	70	Northbound		X	X	Stiff to very stiff glacial till proven to a depth of 10m bgl. Occasional cobbles of sandstone present within boreholes.
3940	4140	Circa 8m	200	Southbound	X	X	X	Stiff to very stiff glacial till proven to a depth of 10m bgl. Occasional gravel of mixed lithology throughout. Material strength is expected to be suitable for embankment loading without undue settlement. Possible alluvium expected surrounding the watercourses to excavate and replace if found.
4860	5010	Circa 7m	150	Overbridge Northbound & Southbound	X	X	X	Soft clay underlain by stiff glacial till further underlain by sandstone at 7m bgl. Consider removal of upper soft clays prior to embankment loading.
5500	5590	Circa 3.5m	90	Southbound	X	X		Firm glacial till underlain by medium dense to dense sand to 3m bgl. Bedrock is expected to be underlying very dense sand. Borehole information is based from the offline option (i.e. over 500m away).

Chainage from (m)	Chainage to (m)	Maximum Height (m)	Length (m)	North / southbound side of carriageway.	Orange route	Blue Route	Green Route	Ground Conditions
6910	7060	Circa 6.5m	150	Southbound	X	X (8m)	X (4.5m)	Soft clay alluvium to a depth of 2m bgl further underlain by stiff glacial till to a depth of 14m bgl. Alluvium to be excavated and replaced with suitable fill for the embankment construction.
7450	7510	Circa 7m	60	Overbridge Northbound & Southbound		X		Firm to very stiff glacial till to a depth of 10m further underlain by weak to strong interbedded mudstone and sandstone. Occasional lenses of sand throughout the material, anticipate ground water entry to excavations in sand.
7600	7660	Circa 7m	60	Overbridge Northbound & Southbound	X			Firm to very stiff glacial till to a depth of 15m further underlain by weak to strong interbedded mudstone and sandstone. Occasional lenses of sand throughout the material.
7650	7690	Circa 5m	40	Overbridge Northbound & Southbound			X	Firm to very stiff glacial till to a depth of 15m further underlain by weak to strong interbedded mudstone and sandstone. Occasional lenses of sand throughout the material. Material strength is expected to be suitable for the embankment widening.
8260	8300	Circa 3m	40	Southbound		X		Firm to stiff glacial till proven to a depth of 8m bgl. Occasional cobbles throughout. Material strength is expected to be suitable for the embankment widening.
8770	8930	Circa 4.5m	160	Southbound		X		Frim to stiff glacial till interbedded with lenses of dense sand. Bedrock is expected at a depth of 5-6m bgl Adequate bearing capacity is expected for the proposed embankment.
8910	9230	Circa 5.5m	320	Northbound	X			Stiff glacial till with occasional cobbles proven to a depth of 7m bgl. Glacial till is identified as being indistinctly laminated which will require consideration of lateral movement as the embankment is built.

Chainage from (m)	Chainage to (m)	Maximum Height (m)	Length (m)	North / southbound side of carriageway.	Orange route	Blue Route	Green Route	Ground Conditions
9080	9300	Circa 5m	220	Northbound & Southbound		X		Stiff glacial till with occasional cobbles proven to a depth of 7m bgl. Glacial till is identified as being indistinctly laminated which may need further consideration during investigations.
9830	10025	Circa 3.5m	195	Northbound			X	Made ground and alluvium to a depth of 5.5m bgl further underlain by laminated stiff glacial till. Excavation and replacement of soft clay and loose sand may be required, or some form of ground treatment prior to construction. (e.g. piled embankment)
10025	10210	Circa 4m	185	Northbound	X			Made ground and alluvium to a depth of 5.5m bgl further underlain by laminated stiff glacial till. Excavation and replacement of soft clay and loose sand for the length of the proposal may be required as above.
10130	10180	Circa 4m	50	Southbound	X			Made ground and alluvium to a depth of 5.5m bgl further underlain by laminated stiff glacial till. Excavation and replacement of soft clay and loose sand for the length of the proposal cannot be ruled out. Attention should be given to bearing capacity failure in glacio-lacustrine clays during design as above..
11810	11870	Circa 7m	60	Overbridge Northbound & Southbound	X	X	X	Made ground underlain by firm to stiff laminated clay to a depth of 20m bgl where coal is encountered. Embankment height may overstress laminated clays. Consider bearing capacity failure condition during construction. Embankment side slopes (1V:3H) proposed are not considered a constraint, but should be checked at design stage.

Chainage from (m)	Chainage to (m)	Maximum Height (m)	Length (m)	North / southbound side of carriageway.	Orange route	Blue Route	Green Route	Ground Conditions
13360	13390	Circa 12m	30	Southbound	X	X	X	Stiff glacial till interbedded with loose sand and laminated silt to a depth of 8.5mbgl. The cutting is expected to be based within the laminated silt which is likely to be weak and prone to sliding from pressure of embankment. Reduced side slope dimensions may be required to provide stability within the cutting.

6.1.3 Subgrade

The sub-grade formation is expected to alternate between in situ soils, ranging from stiff glacial till, laminated glacial clay, local areas of glacial sand and very occasional alluvium, and embankment capping material (class 6F). From an estimation of soil distribution along the route, available excavated material suitable as general fill for re-use in embankments is likely to be cohesive (Class 2A, B or C).

On that basis a sub-base design CBR between 2.5 and 5% is likely achievable along the whole route length. Results of compaction and laboratory soaked and un-soaked data reviewed confirm this as a viable outcome.

However the glacial clays are occasionally high plasticity and in periods of wet conditions it is to be expected that prepared or in situ subgrade fails to meet the anticipated value. Minimum subgrade, undrained strength of 50kN/m^2 should be specified to identify 'soft' areas. Soft spots, when encountered, should be replaced with a capping layer or pavement layer aggregate.

Should alluvium be encountered at formation, it is likely to be soft and require removal and replacement.

6.2 Structure Foundations

The structures that are proposed or required to be adapted are listed in Table 6-4.

Table 6-4 - List of structures and expected ground conditions across the site

Structure	Orange	Blue	Green
Culvert (CH.1820m)	10m extension of the culvert on the northbound side. Ground conditions expected to be glacial till proven to a depth of 14.55m (BH1002 @ Ch1800m). Conventional extension methods are envisaged to suit the existing structural form.		
Highlaws Road Junction (CH.2050 – 2270m)	New 32m length overbridge and approach embankment for grade separated junction and balancing ponds. Ground conditions expected to be glacial till proven to a depth of 6m with interbedded silt and medium dense gravel (BH1004@CH.2180m) with very stiff basal lodgement till to bedrock at 18m bgl (BH1002R @ CH2120m). Spread foundations are a possible solution provided lateral forces can be accommodated. A piled foundation should cater for all structural eventualities. Significant total and differential settlement between the bridge and embankments is not envisaged.		
Floodgate Burn Culvert (CH.3650m)	12m extension to the culvert on the northbound embankment. Ground conditions expected to be stiff to very stiff till to a proven depth of 10m bgl (BH1007 @CH.3680m). Conventional shallow foundations for culvert base and wing walls are anticipated to be acceptable.		
Box culvert adjacent to Priests bridge (CH.4000m)	N/A	N/A	70m x 3.7m Box culvert structure with overpass for dual carriageway. Ground conditions are expected to be firm to stiff glacial till to a proven depth of 15m bgl (BH1009 @CH.4050m). Prepared formation to support ground bearing box is anticipated to be feasible. Bearing pressure and uplift pressures are

Structure	Orange	Blue	Green
			likely to be nominal. Total and differential settlement not envisaged to be prohibitive.
Priests Bridge (CH4000m)	Bridge widening of 5m over 10m length for dualling with raised embankment on the northbound side. Ground conditions are expected to be firm to stiff glacial till to a proven depth of 15m bgl (BH1009 @CH.4050m). Spread foundations are feasible depending upon lateral forces resulting from approach embankment loads. Piled foundations are an alternative.		N/A
Fenrother Junction (CH.4900 - 5000m)	New 32m (36m Green route) length overbridge and approach embankments for grade separated junction and balancing ponds. Ground conditions expected to be firm to very stiff lodgement till to a depth of 7.7m bgl underlain by weak to strong mudstones and sandstones to depth. Ground conditions based on Green route boreholes (BH1012R@ CH.4950m). Online routes not covered by historical ground investigation. Spread or shallow piled group foundations are both feasible depending on depth to very stiff glacial till. Bedrock at an elevation that requires the investigation of possible mine voids. Mine searches may eliminate this risk.		
Earsdon Burn Culvert (CH.6980m)	15m culvert extension on the northbound side for extension of dual carriageway. Ground conditions are soft to very stiff glacial till (possibly alluvium) to a depth of 14m bgl (BH1015 @CH.7030m). Outside of the investigated area during initial GI. With shallow soft clay feasible to remove and adopt spread foundations. Piles an alternative should the soft soils extend to moderate depth.	70m box culvert and approach embankments. Ground conditions are soft to very stiff glacial till to a depth of 14m bgl (BH1015 @CH.7030m). Outside of the investigated area during initial GI. Foundation solution and embankment construction sequence will depend upon thickness of soft layer.	40m box culvert required for dual carriageway overpass. Ground conditions are soft to very stiff glacial till to a depth of 14m bgl. (BH1015 @CH.7030m).
Overpass (CH.7000m)	Pedestrian overbridge 50m length by 5m wide Ground conditions are soft to very stiff ablation till to a depth of 14m bgl (BH1015 @CH.7030m). Spread foundations will depend upon depth to very stiff	N/A	N/A

Structure	Orange	Blue	Green
	glacial clay. Piled group a feasible alternative.		
Causey Park Overbridge (CH.7600m)	N/A	N/A	34m bridge and approach embankments for side road crossing. Ground conditions are firm to stiff glacial till to 16m depth underlain by weak to strong interbedded mudstone and sandstone. (BH1017 @CH7655m). Piled foundations are feasible terminating in the very stiff glacial soil. Firm clay unlikely as a suitable bearing horizon for the bridge foundations. Embankment constructed in advance possibly in stages if firm layer is thick. Shallow underground mine voids a risk at this locality.
Earsden Junction (CH.7600m)	32 m length overbridge for compact grade separated junction and approach embankment. Ground conditions are firm to stiff glacial till to 16m depth underlain by weak to strong interbedded mudstone and sandstone (BH1017 @CH7655m). No ground investigation on location for structures on online options. Spread foundations for bridges a possible alternative to piled groups.		N/A
Burgham Underbridge (CH.9450m)	N/A	N/A	10m length 25m wide underbridge for dual carriageway and cuttings for access road. Ground conditions are firm to stiff glacial till underlain by basal lodgement till from 10m to 25m bgl (BH1027 @ CH9510m). Spread foundations are a possible solution against a feasible piled group.
Longdike Burn Culvert (CH10200m Orange Route)	20m culvert extension both north and southbound side. Ground conditions are soft sandy clay alluvium to 5.6m underlain by stiff ablation till to a depth of 20m bgl (BH1028 @ Ch.10000m). Possible spread foundation (raft) depending upon bearing and uplift pressures. Piled group through soft alluvium into stiff glacial clay a feasible alternative.		30m extension on the northbound side for carriageway loading. The ground conditions are soft sandy clay alluvium to 5.6m underlain by stiff ablation till to a depth of 20m bgl (BH1028 @ Ch.10000m).
Westmoor Junction (CH.11500 – 11600m)	37m overbridge with approach embankments for grade separated junction. Ground conditions are firm to stiff glacial till with occasional laminations throughout. (BH1031 @CH11570m). Confirmation of the extent of		30m overbridge with approach embankments for grade separated junction. Ground conditions are firm to stiff glacial till with occasional laminations throughout.

Structure	Orange	Blue	Green
	the laminations and the effect on embankment stability are to be investigated.		(BH1031 @CH11570m). Confirmation of the extent of the laminations and the effect on embankment stability are to be investigated.
Culvert (CH.12050m)	Culvert Extension of 15m on the southbound side. Ground conditions are firm to stiff glacial till with occasional laminations throughout. (BH1031 @CH11570m). Confirmation of the extent of the laminations and the effect on embankment stability are to be investigated, but not directly on top of likely structural foundation locations. Spread foundations (raft) are likely to be feasible.		
River Coquet Bridge (CH.12700m)	200m length 13.5m wide overbridge deck to be constructed adjacent to current structure. Ground conditions are glacial till overlying weak mudstone and coal at 5.7m bgl, further underlain by moderately strong sandstone to 15m bgl on the southbound side (BH1036 @12490m) and soft to firm glacial till underlain by very weak laminated mudstone and moderately strong limestone (BH1038 @CH.12685m) on the northbound side. Complex foundation issues involving the sloping valley that may be unstable, shallow coal and weak rock at surface, bridge foundation interaction with existing structure are present. Likely foundation solution will be similar to that currently employed in the existing bridge.		
Parkwood Subway (CH.13300m)	Extension of existing structure to 8m length by 14m wide. Ground conditions are Made Ground of reworked basal lodgement till to 16m bgl (BH1044 @CH.13135m and stiff clay and loose sand underlain by laminated silt at 4.3m bgl which is underlain by stiff basal glacial till at a depth of 8.4mbgl (BH1045 @ CH.13390m). In view of made ground thickness should attempt to found in the re-worked glacial till. Total and differential settlement will govern feasibility of shallow foundations.		
Culvert (CH.13380m)	A 20m culvert extension on the southbound side Ground of reworked basal lodgement till to 16m bgl (BH1044 @CH.13135m and stiff clay and loose sand underlain by laminated silt at 4.3m bgl which is underlain by stiff basal glacial till at a depth of 8.4mbgl (BH1045 @ CH.13390m). Foundations comments as for Parkwood Subway.		

6.3 Drainage

Earthworks drainage will take the form of longitudinal toe drains in cuttings and open drains at the crest of cuttings and toe of embankments. These will be incorporated into a drainage system involving the creation of swales and shallow balancing ponds and outlet structures. Online options require a greater number of balancing ponds than are expected for the offline options. Table 6-5 summarises the number of balancing ponds considered necessary.

Table 6-5 - SUDS ponds indicative location along the site for the 3 route options

Orange Route		Blue Route		Green Route	
Chainage	No.	Chainage	No.	Chainage	No.
1090 – 1140m	1	1090 – 1140m	1	2120 – 2230m	3
2120 – 2230m	3	2120 – 2230m	3	3920 – 4000m	3
3860 – 3920m	1	3860 – 3920m	1	6950 – 7050m	2
4040 – 4100m	1	4040 – 4100m	1	9300 – 9400m	2
4720 – 4760m	1	4720 – 4760m	1		
4830 – 4865m	1	4830 – 4865m	1		
4940 – 4970m	1	4940 – 4970m	1		
6540 – 6600m	1	7520 – 7570m	2		
6700 – 6770m	1	8050 – 8090m	1		
8260 – 8290m	2	9620 – 9700m	2		
10210 – 10340m	2	10240 – 10320m	1		
11700 – 11760m	2	10330 – 10400m	1		
		11740 – 11800m	2		

6.4 Contaminated Land Assessment

There are a number of potential sources of contamination within the study area. Table 6-6 below summarises the contaminant sources and the potential pathways, receptors and management options. The possible contaminants associated with these sources are detailed in Table 4-14. The main factors related to contaminated land that will influence the option selection for the scheme are summarised in Table 6-6.

Table 6-6 Contaminated land assessment

Potential Source	Potential Migration Pathways	Potential Receptors	Management Options
Existing Road Network (A1)	• Underground service conduits and trenches • Groundwater flow beneath the site • Surface water flow • Made ground acting as a preferential pathway for contaminant migration • Direct contact with soil / groundwater and inhalation of soil dust	• Site workers • Construction materials • Surface waters • SSSI • Groundwater	• Utility pit vapour monitoring • Soil, gas and groundwater sampling on site • Appropriate OHS techniques to minimise potential exposure

Potential Source	Potential Migration Pathways	Potential Receptors	Management Options
Agriculture	• Underground service conduits and trenches • Groundwater flow beneath the site • Surface water flow • Made ground acting as a preferential pathway for contaminant migration • Direct contact with soil / groundwater and inhalation of soil dust	• Site workers • Construction materials • Surface waters • SSSI • Groundwater	• Utility pit vapour monitoring • Soil, gas and groundwater sampling on site • Appropriate OHS techniques to minimise potential exposure
WW2 Airfield and associated buildings	• Underground service conduits and trenches • Groundwater flow beneath the site • Surface water flow • Made ground acting as a preferential pathway for contaminant migration • Direct contact with soil / groundwater and inhalation of soil dust	• Site workers • Construction materials • Surface waters • Groundwater	• Utility pit vapour monitoring • Soil, gas and groundwater sampling on site • Appropriate OHS techniques to minimise potential exposure
Garage and historical filling station	• Underground service conduits and trenches • Groundwater flow beneath the site • Surface water flow • Made ground acting as a preferential pathway for contaminant migration • Direct contact with soil / groundwater and inhalation of soil dust	• Site workers • Construction materials • Surface waters • Groundwater	• Utility pit vapour monitoring • Soil, gas and groundwater sampling on site • Appropriate OHS techniques to minimise potential exposure
Infilled ponds/ quarries and historical landfills	• Underground service conduits and trenches • Groundwater flow beneath the site • Surface water flow • Made ground acting as a preferential pathway for contaminant migration • Direct contact with soil / groundwater and inhalation of soil dust • Migration and accumulation of ground gases in excavations / confined spaces	• Site workers • Construction materials • Surface waters • SSSI • Groundwater	• Utility pit gas/vapour monitoring • Soil, gas and groundwater sampling on site • Appropriate OHS techniques to minimise potential exposure

Potential Source	Potential Migration Pathways	Potential Receptors	Management Options
Foot and mouth burial pits	• Underground service conduits and trenches • Groundwater flow beneath the site • Surface water flow • Made ground acting as a preferential pathway for contaminant migration • Direct contact with soil / groundwater and inhalation of soil dust • Migration and accumulation of gases in excavations / confined spaces	• Site workers • Construction materials • Surface waters • Groundwater	• Utility pit vapour monitoring • Soil, gas and groundwater sampling on site • Appropriate OHS techniques to minimise potential exposure

Table 6-7 Evaluation of contamination-related impacts

Potential Receptors	Assessment of Impact			Comments
	Green Route	Orange Route	Blue Route	
Site Workers	Low	Medium	Medium	• Green route traverses more greenfield land so is less likely to encounter contamination associated with the A1. • Green route is not located within 250m of historical landfills. • Green route is not located within 100m of current and historical garage / filling station and only one historical tank is located within 100m of the route. • All route options located adjacent to WW2 airfield. • All route options are within 70m of foot and mouth Carcass Pit.
Surface Waters	Medium	Low	Medium	• Green route includes six new watercourse crossings. • Blue route includes one new crossing over Earsdon Burn, near Causey Park Bridge, which is in the vicinity of an old quarry and an old filling station. • Orange Route includes modification of existing crossings. •
Sites of Special Scientific Interest	Medium	Medium	Medium	• All route options share the same bridge over the River Coquet. • Modifications to the existing bridge, including earthworks and foundation construction may create new pollution pathways.
Groundwater	Medium	Medium	Medium	• All route options include new bridges at existing junctions. The use of deep / piled foundations may create pollution pathways into the underlying aquifers.

6.5 Existing Geotechnical Problems

The northbound abutment for the River Coquet Bridge has been the subject of an assessment during recent maintenance periods. The geomorphological map included in Appendix D outlines the area where rotational slips have occurred within the bedrock and superficial soils. Potential slope failures in this area will be a key risk for the development of the design for this proposal. Parkwood is a valley crossing the A1 centred approximately around chainage 13000m to north of the River Coquet. The northern and southern slopes are identified as unstable. BGS mapping identifies the valley as a landslide area. Further study of this area is recommended at detailed investigation stage.

7 Geotechnical Risk Register

The geotechnical risk register relevant to the A 1 North of Northumberland scheme is included below, as well as the Risk Rating methodology that has been applied.

The likely design risks of the project and their potential impact on the scheme are identified in the geotechnical risk register. The risk register is a semi-quantitative assessment based on engineering judgement. The assessment deals with the potential for a design hazard to occur (Likelihood) and its impact (Severity) with respect to the proposed works and scheme, where the product of Likelihood x Severity provides a measure of the assessed Risk. Recommended mitigation measures to reduce the associated risks are considered.

The mitigation measures considered are those that may be applied during design or construction, as appropriate, to mitigate against the hazard identified and, in most cases, to reduce the Risk to "As Low as Reasonably Practicable" (ALARP). For some situations the risks may have been reduced, but significant residual risk remains, which will need to be carefully controlled during construction.

When the risk assessment identifies that the risk falls into the medium to high category, control measures are required to reduce the risk to 'As Low as Reasonably Practicable' (ALARP).

Rating	LIKELIHOOD		SEVERITY
1	Very unlikely	Once in over 100 years	Incident, Minor injury, damage, sickness or other loss (with no time off). Minor impact to programme. Minor impact on scheme cost. Minor, easily rectified environmental impact.
2	Unlikely	Once in 10 to 100 years	Minor damage or loss, First Aid injury or illness, (and/or up to 3 days off) Lost time injury. Impact to programme. Small effect on scheme costs. Any environmental impact regarded as significant.
3	Likely	Once in one to 10 years	Serious / substantial damage or loss Reportable injury or illness, (or over 3 days off). Impact to construction and maintenance/operational costs/programme. Third party environmental impact requiring management response to recover.
4	Very Likely	Once in two to 10 per year	Major loss, or injury, long term absence. Significantly increased construction costs &operational difficulty. Environmental incident triggers damage &/or nuisance prosecution and / or compensation.
5	Certain	More than 10 per year	Catastrophic damage, or Fatality Construction/maintenance/operation unsustainable. Major environmental incident, threat to public health and safety.

Key	RISK		ALARP Criteria
High (H)	12 - 25	Hazard must be avoided (or the level of risk reduced significantly and reliably by controls)	Intolerable risk
Medium (M)	5 - 10	Hazard should be avoided (or the level of risk reduced significantly and reliably by controls)	Within the ALARP region, **but** the higher the number the more critical it is to reduce the risk.
Low (L)	1 - 4	Risks to be controlled	Tolerable

(1) Hazard Reference	(2) Activity/Process/ Material/Element	(3) Hazard (also indicate who is at risk and how)	(4) Stage of Work	(5) Initial Risk Level Likelihood	Severity	Risk Level	(6) Risk Control Measures: Design action taken, record of decision process including option considered, design constraints and justification for options/actions not having been taken	(7) Residual Risk Level Likelihood	Severity	Risk Level	(8) Is there a 'significant' residual risk to be passed on? (Y/N)	(9) Status (Active / Closed)
Geotechnical Risks												
1	Shallow unconsolidated mine workings	Instability of ground leading to subsidence or collapse of the infrastructure.	During Design, During Construction, Maintenance period	3	4	12	Carry out ground investigation at key structures and undeveloped land to reduce the risk of encountering unknown workings. Detailed study for the preferred option.	2	3	6	Y(Detailed study for chosen option)	Active
2	Deep underground mine working (ancient and recent)	Instability of the ground leading to subsidence or collapse of the infrastructure.	During Design, During construction, During Maintenance period.	4	3	12	Carry out a detailed ground investigation for the proposed site extents and structures where relevant.	2	3	6	Y (Passed on to drilling teams)	Active
3	Possible future mining of coal (underground and opencast)	Instability of the ground leading to subsidence or collapse of the infrastructure.	During Design, During construction, During Maintenance period.	3	3	9	Carry out a detailed ground investigation for the proposed site extents and structures where relevant.	1	3	3	Y (Passed on to drilling teams)	Active
4	Area of uncompacted opencast mining backfill	Instability of the ground leading to subsidence or collapse of the infrastructure.	During Design, During construction, During Maintenance period.	4	3	12	Carry out a detailed ground investigation for the proposed site extents and structures where relevant.	2	3	6	Y (Passed on to drilling teams)	Active
5	Mine shaft (and adits) recorded and unrecorded	Instability of the ground leading to subsidence or collapse of the infrastructure.	During Design, During construction, During Maintenance period.	4	3	12	Carry out a detailed ground investigation for the proposed site extents and structures where relevant.	3	3	9	Y (Passed on to drilling teams)	Active
6	Mine Gas	Illness or death to site workers, local residents or workforce.	During Design, During construction, During Maintenance period.	4	3	12	Carry out a detailed ground investigation for the proposed site extents and structures where relevant.	2	3	6	Y (Passed on to drilling teams)	Active
7	Acidic mine water	Emissions at surface have potential to cause widespread pollution	During construction, During Maintenance period.	4	3	12	Carry out a detailed ground investigation for the proposed site extents and structures where relevant.	2	3	6	Y (Passed on to drilling teams)	Active

8	Areas with alluvium and peat	Differential settlement and subsidence of structures founded on soft ground.	During Design, During construction, During Maintenance period.	3	3	9	Carry out a detailed ground investigation for the proposed site extents and structures where relevant.	3	3	9	Y (Passed on to drilling teams)	Active
9	Unknown groundwater depth	Potentially impact on temporary works if shallow ground water.	During Design, During construction, During Maintenance period.	3	2	6	Carry out a detailed ground investigation for the proposed site extents and structures where relevant.	2	2	4	Y (Passed on to drilling teams)	Active
10	Intermittent Laminated Glaciolacustrine deposits.	Long term failure of earthworks following construction via bearing failure and slope instability. Preferential pathway for failure within shallow slopes. Anisotropic shear strength throughout the material.	During Design, During Construction, Maintenance period.	3	4	12	Ground investigation specification to consider requirement f or sufficient samples of laminated glaciolacustrine deposits to be obtained and tested as to provide accurate representation of shear strength parameters. Detailed design to take cognisance of locations of lenses and use suitable parameters in the designs of earthworks in the area.	2	3	6	Y (Designer to speculate failure mode relating to this risk)	Active
11	Unexploded Ordnance (UXO)	Borehole drilling rigs encountering buried ordnance and force and vibration causing explosion which will be life threatening for drilling crews and excavation crews and supervisors during the ground investigation.	Ground Investigation, Piling requirements	1	5	5	Detailed Desk Study requested owing to historical land use as training location for WWII warplane training. Detailed desk study confirmed the locations of recorded ordnance and a site risk of low probability. Clearance certificate only required where risk of explosion is not accepted by the client.	1	5	5	Y (Staff to briefed on key indicators)	Active
12	Cobbles and boulders within cohesive glacial till	Damage to Ground Investigation equipment and lack of supplementary evidence of in situ strength due to lack of Class 1 Sampling	Detailed design, Ground Investigation, Structure / Earthwork construction	4	3	12	Design to take account of the possible increased in situ strength and difficulty in driving. Design parameters to include both reduced strength for earthwork stability and high strength for drivability of piles where required. Suitable section sizes to reduce diversion whilst driving where required.	2	3	6	Y (Inform variability and stratificatio n of Northumber land Till to Designer)	Active
13	Differential settlement between new and existing pavement	Failure of the carriageway due to significant level changes and increased erosion	Maintenance Period	2	4	8	Assessment of the ground conditions for long term settlement from embankment loading on undeveloped land.	1	4	4	N	Active

14	Existing road network (A1), agricultural land use, WW2 airfield, garage and historical filling station, infilled ponds/quarries, historical landfills, tanks and foot and mouth pits. Potential contamination could include: Oils/hydrocarbons, PAHs, BTEX, MTBE, VOCs, SVOCs, PCBs, heavy metals, antifreeze, brake fluids, road salt, slurry, pesticides, herbicides, fertilisers, pathogens, solvents, lubricants, fire-fighting agents and, asbestos.	Contamination could cause sickness, injury or fatality to personnel site workers through dermal contact/ingestion of soils, and inhalation of soil dust. Contaminated soils or material may require waste disposal or treatment, resulting in increased costs, programme delays and potential redesign.	Ground investigation, Construction phases	2	3	6	Undertake targeted and non-targeted contamination sampling and laboratory testing to determine the presence and extent of any contamination. This could include VOC vapour monitoring depending on the contaminant source. Undertake supplementary ground investigation to better delineate areas of significant contamination. If required, remediate the land by treatment or materials removal. Appropriate OHS techniques to be employed to minimise exposure.	1	3	3	N	Active
15	Existing road network (A1), agricultural land use, WW2 airfield, garage and historical filling station, infilled ponds/quarries, historical landfills, tanks and foot and mouth pits. Potential contamination could include: Oils/hydrocarbons, PAHs, BTEX, MTBE,	Creation of pollutant pathways during development works could cause pollution of controlled waters, including groundwater and surface waters. This could result in possible programme delays, redesign and litigation.	Ground Investigation	2	3	6	Undertake targeted and non-targeted contamination sampling and laboratory testing to determine the presence and extent of any contamination. This could include VOC vapour monitoring depending on the contaminant source. Undertake supplementary ground investigation to better delineate areas of significant contamination. If required, remediate the land by treatment or material removal. Appropriate environmental control measures to be employed during development works to prevent cross-	1	3	3	N	Active

	VOCs, SVOCs, PCBs, heavy metals, antifreeze, brake fluids, road salt, slurry, pesticides, herbicides, fertilisers, pathogens, solvents, lubricants, fire-fighting agents and asbestos.						contamination and the creation of pollution pathways.					
16	Infilled ponds / quarries and historical landfills – potential source of ground gas.	Migration and accumulation of ground gases within excavations and confined spaces into below ground structures and excavations could create a risk of explosion and/or asphyxiation.	Ground investigation, maintenance	2	5	10	Undertake targeted and non-targeted ground investigation to establish presence of ground gas, including VOC and gas monitoring. Undertake supplementary ground investigation to better delineate areas of significant ground gas. Appropriate OHS techniques to be employed to minimise exposure, i.e. passive gas monitoring within excavations and confined spaces, plus use of personal gas alarms by site workers.	1	5	5	N	Active

Design and Construction Risks

(1)	(2)	(3)	(4)	(5)			(6)	(7)			(8)	(9)
				Initial Risk Level				Residual Risk Level				
Hazard Reference	**Activity/Process/ Material/Element**	**Hazard (also indicate who is at risk and how)**	**Stage of Work**	**Likelihood**	**Severity**	**Risk Level**	**Risk Control Measures: Design action taken, record of decision process including option considered, design constraints and justification for options/actions not having been taken**	**Likelihood**	**Severity**	**Risk Level**	**Is there a 'significant' residual risk to be passed on? (Y/N)**	**Status (Active / Closed)**
17	Access to site	Single carriageway access road and side road access via main road. Driving to and from site and site and parking to access. Construction segregation required for surveys and construction for laybys.	Design, Survey Phases, Construction and Maintenance.	3	5	15	Reduce requirements to cross lanes. Protective barriers and traffic calming measures introduced where sites are not transient. Complete works from outside of the corridor where possible.	2	5	10	Y (Traffic rules on site for staff protection)	Active
18	Working on sloping ground	Ground investigation required on existing earthworks slopes. Danger to workers and to road users from falling equipment and slips trips and falls when working on a slope.	Ground Investigation, Site Inspections, Spot surveying.	2	4	8	Reduce investigation within slopes where access is difficult, in particular in the area to the north of the River Coquet overbridge. Investigation to be completed at the top of the earthworks and at the toe. Anchored slope climbing rigs only to be used within the slopes.	1	4	4	N	Active

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