A46 Newark Bypass

TR010065/APP/6.3

6.3 Environmental Statement

Appendix 9.1 A46 Newark Northern Bypass Preliminary Sources Study Report Part 1

APFP Regulation 5(2)(a)

Planning Act 2008

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

Volume 6

April 2024

Infrastructure Planning

Planning Act 2008

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

A46 Newark Bypass

Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT

APPENDIX 9.1 A46 NEWARK NORTHERN BYPASS PRELIMINARY SOURCES STUDY REPORT

PART 1

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Table of contents

Chapter		Pages
1.	**Introduction**	**6**
1.1.	Scheme Background	6
1.2.	Site Location	6
1.3.	Project Description	6
1.4.	Scope and Objective of Report	10
1.5.	Limitations	10
1.6.	Geotechnical Category	10
2.	**Sources of Information**	**11**
3.	**Desk Study**	**12**
3.1.	Topography	12
3.2.	Geology	13
3.3.	Superficial Deposits	13
3.4.	Solid geology	15
3.5.	Existing Ground Investigation Data	16
3.6.	Hydrogeology	17
3.7.	Hydrology	18
3.8.	Fluvial flooding	19
3.9.	Pluvial flooding	19
3.10.	Groundwater flooding	20
3.11.	Discharge consents	20
3.12.	Pollution incidents	20
3.13.	Mining Records	21
3.14.	Statutory Designations	21
3.15.	Waste	22
3.16.	Unexploded Ordnance	22
3.17.	Historical Development	24
3.18.	Satellite Data	26
3.19.	Existing Structures	27
3.20.	Man-Made features Satellite views	28
3.21.	Existing Earthworks	31
3.22.	Trade Directory Entries	34
3.23.	Ground Stability Hazards	35
4.	**Ground Conditions**	**40**
4.1.	Ground Summary	40
4.2.	Groundwater	45
4.3.	Summary of Preliminary Geotechnical Parameters	45
4.4.	Appraisal of Existing Ground Investigation Data	47

5. Site Reconnaissance 48
5.1. Findings of Site Walkover 48
6. Preliminary Engineering Assessment 50
6.1. Soft / Compressible Ground 50
6.2. Aggressive Ground 50
6.3. Shrink/ Well Ground 51
6.4. Weathered Ground 51
6.5. Groundwater 51
6.6. Material re-use 51
6.7. Earthwork Material 52
6.8. Drainage 52
6.9. Structure Foundations 52
6.10. Pulverised Fuel Ash (PFA) 53
6.11. Buried Services 53
7. Preliminary Land Contamination Assessment 54
7.1. Waste Classification and Re-use 62
8. Geotechnical Risk Register 63
9. References 72
Appendices (presented in Part 2 and Part 3 of Appendix 9.1 A46 Newark Northern Bypass Preliminary Sources Study Report) **73**

Tables

Table 1-1: Key Layout Differences Between the Two Options 7
Table 2-1: Sources of Information 11
Table 3-1: Existing HAGDMS Reports 16
Table 3-2: Summary of Site History 24
Table 3-3: Summary of Potential Ground Stability Hazards 35
Table 4-1: Ground Model 40
Table 4-2. Geotechnical Parameters as provided in A46/A17 Newark Relief Road Geotechnical Report from February 1987. 46
Table 4-3. Geotechnical Parameters 46
Table 7-1: Potential Sources of Contamination 55
Table 7-2: Potential Receptors and Pathways 57
Table 7-3: Preliminary Conceptual Site Model 58
Table 8-1: Impact Classification 64
Table 8-2: Risk Classification 64
Table 8-3: Risk Matrix 64
Table 8-4: Risk Classification 65
Table 8-5: Risk Assessment 66

Figures

Figure 1-1: Scheme Extents 6
Figure 1-2: Option 1 Layout Plan 8
Figure 1-3: Option 2 Layout Plan 9
Figure 3-1: LiDAR (Open source) highlighting the location of the 13m high earthwork embankments, approaching the B5 Nether Lock Viaduct. 12
Figure 3-2. Superficial Deposits (Source: BGS GeoIndex, October 2020) 14
Figure 3-3: Solid Geology. Letters refer to BGS geology codes. (Source: BGS GeoIndex, October 2020) 15
Figure 3-4: Aquifers – Superficial Deposits (Source: HAGDMS, November 2020) 17
Figure 3-5: Aquifer Designation Map – Bedrock Geology (Source: HAGDMS, November 2020) 18

Figure 3-6: Fluvial Flooding Risk Map (Source: The Flood Map for Planning [7], October 2020) 19
Figure 3-7: Unexploded Ordnance Risk Map (Source: Zetica [11]) 23
Figure 3-8: Satellite view of the A46 scheme extends 26
Figure 3-9: Satellite view of Farndon junction 28
Figure 3-10: Satellite view of Cattle market junction 28
Figure 3-11: Satellite view of Brownhills roundabout, A1/A46 crossing & Friendly Farmer roundabout 29
Figure 3-12: A46 crossing Nottingham - Lincoln rail line 29
Figure 3-13: A46 crossing East Coast Railway and viaduct over River Trent 30
Figure 3-14: Typical Embankment Cross section [16] 33
Figure 3-15 Compressible/Collapsible Ground Rating (Source: HAGDMS [12], November 2020) 36
Figure 3-16 Natural Landslides Hazard Rating (Source: HAGDMS [12], November 2020) 36
Figure 3-17: Landfill Sites Hazard Rating (Source: HAGDMS [12], November 2020) 37
Figure 3-18: Shrink/Swell Hazard Rating (Source: HAGDMS [12], November 2020) 37
Figure 3-19: Slope Hazard Rating, 2017 (Source: HAGDMS [12], November 2020) 38
Figure 3-20: Dissolution Features Hazard Rating (Source: HAGDMS [12], November 2020) 38
Figure 3-21: Coal Mining Hazard Rating (Source: HAGDMS [12], November 2020) 39
Figure 3-22: Non-Coal Mining Hazard Rating (Source: HAGDMS [12], November) 39
Figure 4-1. Plan of historic boreholes (digitised in OpenGround) 42
Figure 4-2. Geological Section 1 of 2 (digitised in OpenGround) 43
Figure 4-3. Geological Sections 2 of 2 (digitised in OpenGround) 44
Figure 4-4. Properties of soils, A46 Geotechnical Report dated September 1985 [13] 45
Figure 4-5. Effective parameters for Mercia Mudstone 47
Figure 5-1 – Photograph taken during Atkins Site Walkover beneath A46 viaduct over River Trent / East Coast Main Line 49

1. Introduction

1.1. Scheme Background

Atkins Limited have been appointed by Highways England to compile a Preliminary Sources Study Report (PSSR) for A46 Newark Northern Bypass scheme. The scheme aims to improve capacity and route standard due to the current congestion issues impacting upon the wider Newark area.

1.2. Site Location

The site is located along a section of the existing A46, northwest of Newark on Trent, with the extents of the scheme being shown in Figure 1-1. The section of the existing A46 carriageway under consideration is approximately 6.5km in length., with the proposed scope entailing the widening of the A46 between Farndon Roundabout and Winthorpe Roundabout. The scope also includes widening of associated infrastructure where the route crosses the railway line (Nottingham-Lincoln line) and the River Trent, twice.

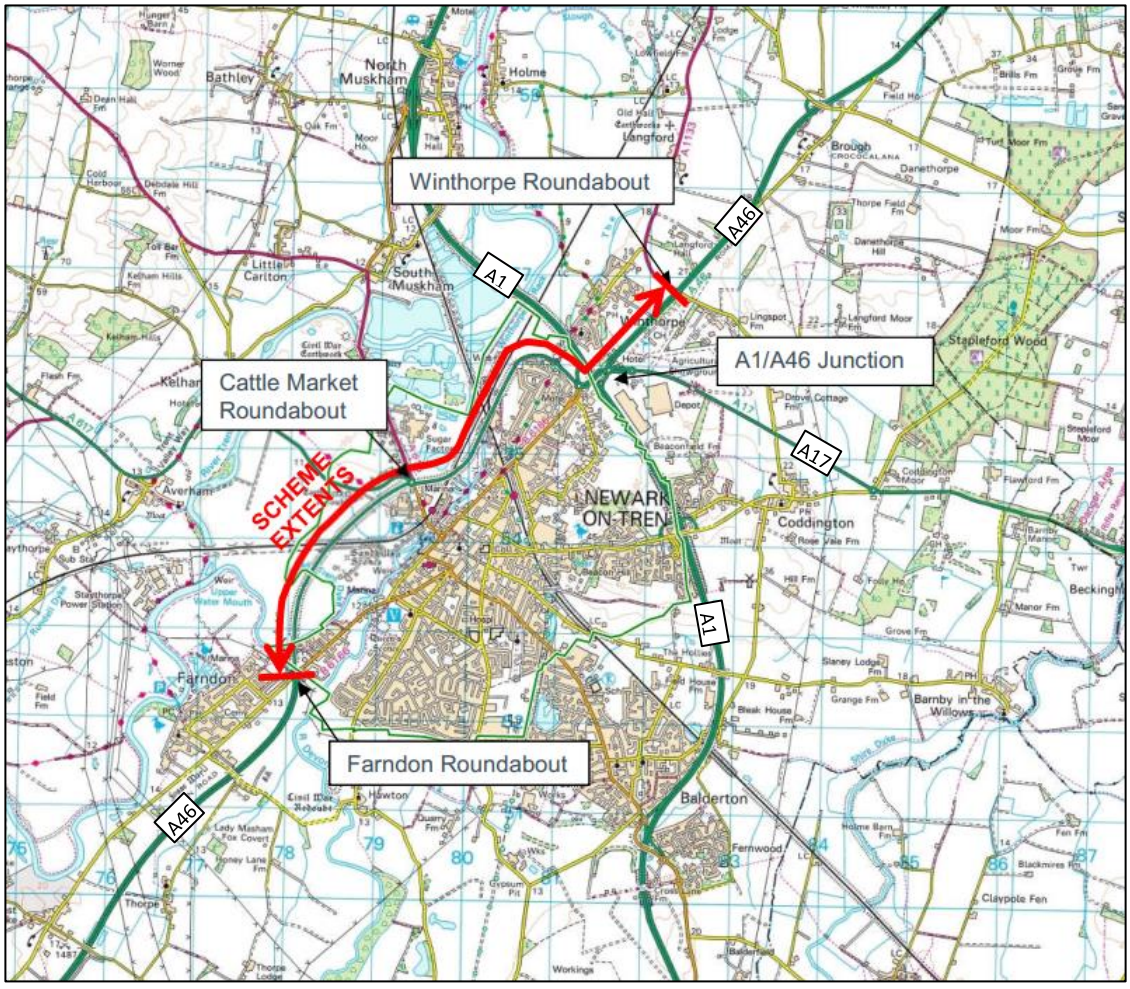

Figure 1-1: Scheme Extents

1.3. Project Description

The scheme comprises two principal solutions, Option 1 and Option 2, as presented in Figure 1-2 and Figure 1-3. Table 1-1 summarises the key

differences in layout between the two options, and these are discussed in more detail below.

Table 1-1: Key Layout Differences Between the Two Options

A46 Section	Option 1	Option 2
Farndon Roundabout	-	Signalised
Cattle Market Roundabout	Layout changed and signalised to allow A46 traffic to pass through the centre of the roundabout	Grade separated with the A46 over the roundabout.
Winthorpe	New section of A46 ties-in to existing A46 to the west of Winthorpe Junction. New link over the A46 to provide access from Friendly Farmer Roundabout to the A46 eastbound.	New section of A46 would cross over the A1 and run slightly to the north of the existing road, joining back into Winthorpe Junction.

For both options, the A46 would be widened to a dual carriageway to provide two lanes in each direction between the Farndon and Winthorpe Junctions. Both options would include a new link and a new bridge over the A1 to the north of the existing bridge, which allows traffic on the A46 to bypass the existing A1/A46 Junction and travel on to Winthorpe Junction.

In Option 1, Cattle Market Junction would be signalised, and the layout changed to allow the A46 to pass through the centre of the roundabout. This would prioritise A46 through-traffic and reduce delays at this junction. The A617 would be diverted to a new roundabout with the A616 to the north of the junction, in order to reduce delays at Cattle Market Junction. Between the new roundabout and Cattle Market Junction, the Great North Road would be widened to provide two lanes in each direction.

In Option 2, Cattle Market Junction would be grade separated, with the A46 elevated to pass over the roundabout. In this option, the A617 and A616 would be retained as they are currently.

In Option 1, the new section of A46 would cross over the A1 to the south of Winthorpe and tie-in to the existing A46 to the west of Winthorpe Junction. This junction would be enlarged, retaining the four-arms it currently has, and signalised to improve traffic flow. A new link over the A46 would provide access from Friendly Farmer Roundabout and the A1 to the A46 eastbound.

In Option 2, the new section of A46 would cross over the A1 and run slightly to the north of the existing road, and tie-in to Winthorpe Junction. The junction would be enlarged to a five-arm roundabout and signalised to improve traffic flow. This option would move the A46 slightly closer to Winthorpe but would remove the need for the flyover crossing over the A46 (as required in Option 1).

Farndon Junction would be signalised in Option 2 to improve flows on the roundabout during peak hours. The general layout of the junction would not be changed.

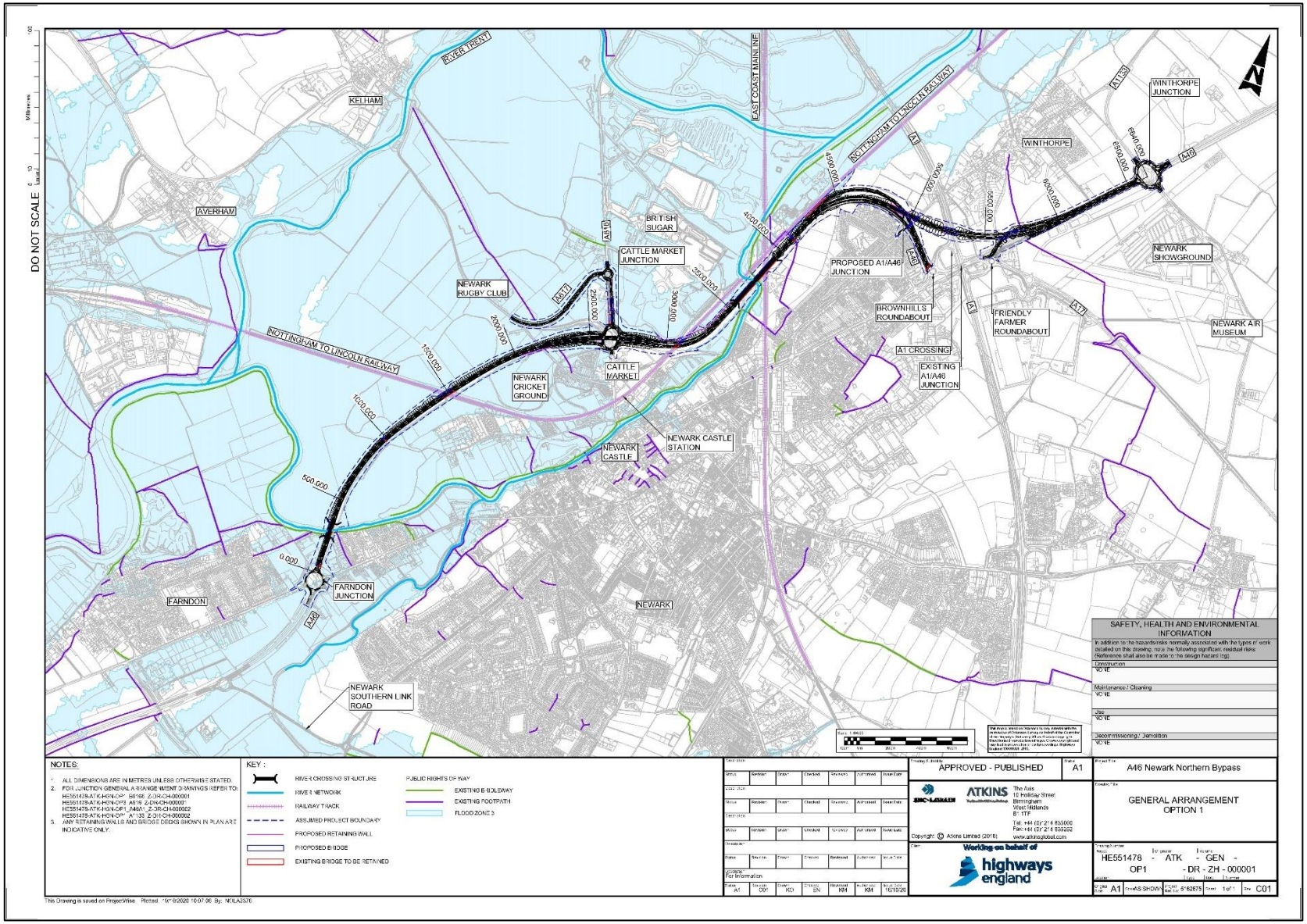

Figure 1-2: Option 1 Layout Plan

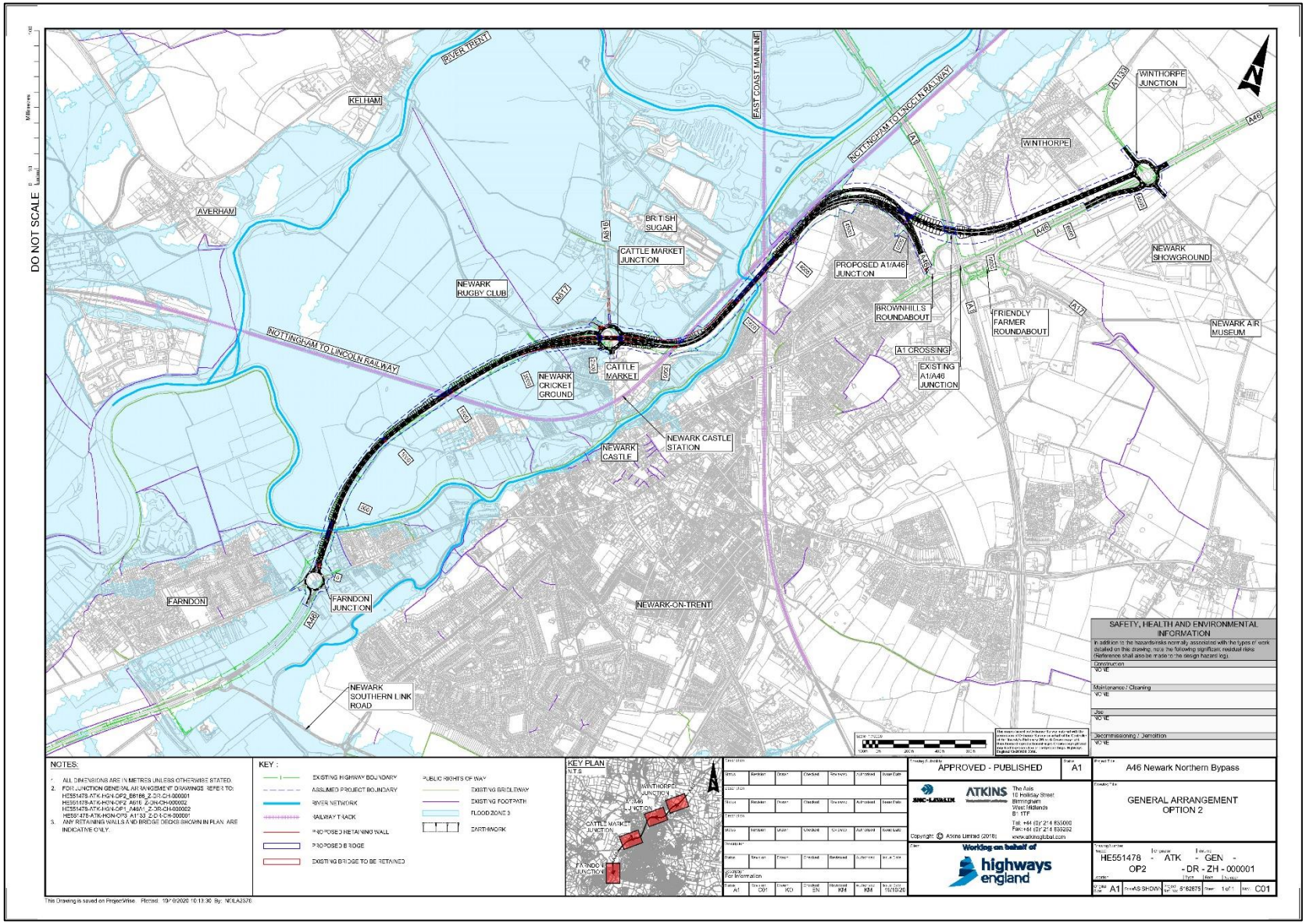

Figure 1-3: Option 2 Layout Plan

1.4. Scope and Objective of Report

The PSSR identifies potential geotechnical and environmental hazards associated with the site. The PSSR provides a review of available sources of geotechnical and geo-environmental data already available for the site. This is to ensure that geotechnical and geo-environmental risks are identified at an early stage in the design and such risks are managed. It will also identify the need for further ground investigation e.g. targeted where there are existing gaps of information.

The PSSR will provide initial information which will be used and developed for following investigation and design stages:

- Ground Investigation Scoping Report (GISR): Proposals for scheme specific Ground Investigation (GI).
- Ground Investigation Report (GIR): provide an initial Conceptual Ground Model and geotechnical parameter assessment which can be developed following intrusive GI for the site.
- Geotechnical Design Reporting: provide initial assessment of the geotechnical design and construction issues (typically earthworks, retaining walls, structure foundations and ground improvement/earthworks re-use potential).
- Geo-environmental design reporting to assess potential pollutant linkages and subsequent assessment of risk to identified receptors.

1.5. Limitations

It should be noted that flood compensation areas are proposed as part of the A46 improvements however, at this stage, the final design and location of the flood compensation areas are not known and consequently they have not been considered as part of this PSSR.

1.6. Geotechnical Category

For the potential solutions currently under consideration, it is recommended the scheme be classified as Geotechnical Category 2: projects concerning conventional types of geotechnical activities, with no unusual or difficult ground conditions and involving no abnormal geotechnical risks [1].

2. Sources of Information

Table 2-1 below presents the sources of information used in preparation of this report.

Table 2-1: Sources of Information

Subject	Type	Reference and Additional Comments	Author / Publisher
Topography	Maps	Google Maps [2]	Google
	Online Database	LiDAR Composite DTM 1m spatial resolution	Environment Agency
Geology	Maps	Geological Survey of England & Wales, Nottingham, Sheet 126, Solid and Drift, 1:50 000 [3]	British Geological Survey (BGS)
	Online Database	BGS Onshore GeoIndex [4]	
		The BGS Lexicon of Named Rocks [5]	
Hydrogeology / Hydrology	Aquifer Designation	Environment Agency What's In Your Backyard? (http://apps.environment-agency.gov.uk/wiyby/) [6]	Environment Agency
		Multi-Agency Geological Information for the Countryside (https://magic.defra.gov.uk/) [10]	Natural England
	Flood Risk Mapping	Flood Map for Planning (https://flood-map-for-planning.service.gov.uk/) [7]	Environment Agency
	Envirocheck	Envirocheck Report [8]	Landmark
Mining records	Coal Mining Map	The Coal Authority Interactive Map (https://mapapps2.bgs.ac.uk/coalauthority/home.html/) [9]	The Coal Authority
	Mining Map	BGS Onshore GeoIndex [4]	British Geological Survey (BGS)
Additional Sources	MAGIC Maps	Multi-Agency Geological Information for the Countryside (https://magic.defra.gov.uk/) [10]	Natural England
	Envirocheck	Envirocheck Report [8]	Landmark
	UXO Maps	Free UXO Risk Mapping (https://zeticauxo.com/downloads-and-resources/risk-maps/) [11]	Zetica
Ground Model	Existing GI	Highways England Geotechnical Data Management System v.5.12.0 (https://www.hagdms.co.uk/) [12]	Highways England

Subject	Type	Reference and Additional Comments	Author / Publisher
Site reconnaissance	Site walkover	N/A	Atkins
Existing earthworks / structures	Historic GIR / GFR	Newark Relief Road, A46 Geotechnical Report (1985) [13] A46/A17 Newark Relief Road Geotechnical Feedback Report (1991) [16]	Department of Transport
Existing earthwork condition	Principal earthwork inspections	Highways England Geotechnical Data Management System v.5.12.0 (https://www.hagdms.co.uk/) [12]	Highways England

3. Desk Study

3.1. Topography

The area is part of the River Trent flood plain and is low lying and flat. The topography does not feature any steep gradients [2].

The current earthworks predominantly consist of embankments (up to 13m high, slopes 1:2.5 [12]), with some areas at grade in proximity to roundabouts and north of approximate project chainage 4500, as highlighted in the LiDAR map [17] in Figure 3-1.

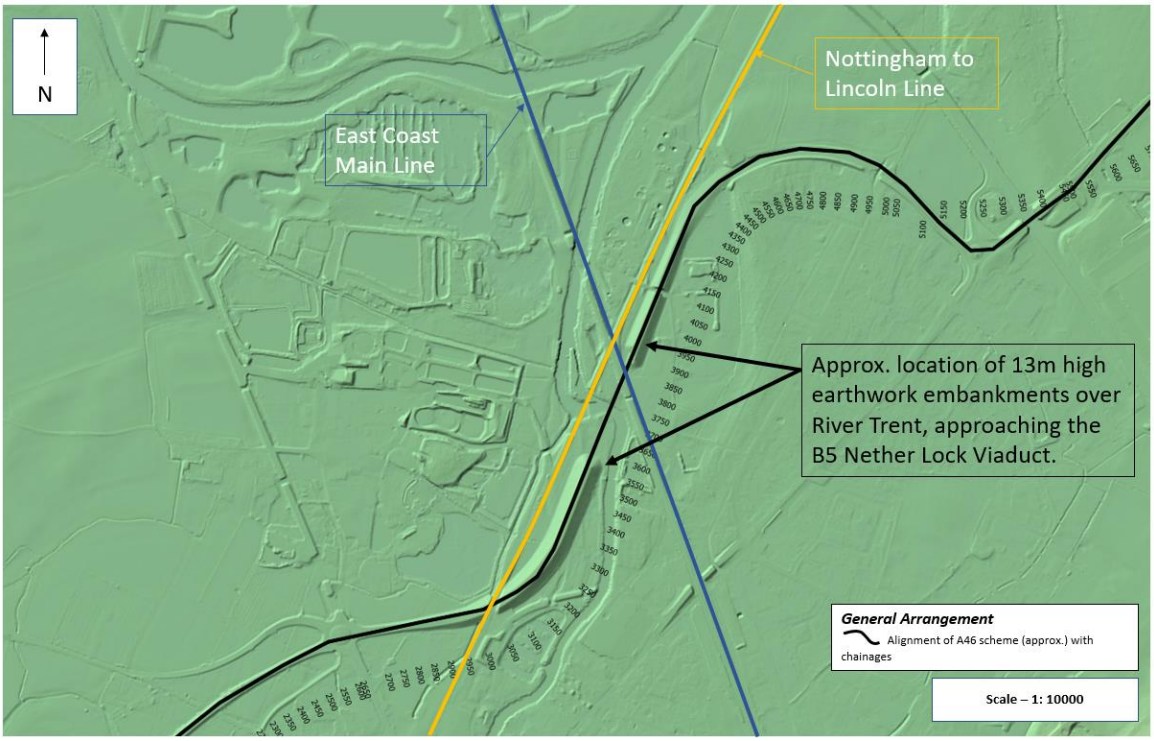

Figure 3-1: LiDAR (Open source) highlighting the location of the 13m high earthwork embankments, approaching the B5 Nether Lock Viaduct.

3.2. Geology

A general description of the anticipated geology along the entire site is summarised below.

3.3. Superficial Deposits

The following Superficial Deposits are indicated by BGS Onshore GeoIndex [4] and presented in Figure 3-2. The general descriptions of the materials have been taken from the BGS Lexicon [5].

Alluvium (ALV)

The site runs through Superficial Deposits comprising Alluvium (ALV) between 0.3km north of the Farndon Junction (Ch. 225) and up to 0.3km east of the A1/A46 Junction (Ch. 5600).

Alluvium is a general term for clay, silt, sand and gravel. It is the unconsolidated detrital material deposited by a river, stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope. Synonym: alluvial deposits. Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A stronger, desiccated surface zone may be present'.

The 1985 Geotechnical Report [13] identifies that the Alluvium present at the site is geologically highly variable. In particular, the following geotechnical risks were noted:

- A thin seam of very soft clay occurs across the floodplain at ~2m depth.
- The floodplain is riddled with alluvial channels (relict meanders of the River Trent). These contain soft clay and could cause differential settlements where alternatively stiff/soft clay occur. Deep channels may also threaten stability of adjacent earthworks.
- The alluvial clay acts as a semi-permeable barrier and is thought to prevent groundwater flowing rapidly upwards from gravels to the surface during periods of flood.
- Site excavated Alluvium was considered unacceptable for re-use within the works and was only used to backfill borrow pits.

Specific mention is made of a deep channel of very soft clay at Nether Lock, which is considered to be "*unique within the context of the A46".* The channel is described as 150m wide and at least 6m deep [13].

River Terrace Deposits (RTD)

Holme Pierrepont Sand and Gravel Member (HPSG)

Superficial Deposits are shown to be present between Farndon Roundabout (Ch. 0) and the A1/A46 junction (Ch. 5200) and comprise Holme Pierre Sand and Gravel Member (HPSG). The HPSG stratum lies beneath the ALV where present.

HPSG sedimentary deposits, fluvial in origin. They are detrital, ranging from coarse to fine grained and form beds and lenses of deposits reflecting the channels, floodplains and levees of a river or estuary (if in a coastal setting) [4].

They are predominantly cold-phase sands and gravels that underlie the Holme Pierrepont Terrace. Generally pinkish, poorly sorted and compositionally rather immature matrix-supported, sandy, trough-cross bedded (braided river) gravels with syndepositional ice-wedge casts. Gravel dominated by rounded pebbles of "Bunter" quartz/quartzite (typically c.80%), plus flint, Triassic and Upper Carboniferous sandstone, Lower Carboniferous cherts, etc, and other "exotic" lithologies. Forms a fairly well-preserved terrace typically 1m to 2m above the floodplain in the upper and middle Trent, with the deposits extending beneath those of the younger Hemington Terrace and the floodplain alluvium'.

Balderton Sand and Gravel Member (BDTN)

Between the A1/A46 Junction (Ch. 5425) and Winthorpe Junction in the north part of the scheme (Ch. 6640), the Superficial Deposits comprise Balderton Sand and Gravel Member (BDTN). BDTN are sedimentary deposits, fluvial in origin. They are detrital, ranging from coarse to fine-grained and form beds and lenses of deposits reflecting the channels, floodplains and levees of a river [4].

They are predominantly cold-phase sands and gravels that underlie the Balderton Terrace. Orange-brown sandy gravel dominated by rounded pebbles of "Bunter" quartz/quartzite (c.75%) with subordinate subangular flint (c.15%), and rarer Triassic sandstone, etc. Infills a broad sinuous channel extending northeast from Newark towards the Lincoln Gap; terrace surface falls from c.20m above OD (c.10m above the Trent floodplain) to c.11m OD. Sections show intraformational and epigenetic ice wedge casts. Upper part locally includes a thin fluvio-aeolian coversand (Whisby Sand Bed, pre-Ipswichian) and a rubified paleosol (Hykeham Soil: Ipswichian). Basal part locally includes channel-filling organic silts (Thorpe on the Hill Bed), which yield a temporate flora and fauna assigned to MIS 7. Correlated with the Southrey Sand and Gravel Member (Trent Valley Formation, pre-diversionary River Trent east of Lincoln Gap) and Egginton Common Sand and Gravel Member (Trent Valley Formation)'.

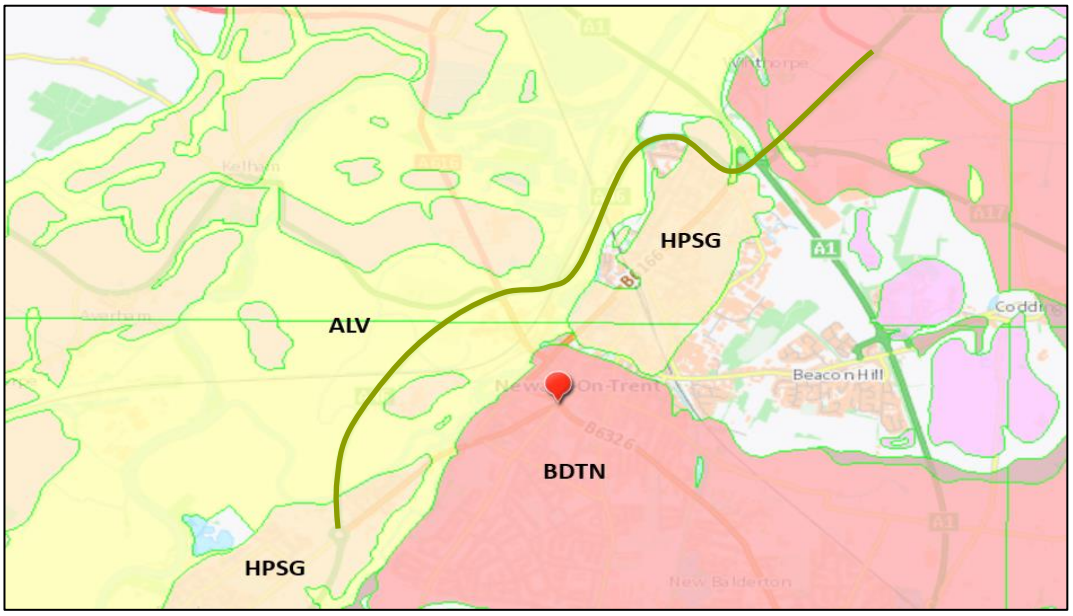

Figure 3-2. Superficial Deposits (Source: BGS GeoIndex, October 2020)

3.4. Solid geology

Bedrock Geology

The solid geology of the A46 Northern Bypass scheme comprises Mercia Mudstone Group (MMG) – Mudstone.

The following Solid Geology is presented in Figure 3-3. The general descriptions of the materials have been taken from the BGS Lexicon [5].

Mercia Mudstone Group (MMG)

The available geological mapping indicates the bedrock to comprise Mudstone of the Mercia Mudstone Group (MMG) below the entire A46 Northern Bypass scheme. MMG is a sedimentary bedrock formed approximately 200 to 251 million years ago in the Triassic Period. The local environment was previously dominated by hot deserts. Gunthorpe member rocks (GUN) are fluvial, lacustrine and marine in origin. They are detrital, deposited in lagoons or shallow seas; where a hot, arid climate also leads to the precipitation of beds of evaporites [4].

MMG is dominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite-bearing units in some basinal areas. Thin beds of gypsum/anhydrite widespread; sandstones are also present'.

Edwalton Member Mudstone (EDW), Gunthorpe Member Mudstone (GUN), and Branscombe Mudstone (BCMU) indicated in Figure 3-3, are part of Mercia Mudstone Group (MMG).

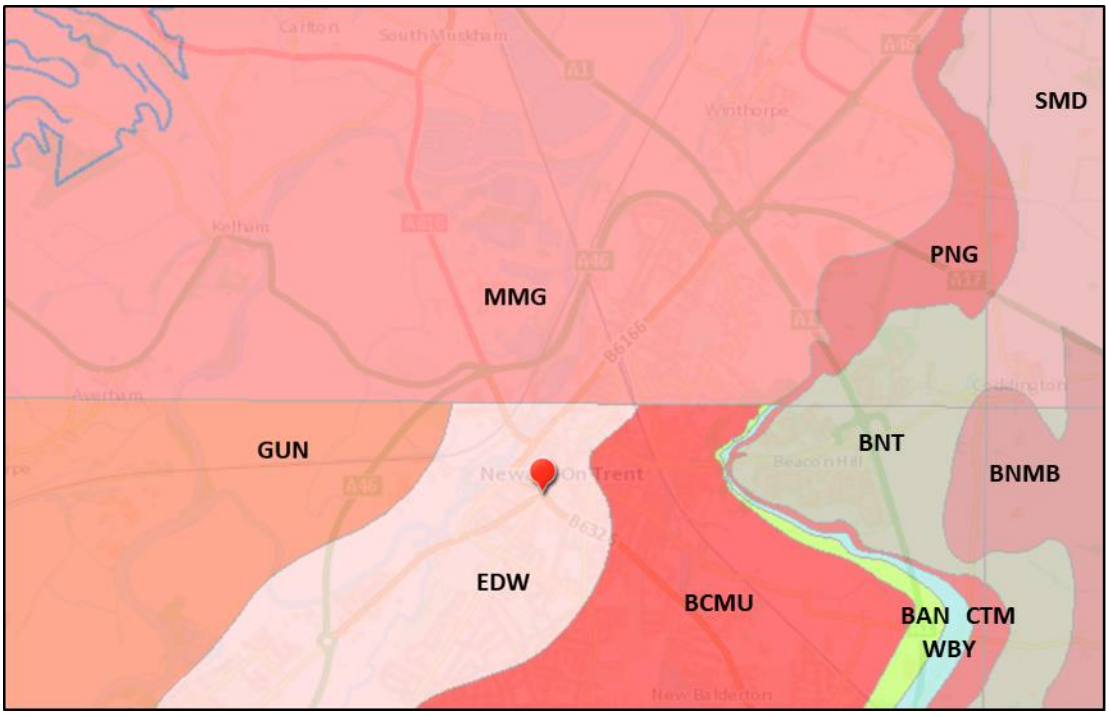

Figure 3-3: Solid Geology. Letters refer to BGS geology codes. (Source: BGS GeoIndex, October 2020)

3.5. Existing Ground Investigation Data

Table 3-1 includes existing reports identified from the Highways Agency Geotechnical Database Management System (HAGDMS) [12] between Farndon Roundabout and Winthorpe Roundabout.

Table 3-1: Existing HAGDMS Reports

Scheme Title	Reports	Date	Author	HAGDMS Number
A46 Newark Relief Road	Geotechnical PSSR, Factual Reports, Ground Investigation Reports, Geotechnical Feedback Report	1978-1991	Various	Various (~15 docs)
A46 Newark to Lincoln Improvement	Statement of Intent, Geotechnical PSSR, Factual Report, Geotechnical Report	1987-1992 1999-2003	Various	Various (~10 docs)
A46 Newark to Winderpool Improvement	Statement of Intent, Geotechnical PSSR, Factual Reports, Geotechnical Design Reports, Geotechnical Feedback Reports	1992-1996 2003-2013	Various	Various (~25 docs)
A46 Newark Bypass – Friendly Farmer Roundabout Improvement	Preliminary Sources Study, Ground Investigation Report & Geotechnical Design Report	2018	Kier	30265
A46 Western Junction Brownhills Roundabout	Preliminary Sources Study, Ground Investigation Report	2018	Kier	30204
A46 Western Junction Brownhills Roundabout	Geotechnical Design Report	2018	Kier	30621
A46 Under Road Crossing Newark Sewer Flooding Strategy	Ground Investigation Report	2017	GHD	29740
East Midlands Asset Delivery GeoAmp	Geotechnical Asset Management Plan	2017	Kier	29490
Area 7: East Midlands Asset Delivery GeoAMP	Geotechnical Asset Management Plan	2019	Kier	31022
Area 7: East Midlands	Geotechnical Asset Management Plan	2020	Kier	32027

Scheme Title	Reports	Date	Author	HAGDMS Number
Asset Delivery GeoAMP				

A review of the above existing HAGDMS reports revealed that “A46 Newark to Lincoln Improvement” and “A46 Newark to Winderpool Improvement” reports are located out of the area of interest for this scheme.

These data are from “A46 Newark Relief Road” report and summarized in Table 1-1 and has provided a significant amount of Ground Investigation (GI) which was carried out along the alignment of A46 Northern Bypass scheme Borehole location plan and longitudinal sections are reported in Appendix A.

3.6. Hydrogeology

The HAGDMS website [12] indicates that the Superficial Deposits are designated as Secondary A Aquifers, as indicated in Figure 3-4. The Environment Agency [6] provides designation for Secondary A Aquifer: ‘Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers’.

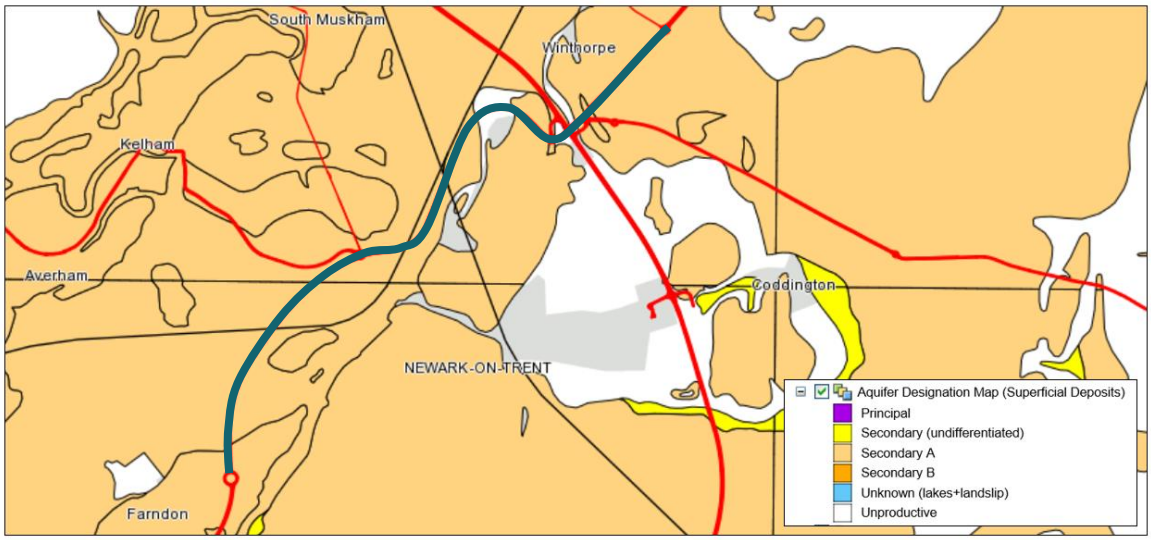

Figure 3-4: Aquifers – Superficial Deposits (Source: HAGDMS, November 2020)

Bedrock formations are designated as Secondary B Aquifers, as indicated in Figure 3-5. The Environment Agency [6] provides designation for Secondary B Aquifer: ‘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. These are generally the water-bearing parts of the former non-aquifers’.

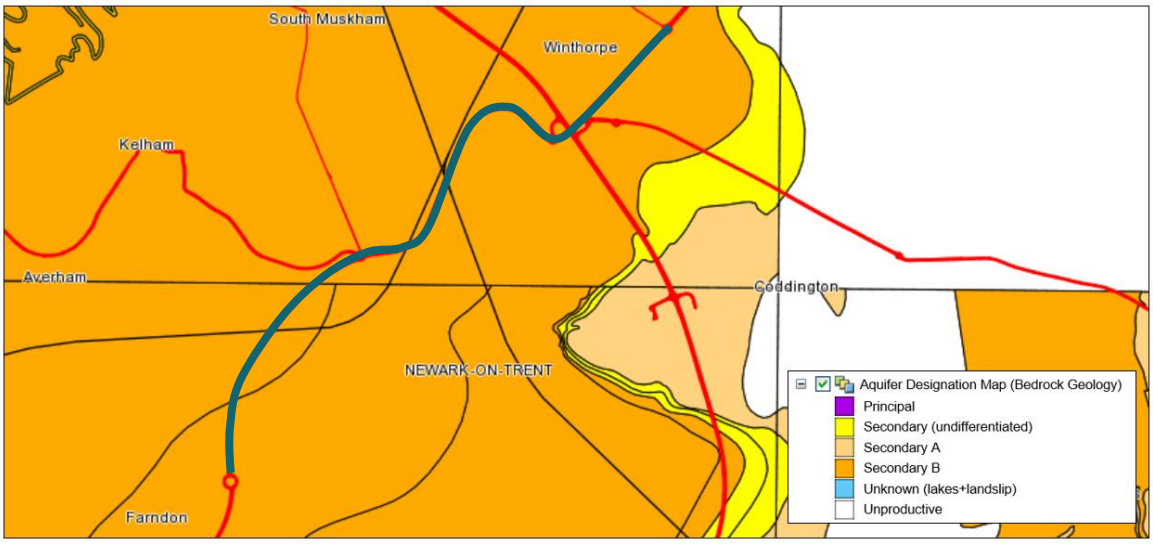

Figure 3-5: Aquifer Designation Map – Bedrock Geology (Source: HAGDMS, November 2020)

A review of statutory data contained in the Envirocheck Report [7] indicated there is one recorded groundwater abstraction license within the southern section of the scheme at land near Farndon. The abstraction is operated by H Price & Son for general farming and domestic purposes.

There are a further six groundwater abstractions located within a 250m search area of the scheme predominantly operated for general farming and domestic, process water (public administration, chemical, industrial / commercial / public services) and spray irrigation purposes.

3.7. Hydrology

The A46 crosses the River Trent, flowing in a northerly direction, north of Farndon roundabout and south of intersection between the East Coast Mainline and Midlands Railway (Newark Crossing). The Old Trent Dyke also crosses the south-western part of the A46 in two locations, near Newark Cricket Ground and west of Hiram's Paddocks. In addition, there are several field drains and smaller unnamed watercourses within 250m of the scheme.

There are several lakes located north of the A46, approximately 50m at their closest point, between the A1 and A616 Great North Road and adjacent to Newark Crossing. Kings Marina is located just west of Northgate Retail Park, immediately south of the A46.

The Envirocheck Report [7] indicated there are no recorded surface water abstractions on the scheme.

There are four recorded surface water abstractions within 250m of the scheme, with the nearest record located 24m southwest of the A46 in the vicinity of the Cattle Market junction. The abstraction is operated by British Sugar Plc for non-evaporative cooling purposes. The other surface water abstractions are operated for hydroelectric power generation and process water (food and drink and industrial / commercial / public services) purposes.

3.8. Fluvial flooding

The Flood Map for Planning [7] indicates the area in the vicinity of the River Trent and its tributaries is designated as 'Flood Zone 3' which has a high probability of flooding (>1 in 100 or greater annual probability). The A46 Newark Northern Bypass scheme passes through this zone between Farndon Roundabout and A1/A46 Junction, as indicated in Figure 3-6.

The area in close proximity of A1/A46 Junction is designated as 'Flood Zone2' which has a moderate probability of flooding (between 1 in 100 and 1 in 1000 annual probability).

The remaining part of the route, between A1/A46 Junction and Winthorpe Junction, passes through an area designated as 'Flood Zone 1' which has a low probability of flooding (1 in 1000 annual probability).

Flooding considerations affected the design of the existing A46 earthworks including building over free draining material, and use of material capable of withstanding wave action and rapid drawdown. The existing highway embankments in some parts of the scheme incorporate 3 No. floodbanks to protect housing at Weydale, Farndon and Kelham Road and are designed to prevent horizontal transfer of surface water. Local marl fill and grout curtain cut-offs were used to create suitably impermeable floodbanks [13][16].

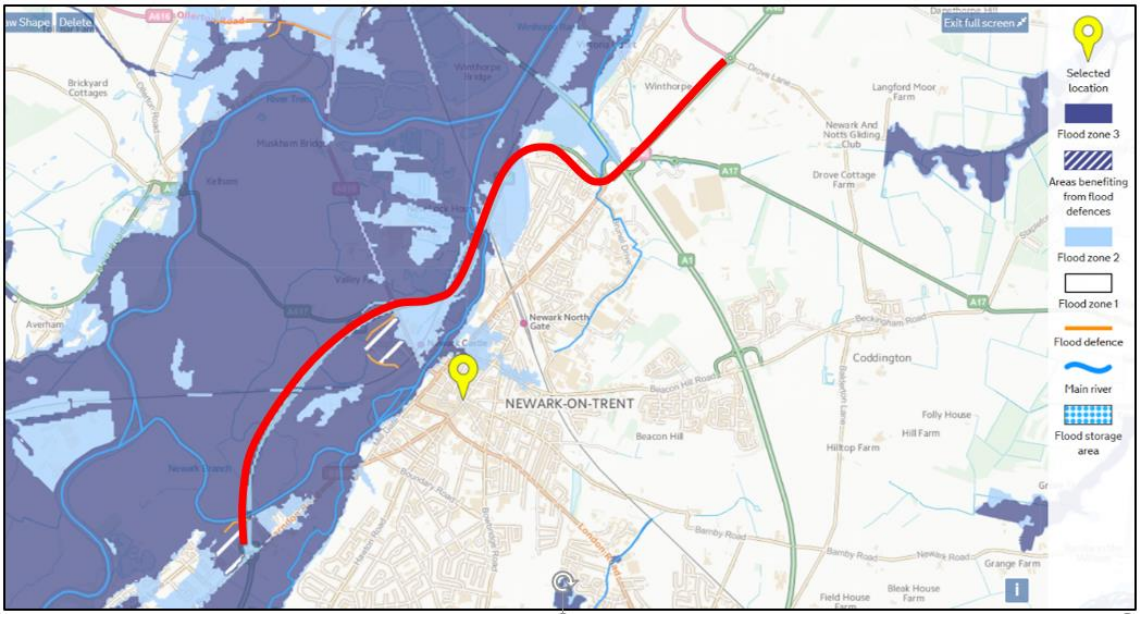

Figure 3-6: Fluvial Flooding Risk Map (Source: The Flood Map for Planning [7], October 2020)

3.9. Pluvial flooding

The site is at risk of surface water flooding following intense rainfall as a result of the shallow lower permeability layers present on site [4].

3.10. Groundwater flooding

The underlying Superficial Deposits and Solid Geology are classified as aquifers (refer to section 3.4), because they may store and yield amounts of groundwater [10]. Therefore, groundwater flooding could be a risk on the site, although the productivity is low as indicated in BGS Onshore GeoIndex [4].

The 1985 Geotechnical Report [13] identifies that the alluvial clays present at the site act as a semi-permeable layer preventing water flowing upwards from the gravels to the surface. Removal of alluvial material and replacement with granular fill may exacerbate future groundwater flooding if not mitigated against (e.g. incorporating impermeable geomembranes).

3.11. Discharge consents

The Envirocheck Report [7] indicates that there are 23 active discharge consents within 250m of the scheme, predominantly located in the vicinity of the central section (between the Cattle Market roundabout and Winthorpe roundabout) with some located in the vicinity of the southern section (between the Farndon roundabout and Cattle Market roundabout)..

Central Section

There are 19 active discharge consents in the vicinity of the central area of the scheme, the closest of which is located 71m southwest of the scheme and is operated by Severn Trent Water Limited for discharge of public sewage: storm sewage overflow into the River Trent. The other entries relate to the discharge of trade / treated effluent, sewage, process water, storm overflow and / or crude effluent into receiving waters including the River Trent, River Devon, Old Trent Dyke and groundwater.

Southern Section

There are four active discharge consents in the vicinity of the southern area of the scheme, the closest of which is located 188m southwest of the scheme and is operated by V W Idisi for discharge of sewage effluent to groundwater. The other entries relate to the discharge of sewage and final / treated effluent to groundwater or a tributary of the River Devon.

3.12. Pollution incidents

The Envirocheck Report [7] indicated there are five significant substantiated pollution incidents recorded within 250m of the scheme, outlined as follows:

- 117m north of A46 near Robert Dukeson Avenue – September 2009 – Significant land pollution incident from soot;
- 165m southwest of A46 near Fleming Play Area – October 2012 – Significant incident land pollution incident from tyres; and
- 249m east of A1/A46 Junction – August 2005 – Significant water pollution and minor land pollution from suspended solids.
- West of Winthorpe Roundabout – September 2012 - Significant water pollution and minor pollution incident to land from sewage;

- West of A1 near Enterprise Rent-a-Car – May 2005 – Significant land and water pollution incident from organic chemicals.

There are a further 11 recorded pollution incidents to controlled waters recorded within 250m of the southern and central areas of the scheme, all of which were designated Category 3 – Minor Incidents caused by pollutants including oils, organic wastes, sewage, and chemicals to surface watercourses within the Trent Catchment area.

3.13. Mining Records

The Coal Authority Interactive Map [9] indicates the site is not located within a Coal Mining Reporting Area. No coal mining features, or license areas are recorded in the vicinity of the site.

It must be noted, however, that non-coal mining activity was present between north of project chainage 3750-4450. The historic mining activity are located on the north western side of the Nottingham-Lincoln railway line, and therefore not directly adjacent to the scheme.

The 1985 Geotechnical Report [13] states that the A46 route crosses borrow pits used for construction of the nearby Great North Road. These and also borrow pits associated with construction of the existing A46 have potentially been backfilled with locally sourced alluvium, which may pose a risk to future works if not properly identified by additional GI.

3.14. Statutory Designations

A review of the MAGIC website [9] revealed there are no statutory environmental designations on the site.

There are six scheduled monuments located on or within close proximity to the study area, comprising:

- The Roman Settlement of Crococalana, located to the north-east of the study area around Brough;
- A Civil War Redoubt, located 200m west of the Newark rail crossing near the centre of the study area;
- A Civil War Redoubt, located 75m north of the route, just north-east of Cattle Market roundabout;
- A Civil War Redoubt, located 155m north of the route, just to the south of Kelham Road;
- A moated site, located 240m north of the route, adjacent to Kelham Road on south-west side; and,
- A Civil War Sconce/Earthwork located 150m south-east of the route adjacent to Riverside Park and railway crossing.

In addition, the north-eastern end of the study area is recorded as a Roman Road.

There are four listed buildings within the study area:

- A Concrete Footbridge across the River Trent, located 70m east of A46 viaduct and just west of Hatchet's Lane (Grade II*);
- The Causeway Culvert located at the Cattle Market Roundabout on the route (Grade II);
- The Causeway Arches located on Great North Road approximately 80m and 195m north of the Cattle Market Roundabout (both Grade II).

3.15. **Waste**

A review of historic maps and statutory data contained in the Envirocheck Report [7] indicated there are no recorded active or historical landfills located on site or within 250m of the scheme.

There are two Licensed Waste Management Facilities located within 250m of the scheme. The closest is located approximately 195m east of the central section of the scheme and is operated by British Sugar Plc whereas the other entry is located approximately 226m southwest of the central section of the scheme and is operated by Scrap It Waste Ltd.

There are six records of Potentially Infilled Land features within 250m of the scheme, two of which are located within the central section of the scheme and relate to potential areas of infilled land associated with former surface water features.

3.16. **Unexploded Ordnance**

Zetica has produced freely available risk maps [11] indicating the potential risk of air dropped World War Two unexploded ordnance (UXO) to be present on the site. The mapping classifies the ground directly underlying the site as 'Low Risk' with less than 15 surveyed bomb strikes per 1000 acres, as shown in Figure 3-7 below.

It should be noted that the risk map is not a risk assessment and does not consider other sources of UXO such as enemy or allied ground ordnance.

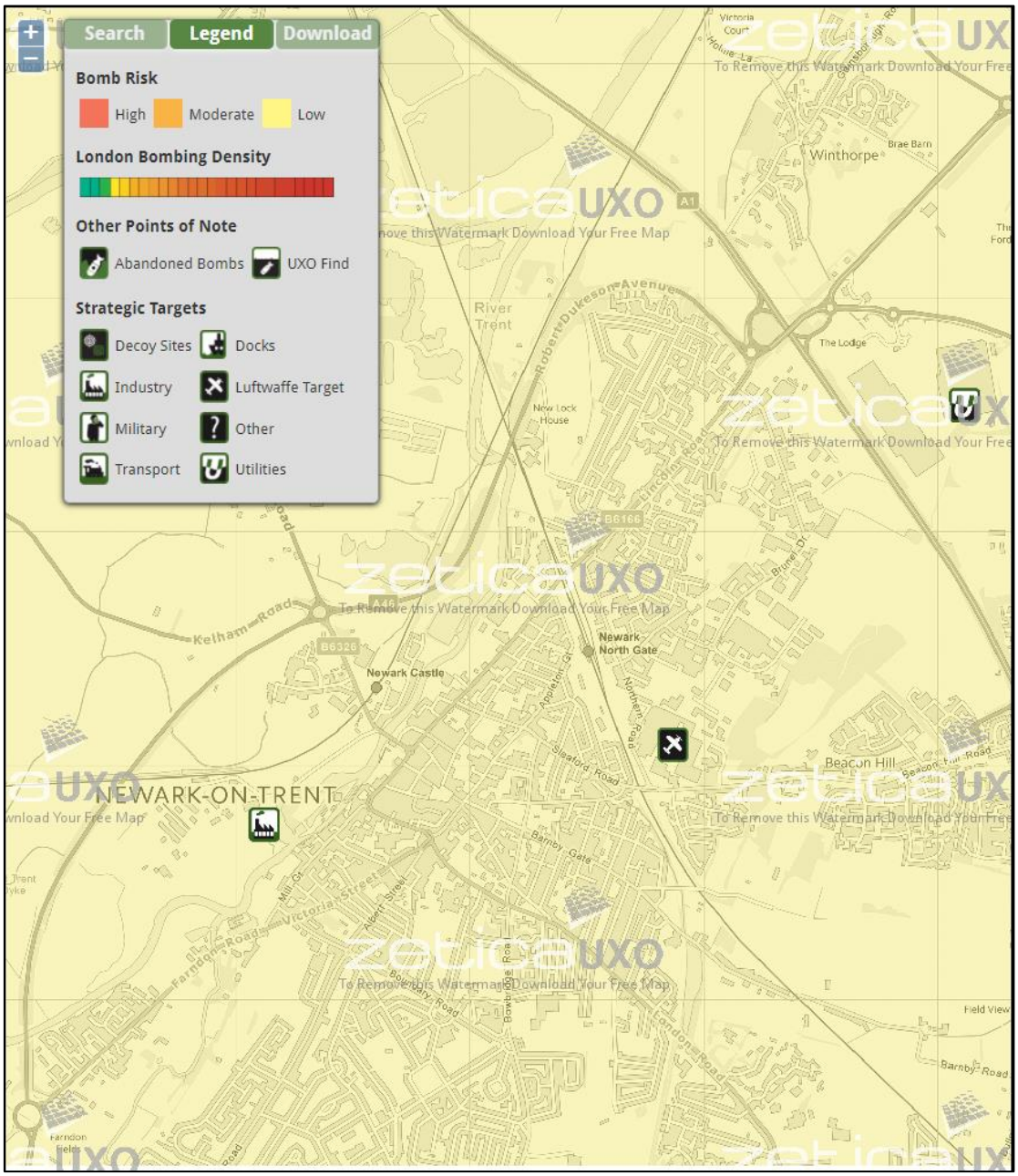

Figure 3-7: Unexploded Ordnance Risk Map (Source: Zetica [11])

3.17. Historical Development

Using historical Ordnance Survey plans provided in the Envirocheck Report [7] a summary of the historical development of the site and surrounding area within a radius of 250m is provided in Table 3-2.

Table 3-2: Summary of Site History

Map Dates	Within Scheme Route Options	Within 250m Study Area
1884-1886 (1:2500) 1884 (1:10,560)	The River Trent is shown crossing the route options in southern extent and central sections flowing west to east. Malthouse is mapped within the south west section of the route options. Old Trent Dyke (spring) is shown crossing the western extent of the route options western extent flowing away from river east to west. The Midland Railway: Nottingham to Lincoln line is shown crossing the western extent of the route options. Great North Road is shown crossing the route options in central section. Great Northern Railway (currently known as East Coast Mainline) is shown crossing the route options in the central section of the site. Unnamed building is shown present, 25m west of New lock House, in the central section of the route options. Chemical manure works mapped within the central section of the route options.	Flour mill is marked approximately 50m south-east. Windmill (Flour) is mapped approximately 50m southwest. Unnamed Road is mapped approximately 100m south. Railway crossing mapped 10m west. Brewery is mapped 250m southwest. Wellington foundry is mapped 250m southwest. Malthouses is mapped 200m southwest. Windmill (flour) is mapped 100m north. Old bleaching house is mapped approximately 100m south.
1900 (1:2,500) 1900-1901 (1:10,560)	A football ground has been constructed in the central section of the route options.	Flour mill is no longer labelled. Windmill (Flour) is now labelled as Windmill (Disused). Two Nurseries are shown present at 200m & 250m southwest. Goods shed is shown present 250m southwest. Tow Path for the River Trent is shown present running from south to north crossing the central section of the route options. Brewery is no longer named. Windmill (Flour) is now named as Mill Cottage. Kings Sconce is now shown present 200m south of the central section of the route option.
1919-1920 (1:2500) 1921 (1:10,560)	No significant changes.	Wicker Works is now shown present 180m southeast. Four earthworks are now shown present 250m east, 200m west, 200m west & 200m northwest.

Map Dates	Within Scheme Route Options	Within 250m Study Area
		Boiler works is shown present 200m southwest. Nursery is shown present 50m south.
1938 (1:10,560)	No significant changes.	Foss Way (Roman Road) located approximately 50m east.
1948 (1:10,560) Aerial Photograph	No significant changes.	No significant changes.
1956 (1:10,000) 1955-1956 (1:10560)	Midland Railways is no longer labelled.	Residential houses are now shown present 200m south. Sewage works is mapped present 80m north west. Unnamed buildings are shown present 80m south.
1965 (1:1250) 1966-1969 (1:10,000) 1969 – 1970 (1:1250)	Unnamed building is marked as Works. Football ground is mapped towards central section of the route in the map.	Unnamed Road is now shown present. Roundabout 100m south.
1969-1981 (1:2500) 1972-1984 (1:10,000) 1973-1984 (1:1250) 1971-1973 (1:10000)	Drains are now labelled, immediately east of the route and 50m southwest of Great Northern Road roundabout.	Wicker Works is now labelled as Works. Nursery in southwest is no longer labelled. Earthwork is now labelled as Civil war earthworks. Drains are mapped 50m southeast & 50m southwest. Football ground is mapped 50m northwest. Chemical manure works now named as Works. School is mapped 250m south. Filter bed tanks for sewage works are now present. Kings Sconce is now named as works.
1985-1996 (1:2500) 1990-1996 (1:1250) 1992 (1:10,000)	Road is now shown present within the route option boundary. Drain is no longer labelled. Bridge is built over River Trent. Road is now constructed. Roundabout in central section of the site. Football ground no longer labelled. Overpass bridge mapped within route option. Track is crossing the route options. Viaduct is now shown present.	Roundabout is mapped 10m south. Civil War earthwork is now labelled as Sandbills Sconce. Football ground to northwest no longer labelled. Cattle Market now, east of Great North road roundabout. Road construction within the route option up to existing roundabout 100m south. Newark curve now named as dismantled railway. A scrap yard is mapped 250m north.

Map Dates	Within Scheme Route Options	Within 250m Study Area
1999 (1:2500) (Aerial photograph) 2000 (1:10,000)	No significant changes.	Residential houses mapped 50m east. Lorry Park is mapped 10m east. Electric substations are mapped 50m south west & 50m northwest. Earthwork is shown present 200m west. Bus Depot is shown present 250m southwest. British Sugar Mill is mapped approximately 250m west.
2006 (1:10,000)	No significant changes.	Kings Marina is present 180m southwest. Residential area present 20 m south.
2018 (1:10,000)	No significant changes.	No significant changes.

3.18. Satellite Data

The satellite images from Google Earth as shown in Figure 3-8 below indicate that the land to the south east of A46 has been developed for residential use (Newark on Trent). Just at the beginning of the proposed scheme and at the west of the motorway, the Farndon village lies whereas towards the end of the scheme and to the north and west of the motorway Winthorpe village lies.

Figure 3-8: Satellite view of the A46 scheme extends

3.19. Existing Structures

There are nine major structures of which four are bridges incorporating piled and spread foundations, four box culverts, one overbridge and several pipe culverts [16]. The location of these structures is presented in the Appendix C.

Where piles have been used, steel 'H' bearing piles were used exclusively during construction of existing structures, driven into the underlying Mercia mudstone "*Keuper Marl".* The design of the pile cross-section includes provision for higher corrosion rates, as "aggressive" soft silty organic clays are present on site. The rate of attack on the steel was estimated to be 1.85mm per 120 years [16].

Four box culverts and one farm accommodation overbridge with spread foundations were founded onto gravels [16].

Sheet piles are used on the banks of the River Trent in places to protect pier areas from erosion.

To alleviate differential settlement at bridges, alluvial clay was removed and replaced with granular fill at bridge approaches. An impermeable membrane was used to prevent upward groundwater flooding [16].

The 1985 Geotechnical Report also states that piled concrete U-boxes were to be used to support embankments beyond the abutment of the viaduct at Nether Lock spanning the River Trent / East Coast Main Line [13]. Ground anchors and sheet piles were used at the north abutment of Bridge B4 (spanning the Nottingham to Lincoln railway line) [16].

3.20. Man-Made features Satellite views

The following Figures present some man-made features in the area of the A46 as detected from Google Earth. Farndon junction is an at – grade junction lying at the beginning of the proposed scheme to the east of Farndon village as shown in Figure 3-9 below.

Figure 3-9: Satellite view of Farndon junction

Cattle Market junction is an at-grade junction lying at the north of Newark on Trent as shown in Figure 3-10 below.

Figure 3-10: Satellite view of Cattle market junction

Brownhills roundabout, existing A1/A46 junction, A1 crossing and Friendly Farmer roundabout lie at the norh east between Newark-on-Trent and Winthorpe village as shown in Figure 3-11 below:

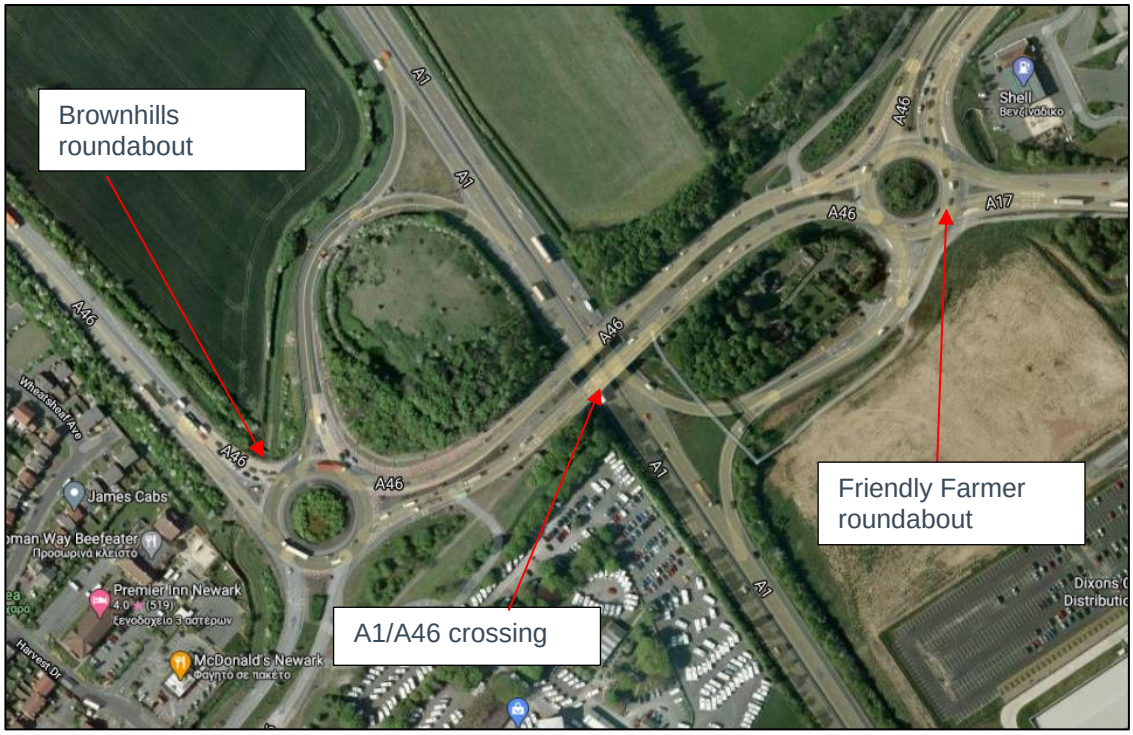

Figure 3-11: Satellite view of Brownhills roundabout, A1/A46 crossing & Friendly Farmer roundabout

A46 crosses via overbridges the national railway in two sections (Nottingham – Lincoln rail line and East Coast railway) as shown in Figure 3-12 and Figure 3-13 below.

Figure 3-12: A46 crossing Nottingham - Lincoln rail line

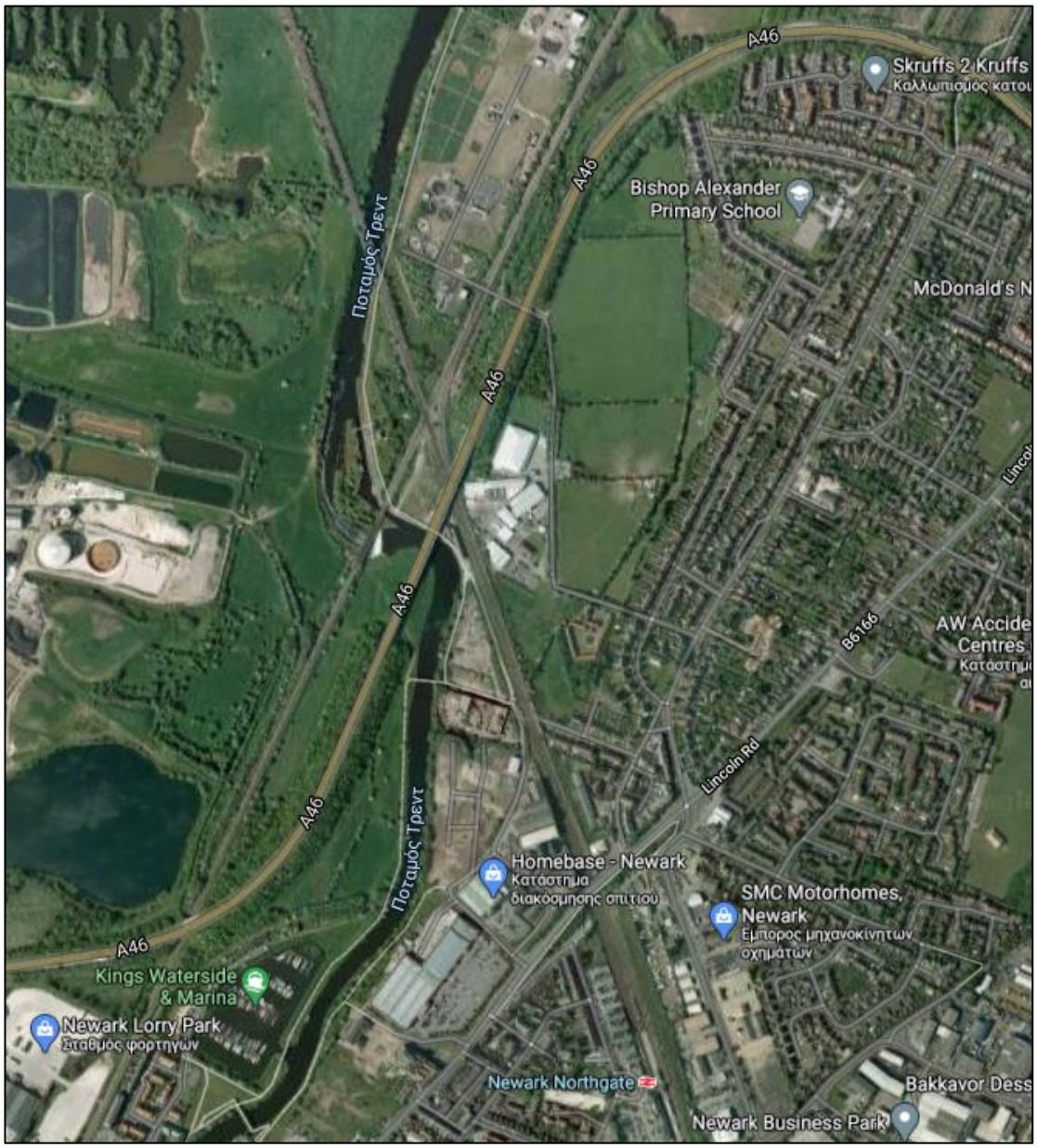

Figure 3-13: A46 crossing East Coast Railway and viaduct over River Trent

As shown in Figure 3-13, there is also a viaduct crossing River Trent.

3.21. Existing Earthworks

The Geotechnical Feedback Report for A46 Newark Relief Road [16] presents design sections of Earthworks. These are collated in Appendix C and a typical embankment cross section is provided in Figure 3-14 below.

Based on the GFR [16] granular fill material was used in the embankments outside the floodplain.

Various materials were used including marl and mudstone, silty sands and gravels, crushed concrete and silty/clayey sands and gravels from various nearby site cuts and excavations/borrow pits.

These materials were tested in order to satisfy the Specification in terms of class properties.

- the embankments were built on a coarse gravel drainage blanket.
- Class D1 was used for free draining applications,
- Class D4 was used for Capping Layers,
- Class D6 was used for Impermeable applications,
- Class D7 for landscape areas,
- Class D8 for selected granular fill.
- Lightweight fill (pulverised fuel ash) was used between bridges B4 and B5 and

Differential settlement issues were mitigated during construction by specifying long settlement periods (staged construction) or surcharges. In selected areas a surcharge of 20kPa or 30kPa was applied to embankments for 6 months before surfacing [13].

At Nether Lock, 15m wide granular shear keys were used where a particularly deep area of soft clay was identified to enhance stability. A surcharge of 40kPa was proposed to last for 15 months. Additionally, the embankments were specified to be constructed using PFA to reduce lateral displacement potentially affecting the Nottingham to Lincoln railway line and Fiddlers Elbow footbridge.

It was identified prior to construction that in typical floodplain conditions, the most critical failure mechanism is non-circular (stiff clay underlain by very soft clay) [13].

The existing highway embankments in some parts of the scheme incorporate 3nr floodbanks to protect housing at Weydale, Farndon and Kelham Road and are designed to prevent horizontal flow of surface water through the embankment. Local marl fill and grout curtain cut-offs were used to create suitably impermeable floodbanks [13][16].

The earthworks are built over free draining material (20mm-75mm rockfill) and because of the large fetch of the floodplain include material capable of withstanding wave action (rockfill) [16].

Based on the available Areas 7 GeoAmp reports the Geotechnical Risk Rating is Low.

A review of existing principal earthwork inspections in HAGDMS has shown that no defect observations are recorded on the site. The site walkover undertaken by

Atkins in January 2021 confirmed that earthworks are in a good condition with the exception of occasional burrowing.

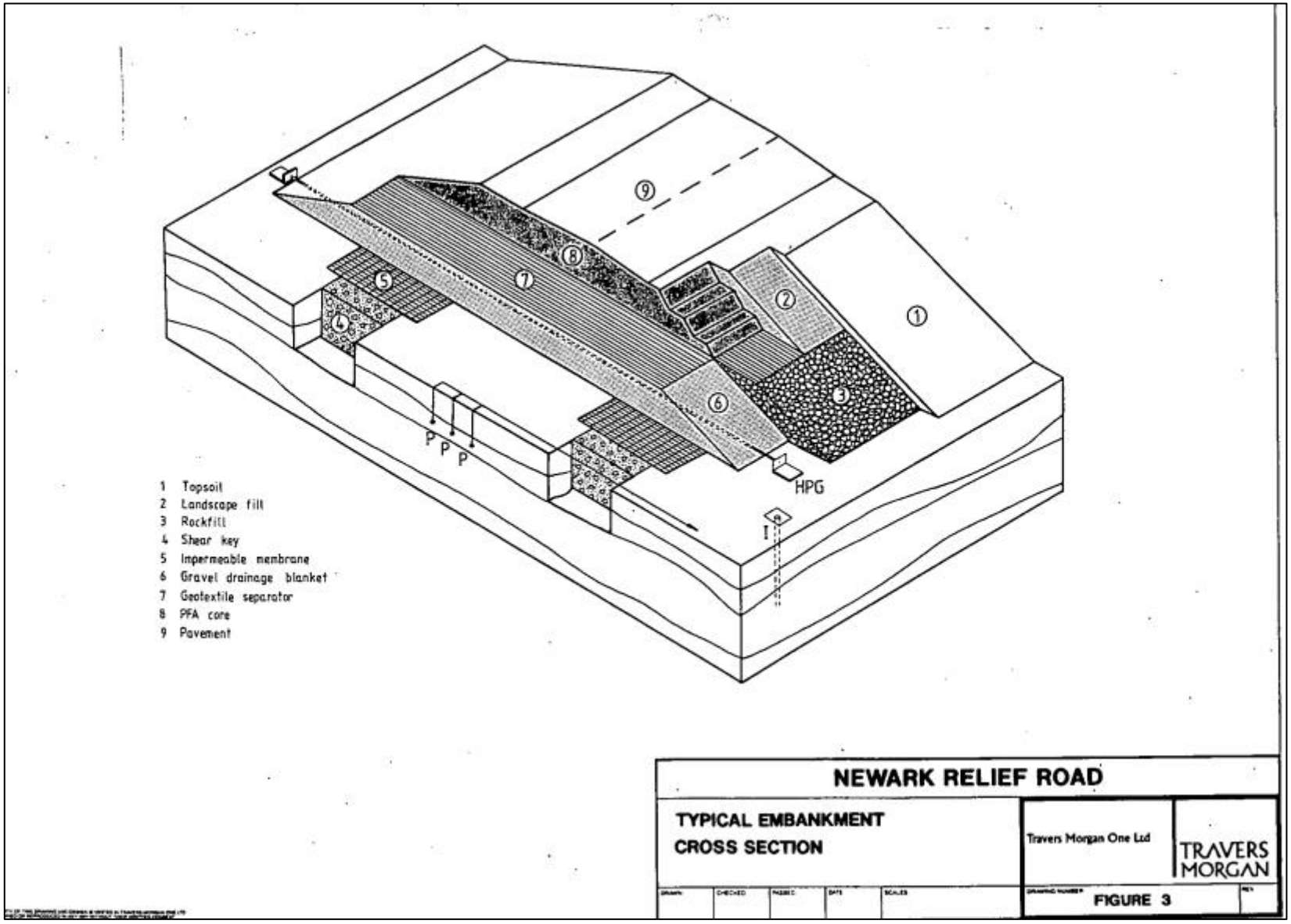

Figure 3-14: Typical Embankment Cross section [16]

3.22. **Trade Directory Entries**

The Envirocheck Report [7] provides a summary of historical and active trades registered on the scheme and in the surrounding area. A summary of registered active and historical trades within 250m of the scheme which may potentially give rise to contamination that may affect the site is provided below:

Southern Section

There are nine trade directory entries noted within 250m of the scheme which include eight active trade directory entries, the closest of which is located 36m south of the southern section of the scheme and relates to C R S Gas Solutions Ltd. The other entries relate to disability equipment manufacturers & suppliers, cleaning services, road haulage services, hospitals and car dealers.

Central Section

There are nine trade directory entries noted within 250m of the scheme which include six active trade directory entries, the closest of which is located 130m southwest of the central section of the scheme and relates to Greenberry Engineering Services Ltd. The other entries relate to antiques repair & restoring services, petrol filling stations, road haulage services and boiler manufacturers.

3.23. Ground Stability Hazards

A summary of potential ground stability hazards has been collated from HAGDMS and are summarised in Table 3-3.

Table 3-3: Summary of Potential Ground Stability Hazards

Feature	Summary
Compressible/Collapsible Deposits	The scheme falls under Class D: “High” hazard rating with a significant potential for compressible problems (Figure 3-15). The area in the vicinity of Winthorpe Roundabout is classified as Class B: “Low” hazard rating. The 1983 Geotechnical Report describes a deep channel of very soft clay at Nether Lock, which is considered to be “*unique within the context of the A46*”. The channel is described as 150m wide and at least 6m deep [13].
Natural Landslides	The natural landslides hazard falls under Class B: “Low” to Class C: “Medium” for the majority of the scheme. The area between Cattle Market Roundabout and the railway crossing falls under Class D “High” category (Figure 3-16).
Landfill Sites	The area between the existing Cattle Market Roundabout and the railway crossing on the north-east falls under Class A: “Low” hazard rating. No data present for the rest of the scheme (Figure 3-17).
Swelling and Shrinkage	The area falls under Class B: “Low” hazard rating (Figure 3-18).
Slope Hazard Rating	The majority of the area between the existing Farndon Junction and A1/A46 Junction falls under “Low” hazard rating. The slope hazard rating at the railway crossing is “Very High”. No rating assigned to the area between A1/A46 Junction and Winthorpe Roundabout as it is at grade (Figure 3-19).
Dissolution Features Hazard	The dissolution features hazard rating falls under Class A: “Very Low” (Figure 3-20).
Coal Mining Hazard	The scheme falls under hazard Class A: “Outside coalfield area” category (Figure 3-21).
Non-Coal Mining Hazard	The majority of the area has no hazard rating assigned. The area in the vicinity of the railway crossing falls under Class E: “Very High” category (Figure 3-22).
Historic Borrow Pits	The 1985 Geotechnical Report [13] identifies that the A46 Newark Relief Road crosses historic borrow pits used for construction of the Great North Road. There are potentially infilled borrow pits associated with construction of the existing A46.

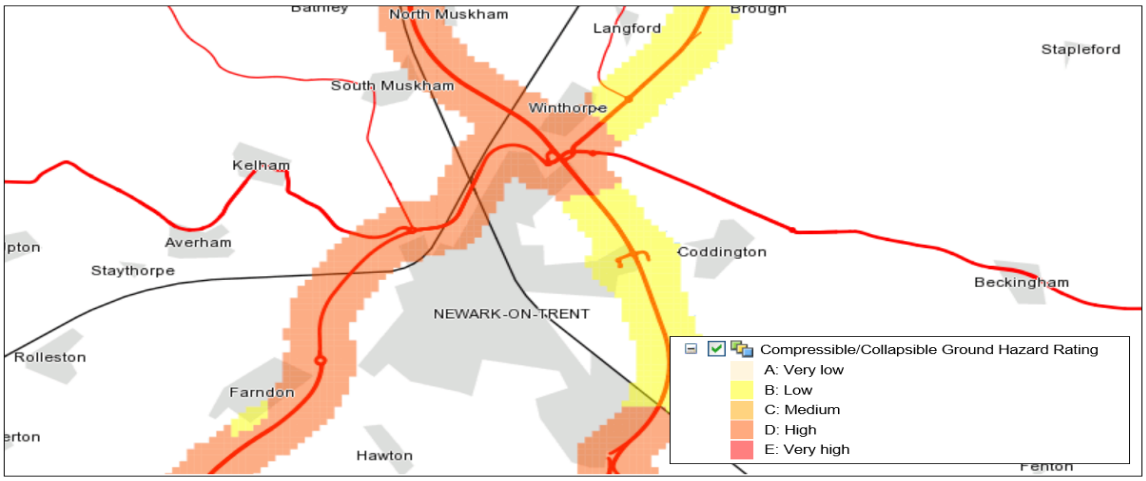

Figure 3-15 Compressible/Collapsible Ground Rating (Source: HAGDMS [12], November 2020)

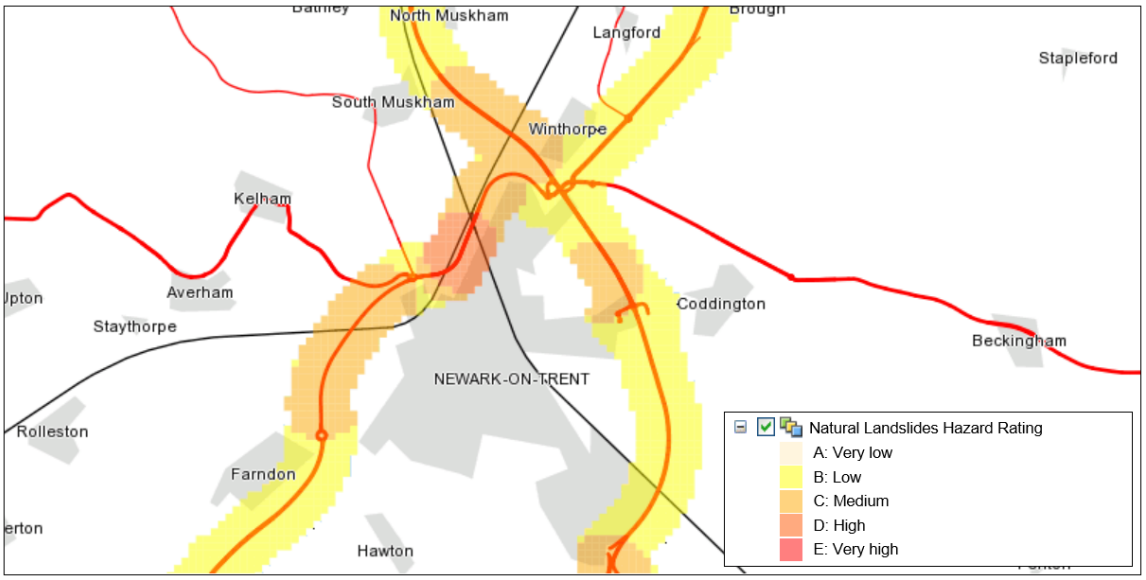

Figure 3-16 Natural Landslides Hazard Rating (Source: HAGDMS [12], November 2020)

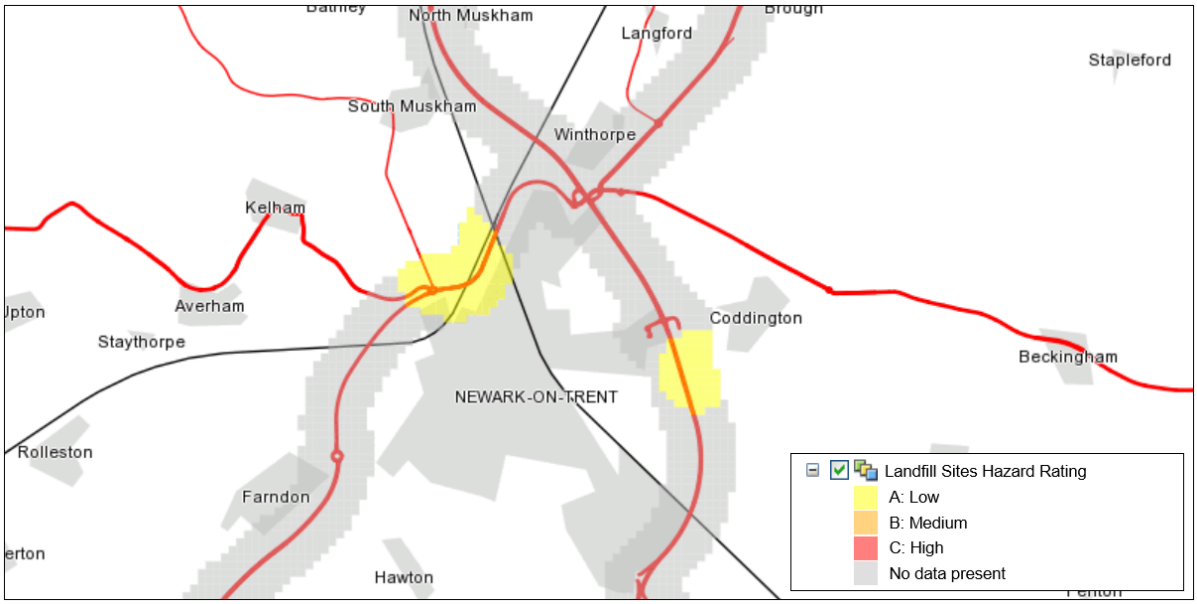

Figure 3-17: Landfill Sites Hazard Rating (Source: HAGDMS [12], November 2020)

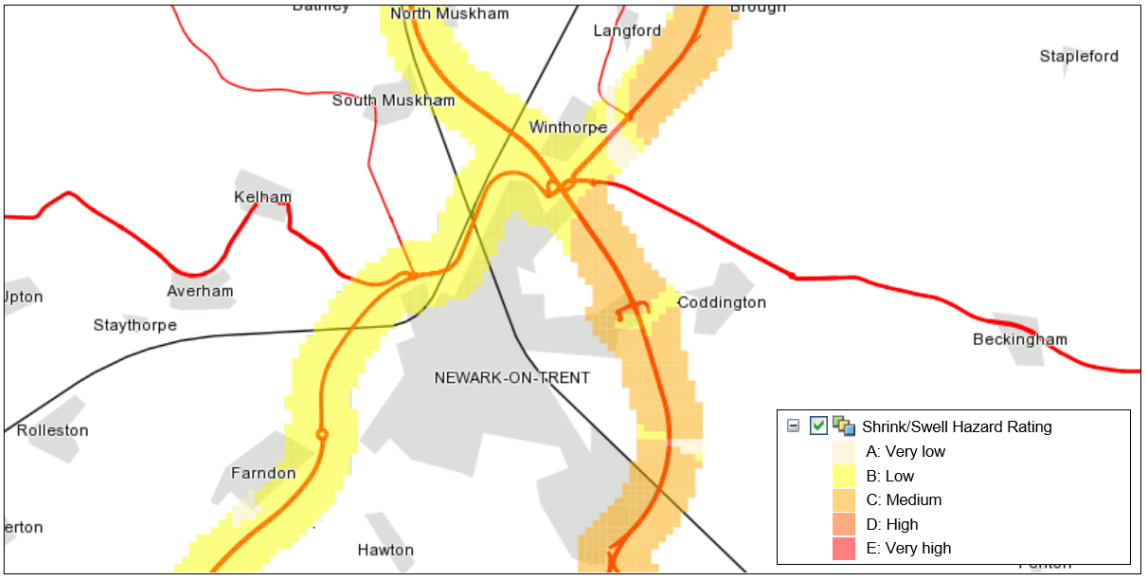

Figure 3-18: Shrink/Swell Hazard Rating (Source: HAGDMS [12], November 2020)

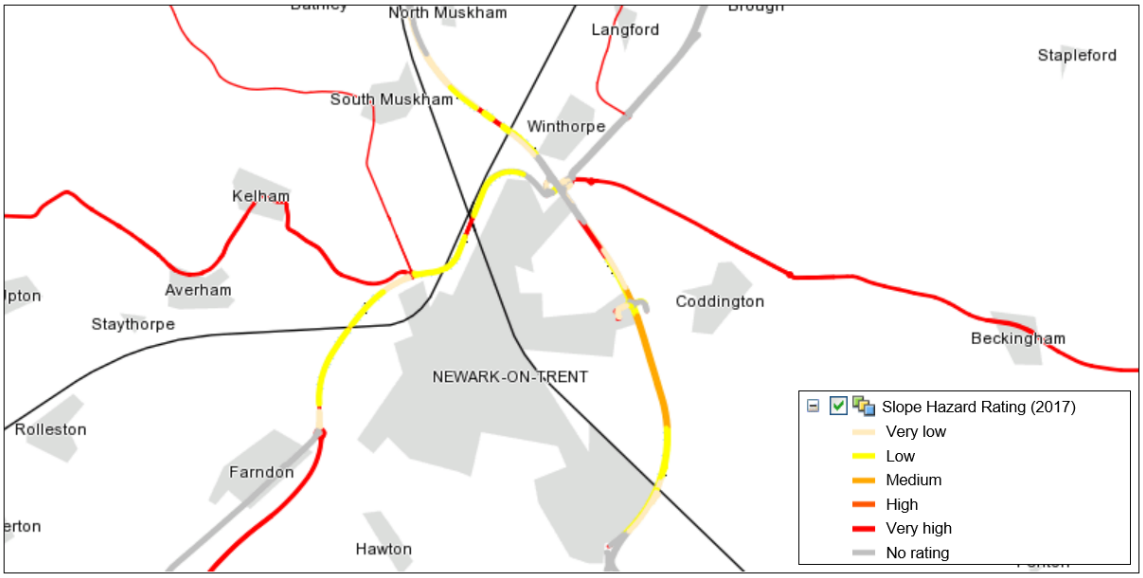

Figure 3-19: Slope Hazard Rating, 2017 (Source: HAGDMS [12], November 2020)

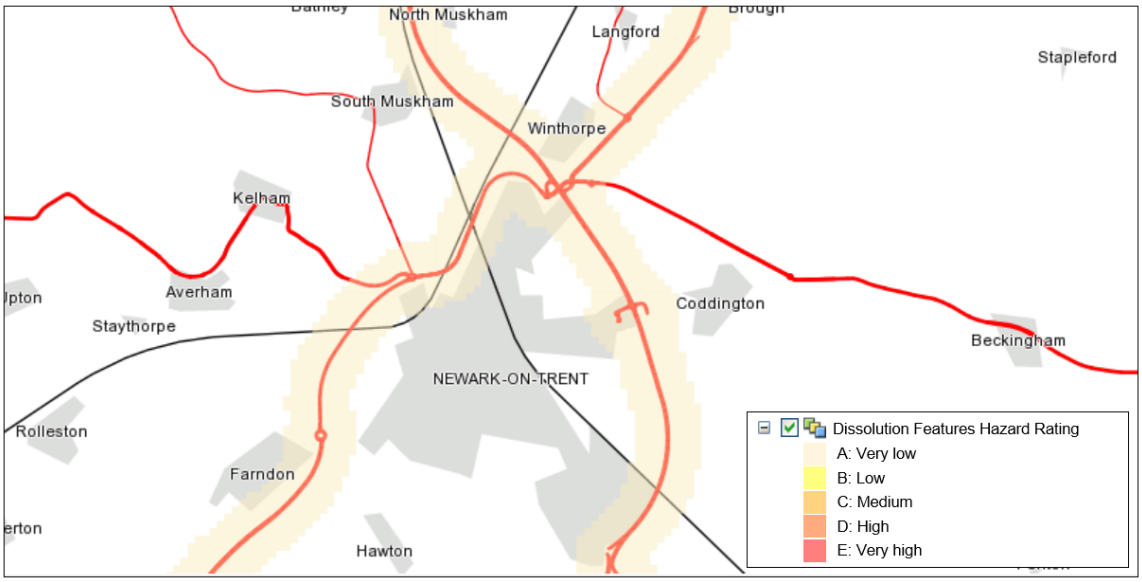

Figure 3-20: Dissolution Features Hazard Rating (Source: HAGDMS [12], November 2020)

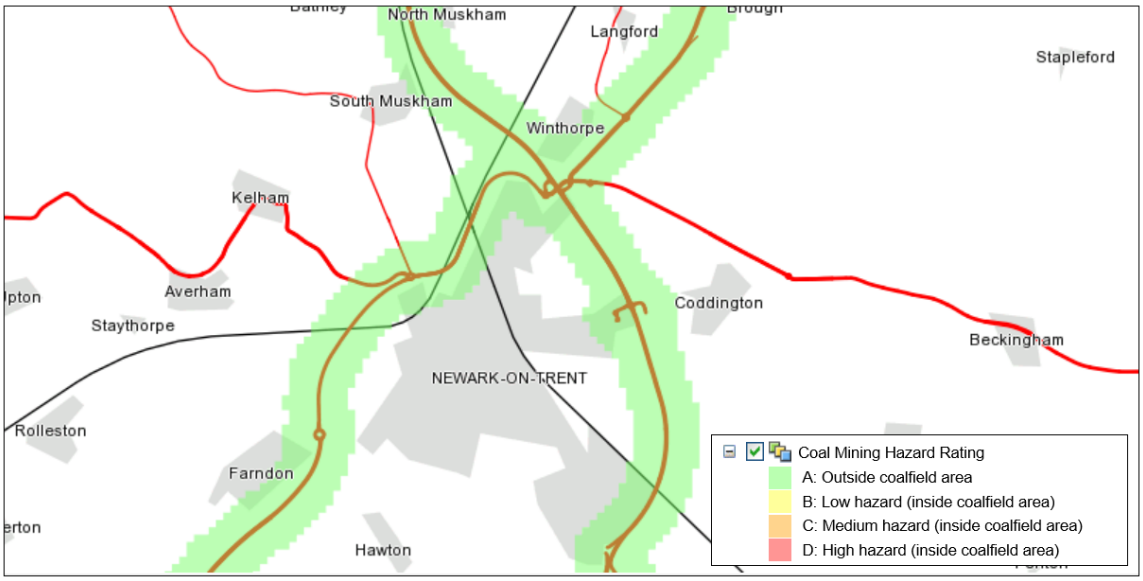

Figure 3-21: Coal Mining Hazard Rating (Source: HAGDMS [12], November 2020)

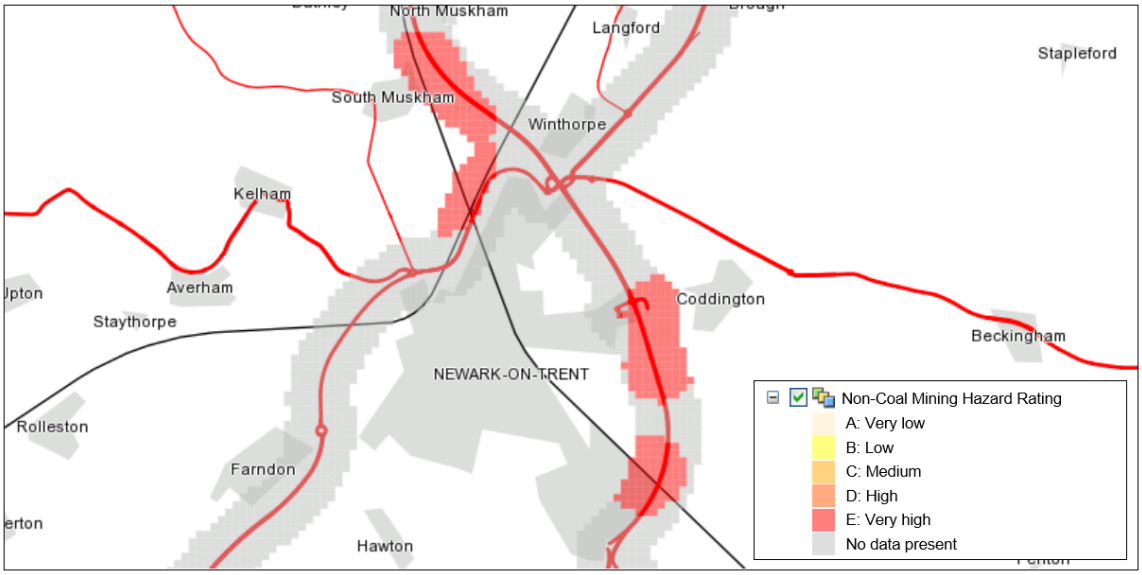

Figure 3-22: Non-Coal Mining Hazard Rating (Source: HAGDMS [12], November)

4. Ground Conditions

4.1. Ground Summary

By reviewing the available Ground Investigation (GI) data and geological mapping, a preliminary ground model has been developed.

Previous ground investigations have identified that the ground beneath the site is complex and highly variable because of to the presence of relict meanders of the River Trent in the floodplain, presence of a layer of soft clay across the floodplain and deep infilled alluvial channels [13], as outlined in Section 3.4 Superficial Deposits.

The geological units are arranged typically as indicated in Table 4-1 below.

The thickness of the layers is derived by the corresponding available exploratory holes.

Table 4-1: Ground Model

Unit	Stratigraphy name	Minimum thickness (m)	Maximum thickness (m)	General descriptions and comments
Topsoil	-	0.20	1.30	TOPSOIL ranges from a minimum of 0.20m to a maximum of 0.80m. In some locations MADE GROUND is encountered at existing ground level, ranging from 0.20m to 0.40m in thickness.
Superficial Deposits	Alluvium[1]	0.20	3.70	Firm stiff brown becoming soft grey/brown-grey with depth silty CLAY. In some locations this layer material is not encountered.
	River Terrace Deposits (Holme Pierrepont or Balderton member)	1.30	6.50	Loose/medium dense grey brown medium-coarse SAND and GRAVEL. In some locations this layer material is not encountered.
Solid Geology	Mercia Mudstone Group	4.90	9.30	Red-brown clayey SILT with lenses of grey clayey silt and stiff red-brown very sandy very silty clay. Encountered in less than 5 No. locations.
		0.80	13.30	Firm/Stiff becoming very stiff with depth red-brown silty CLAY with fragments of weak red-brown MUDSTONE and occasional moderately-strong bands.

Unit	Stratigraphy name	Minimum thickness (m)	Maximum thickness (m)	General descriptions and comments
		Not proven	Not proven	Moderately strong becoming strong red-brown silty MUDSTONE with thin veins of white gypsum.

[1]Note that alluvial clays are highly variable along the scheme, as a result of relict meanders of the River Trent.

Plan and longitudinal sections of the ground model taken from “A46 Newark Relief Road” report [12] are presented in Appendix B.

Historic boreholes from the “A46 Newark Relief Road” report [12] have been digitised using Bentley OpenGround software.

Plan and long sections generated using OpenGround are presented in Figure 4-1 to Figure 4-3 below.

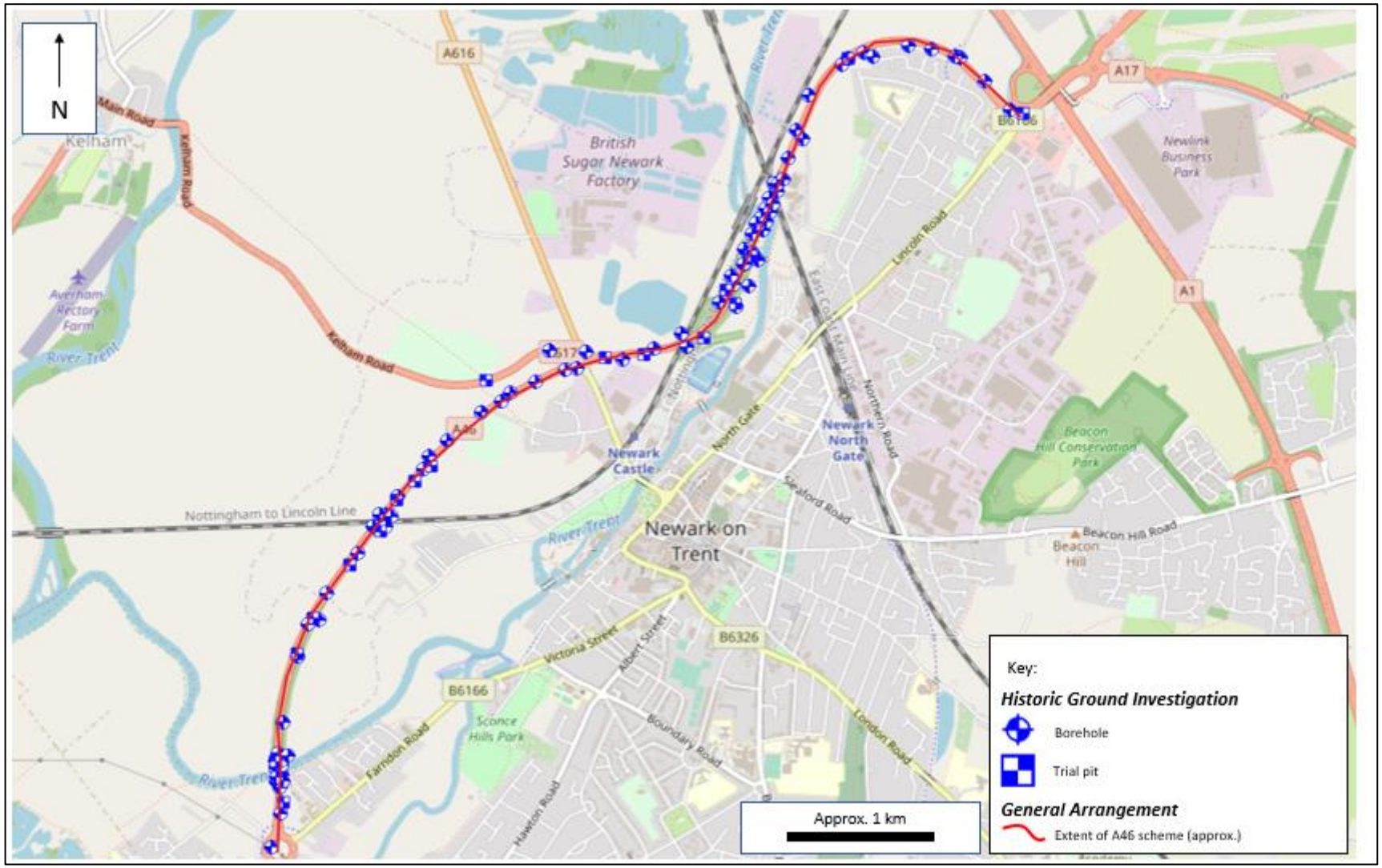

Figure 4-1. Plan of historic boreholes (digitised in OpenGround)

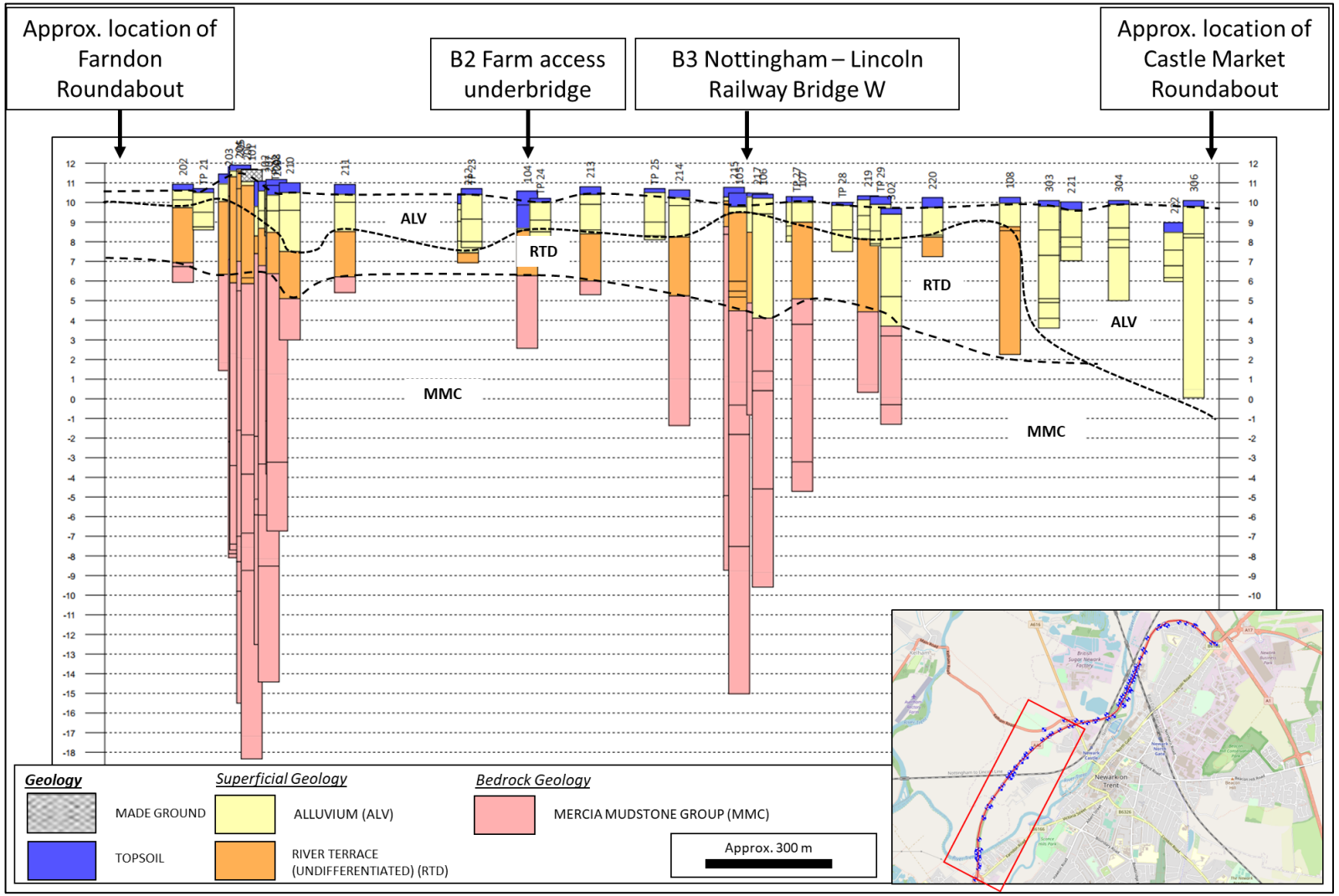

Figure 4-2. Geological Section 1 of 2 (digitised in OpenGround)

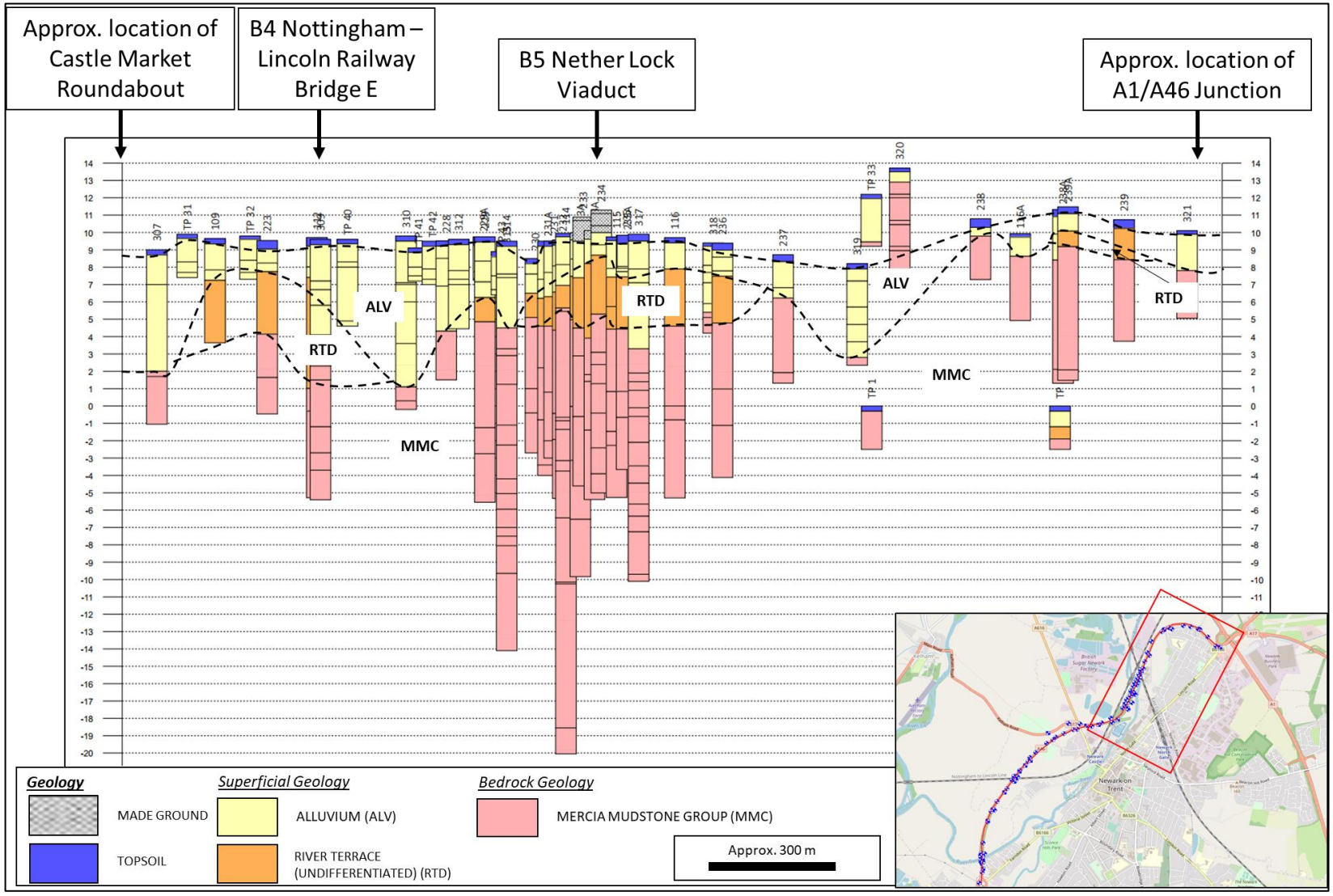

Figure 4-3. Geological Sections 2 of 2 (digitised in OpenGround)

4.2. Groundwater

The level of the upper water table is directly related to the level of water in the River Trent. When the level of water changes in the river so does the groundwater table.

In many areas the groundwater lies about 1.50m-2.00m below ground level, as indicated in Table 3-1 in Section 3.3.

4.3. Summary of Preliminary Geotechnical Parameters

A review of existing geotechnical reports for the A46 Newark Relief Road shows that ground investigations for the scheme have been carried out as far back as 1978 (Exploration Associates Limited). Design parameters derived as part of these previous investigations provides an insight into likely geotechnical parameters and the ground conditions on the site in advance of the next phase of GI.

Historic reports reach a consensus that sand and gravel beds associated with the River Trent valley are overlain by alluvial deposits of soft and stiff clays. At depth Mercia mudstone (historically known as Keuper Marl) underlies the entire route.

The Department of Transport Newark Relief Road A46 Geotechnical Report dated September 1985 [13] provides a table of soil properties for the site. This report summarises findings from the GI conducted by Exploration Associates Limited in 1978 and findings from a supplementary investigation completed in April 1985. The soil properties table from this report is provided in Figure 4-4 below:

TABLE 1. PROPERTIES OF SOILS

Deposit	c_u kN/m^2	c' kN/m^2	Ø' (deg)	Unit Weight kN/m^3	Water Content %	C_v m^2/year
Clay crust	70	0	30	18.6	22	4
Soft clay	13	0	30	17.7	40	1
Gravels	-	0	30	21.5	-	-
Keuper IV	70	0	30	19.8	25	0.6 - 460
Keuper III	100	0	35	19.5	16	0.1 - 2000

the upper limits to the C_v for Keuper Marl are the highest measured values; in many cases consolidation took place faster than could be measured.

Figure 4-4. Properties of soils, A46 Geotechnical Report dated September 1985 [13]

A report titled A46/A17 Newark Relief Road Geotechnical Report from February 1987 summarises findings from the 1978 investigation, in addition to further investigations in 1985 and September 1986 which were carried out due to alignment changes. Table 4-2 provides parameters extracted from this report:

Table 4-2. Geotechnical Parameters as provided in A46/A17 Newark Relief Road Geotechnical Report from February 1987.

Unit	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Natural Moisture Content (%)	CBR (%)	Undrained shear strength C_u (kN/m^2)	m_v (m^2/MN)	c_v (m^2/yr)
Alluvial Clay	10-20	22-40	10-20	7-20	2-5	-	-	-
Keuper Marl	13-16	32-34	17-19	12-16	-	160-230	0.1-0.05	5-100

The A46/A17 Newark Relief Road Geotechnical Feedback Report from November 1991 [16] discusses items of geotechnical interest arising from the construction of the A46/A17 Newark Relief Road. The report details that during construction good use was made of local sand and gravel sources (borrow pits in proximity to the road) for granular fill. Testing of sands and gravels extracted from borrow pits at British Sugar and Trent Dyke gave an internal friction angle of 58^0, and Crankley Point 50^0.

A summary of preliminary representative geotechnical parameters was derived by a review of the A46 Newark Relief Road Geotechnical Report and A46 Newark Relief Road Geotechnical Assessment Report and is presented in Table 4-3 below:

Table 4-3. Geotechnical Parameters

Unit	γ(kN/m^3)	c'(kPa)	φ'(deg)	c_u(kPa)	c_v(m^2/year)	m_v(m2/kN)	CBR(%)
Topsoil	-	-	-	-	-		-
Soft alluvial clay	17.7	-	30	13	1.0	1.26x10^{-3}	-
Alluvial Clay	-	-	30	70	4.0	3.5x10^{-4}	2 to 5
Sand & Gravel	21.5	-	33*	-	-	-	18
Mercia Mudstone	19.5	-	25 - 30	>70	10	0.12x10^{-3}	-
*Based on N'SPT' of 20							

More recently some localised GI has been undertaken at A46 Under Road Crossing (2017) and A46 Western Junction Brownhills Roundabout and Friendly Farmer Roundabout (by ESG in 2018). The results of these localised ground investigations are broadly in agreement with the findings of the more extensive ground investigations carried out in the 1970s and 1980s.

Typical effective parameters depending on the grade of weathering for Mercia mudstone are provided in the CIRIA 570 Engineering in Mudstone and are presented in the Figure 4-5 below:

Weathering Grade	c' (kPa)	ϕ' (°)	ϕ_r' ($c_r' \approx 0$) (°)
IV	<20	32–25	24–18
III	<20	42–32	29–22
I–II	>25	>40	32–23

Figure 4-5. Effective parameters for Mercia Mudstone

4.4. Appraisal of Existing Ground Investigation Data

GI information is available along the entire route alignment from Farndon Junction to A1/A46 Junction, whereas for the remaining part of the route from A1/A46 Junction to Winthorpe Roundabout the available GI information is limited.

The quality and quantity of the information from the existing ground investigations can be considered wide enough to gain an idea of the geology in the area, due to the following factors:

- adequate geological descriptions on historical borehole logs;
- adequate in-situ and laboratory test data;
- certainty over exact location of boreholes;
- certainty over groundwater regime.

In order to obtain information to develop a suitable ground model for the scheme, it is proposed:

- to undertake a ground investigation including laboratory testing and suitable in-situ testing to verify and assess the ground conditions. Proposed ground investigation will include exploratory holes undertaken on top of the existing embankments to verify the embankment material and exploratory holes located at the base level of the proposed earthworks and structures to confirm the existing natural ground conditions, especially the depth of soft Alluvium. By locating adjacent boreholes at the top and toe of existing earthworks, a full profile of earthwork fill and natural ground conditions below will be obtained.
- The proposed ground investigation should cover new road sections, areas of proposed widening works, areas requiring special design solutions (i.e. where existing infrastructures cross the route, or in their proximity) and areas where the current available ground investigation is limited (area running from A1/A46 Junction to Winthorpe Roundabout, characterized by lack of historic GI data).

5. Site Reconnaissance

Site Walkover – January 2021A site walkover was undertaken by an Engineering Geologist and an Environmental Consultant from Atkins on the 27th and 28th January 2021. The site walkover was carried out on foot within the highway corridor / existing earthworks footprint and using public rights of way where suitable.

The aims of the walkover survey were to:

- Establish any potential site access constraints which might impact any proposed ground investigation (GI);
- Obtain an extensive photographic survey using FieldMove software to obtain geo-referenced images of the site; to assist with planning the ground investigation from the office;
- Wherever possible, view existing earthworks and structures to gain knowledge of current condition.
- Establish the location of any problematic ground (e.g. soft ground, localised flooding, dense vegetation) which could impact site works.
- Carry out reconnaissance for potential parking or site compound locations for future site works.
- Gain general understanding of the site layout in a higher level of detail than is possible via desk-based studies, and to identify any site features which have not been identified elsewhere in the PSSR.

5.1. Findings of Site Walkover

The site walkover covered the full length of the scheme from Farndon Roundabout to Winthorpe Roundabout. The emphasis of the walkover was to observe the earthworks of the northbound side of the road (side where new carriageway is proposed). Third party land was not accessed except for public rights of way.

Significant areas of surface water flooding were noted on fields surrounding the site during the walkover. This did not directly affect the road itself due to its elevated position, and it being largely on sections of embankment. Flooding may however provide access issues should flooding occur during the ground investigation.

No significant instability was noted on the existing earthworks. These are typically covered with medium sized trees with little undergrowth. In places embankments are covered with grass and short shrubs. There is evidence that recent de-vegetation has taken place in some locations.

In some areas there is evidence of some fairly extensive rabbit burrowing; it does not appear to impact the global stability of the earthworks.

Throughout the section the verge of the northbound lane of the A46 is unlikely to provide an adequate safe space to undertake exploratory holes safely. Therefore, traffic management is likely to be required for exploratory holes at road level.

A number of existing potential access routes were identified; both directly from the A46 itself and also from farm tracks on third party land. In places, the existing railways and River Trent may act as an obstacle to some access; borehole drilling rigs may have to track some distance across fields to reach certain sites.

Some localised de-vegetation may be required in addition to removal of fences prior to ground investigation works commencing.

Potentially contaminative uses were identified along and in the vicinity of the route including petrol filling stations, railway lines, sewage works and various industrial land uses.

Multiple areas of fly tipping were noted along the existing earthworks and within some of the drainage ditches at the base of the earthworks. Waste included nominally empty fuel additive containers, food waste and general household waste.

No visible evidence of contamination was identified on the surface of identified drainage ditches or the River Trent. Due to the level of water within the Trent, it was not possible to observe whether any contamination was present within any of the drainage outfalls.

An additional site walkover will be undertaken with the ground investigation contractor prior to mobilisation of site works to confirm site access routes. An ecologist will be present for this additional site visit. This will be based on the findings of the initial walkover by Atkins engineers.

Figure 5-1 – Photograph taken during Atkins Site Walkover beneath A46 viaduct over River Trent / East Coast Main Line

6. Preliminary Engineering Assessment

This section presents the geotechnical risks associated with the design construction of the scheme.

It must be noted that the below sections are not exhaustive and that the geotechnical risks will be updated as the scheme progresses.

6.1. Soft / Compressible Ground

Due to the presence of compressible and weak Alluvium, there is high risk of earthwork instability and excessive total and differential settlement of the widened earthworks along the route.

The 1985 Geotechnical Report [13] identifies that the Alluvium present at the site is geologically complex due to the presence of relict meanders of the River Trent and that a thin layer of very soft clay is located at typically 2m depth across the floodplain.

The alluvium was not generally removed beneath the existing A46 embankments as this was considered to be too costly. Instead, the ground was improved by surcharging for a period of 12-15 months.

Options to address the soft alluvium are:

- Excavate the soft clay beneath the footprint of the widened earthwork and replace with a stronger material. This would result in an the need to dispose of the soft alluvium as it is unlikely to be suitable to reuse into the works.
- Surcharge the ground beneath the widened embankment. Possibly incorporating staged construction.
- Soil /cement mixing to improve the strength and stiffness of the alluvium beneath the footprint of the works.

Ground improvement and/or piling will need to be considered in the area of the deep alluvial filled channel near to Nether Lock. This is approximately 6m deep and will not be viable to remove.

6.2. Aggressive Ground

Based on the historic ground investigation, the Mercia mudstone contains gypsum, which could stem from pyrite oxidisation. The gypsum from the Mercia mudstone is predominately 'Satin Spar 'and is an evaporite mineral which is susceptible to dissolution under certain conditions. The presence of sulphate minerals, depending on the content level, could lead to sulphate chemical attacks on buried concrete structures and therefore compromising said structures. Adequate mitigation measures could be required to protect against sulphate attack when natural ground is in contact with concrete.

The stiff alluvial clay, the sands and gravel and the Mercia mudstone produced non-aggressive classifications. However, wherever tested the soft alluvial clay proved to be aggressive [13]. Appropriate laboratory testing should be scheduled to fully determine the presence of sulphate material in the Mercia mudstone.

6.3. Shrink/ Well Ground

Thin veins of gypsum were noted in boreholes from the existing Ground Investigation. If during the recommended Ground Investigation, gypsum is found to be a continuing prevalent issue, then treatment or prevention methods will need to be considered to ensure that swell or differential swell does not occur due to the expansion of this material.

6.4. Weathered Ground

According to the BS5930:1990, the Mercia mudstone description may vary between a rock or soil classification. This is predominantly a result of the various degree of weathering that the Mercia mudstone can endure. Due to the presence of various superficial material thickness above the Mercia mudstone, the bedrock may have a variable weathering profile. This will an important consideration for the design of piled foundation.

6.5. Groundwater

Due to the location of the scheme in close proximity to the River Trent and associated watercourses, groundwater and the groundwater table are shallow (1m to 2m depth). Due the presence of variable superficial geology beneath the scheme, the hydraulic conductivity could have a significant range. Long term monitoring of groundwater variation could be required.

The presence of granular material (River Terrace Deposits – Undifferentiated) could contain perched groundwater.

Alluvial clays act as a semi-permeable layer which prevents groundwater flow upwards from sands and gravels beneath. If these clays are removed, replacement granular fill would need to incorporate an impermeable layer to counter this groundwater upward flow.

The need to resist wave action, and to prevent the flow of floodwater through the embankment were critical design decisions for the existing embankment. These considerations will also be relevant to the widened earthworks.

6.6. Material re-use

Widening of the existing earthworks will require stripping of the Topsoil layer from the:

- existing embankment slopes;
- area between existing and proposed embankment toe lines;
- existing cut slopes; and
- area between existing and proposed cut crest lines.

The majority of the Topsoil volume generated during the proposed works is expected to be re-used again as Topsoil to cover the new widened sections of earthwork slopes.

Any excavations associated with the works are likely to be within the Alluvium or River Terraced Deposits. The Alluvium is unlikely to be suitable for re-use with

the exception of Class 4 (landscaping). The River Terrace Deposits are likely to yield Class 1 fill and may be incorporated in the main embankment fill works.

No significant volume of structural fill (Class 6) is expected to be generated from the areas of embankment widening as any excavations will be limited to the existing slope surface to allow the formation of benching.

A site specific ground investigation will confirm the proportion of the material volume that can be re-used directly, material that can be re-used provided it is modified (e.g. reduce moisture content of cohesive material by mixing with lime or spreading and allow it to dry out) and material that will be deemed unacceptable and will have to be exported.

Parts of the proposed widening works will be located within the existing flood area and will therefore reduce the current flood capacity. The flood alleviation strategy is expected to require the excavation of nearby areas by reducing the ground levels by up to approximately 1m to compensate the flood volume capacity reduction imposed by the proposed earthworks.

6.7. Earthwork Material

It is likely that the proposed earthworks will comprise granular material and rockfill (where used) with preference to using waste products (glass sand, PFA, crushed concrete) where possible.

6.8. Drainage

The risk of all types of flooding are a major consideration on this scheme. The strategy for managing water across the site will need to be carefully considered and tied in to local and regional strategy to ensure that flooding or insufficient drainage does not result in the failure of earthworks and structures.

The drainage capacity of the soil will need to be adequately assessed during the Ground Investigation phase. With the presence of saturated sand and gravel material immediately below the site (groundwater dependent), and the low permeable Mercia mudstone below this surface run off and lack of infiltration into the soil could a significant hazard. Soakaway testing should be undertaken to determine the infiltration rate of the sand and gravel layers in order to facilitate the design of the balancing ponds and earthwork drainage channels.

6.9. Structure Foundations

Due to the presence of compressible Alluvium, there is a significant risk of differential settlement along the route, especially in relation to the widening of the existing structures.

Piled solutions (driven or bored piles) are likely to be preferable where alluvium is present. The risk of negative skin friction shall be considered for piles situated in or near compressible ground.

Where the Alluvium thickness is small (<2m) or absent, the River Terrace Deposits are likely to be a suitable founding stratum for shallow foundations.

Any ground bearing concrete would be designed in accordance with BRE Special Digest 1 [18] to mitigate the risk of chemical attack.

6.10. Pulverised Fuel Ash (PFA)

Figure 3-14 in Section 3.14, Existing Earthworks, demonstrated the presence of PFA at the core of the existing embankment in some sections. PFA has been widely used as fill material in the construction of earthwork, and therefore the behaviour of working with PFA is well understood. However, there is a likelihood that the PFA is either not cemented or there are only few cemented layers within the body of PFA. Exposing layers of PFA that has not been fully cemented can result in localised material loss.

The environmental risk associated with unearthing and exposing PFA has been further highlighted in Section 7, Preliminary Land Contamination Assessment.

6.11. Buried Services

A thorough review of all existing nearby services should be provided prior to undertaking the proposed Ground Investigation design, to ensure exploratory hole locations are proposed outside exclusion zones, and at appropriate distances. Based on the preliminary findings, overhead and buried high voltage cables are present, as well as low, medium and intermediate pressure gas lines. A major sewer crossing perpendicularly beneath the A46 just north of the Nether Lock Viaduct.

7. Preliminary Land Contamination Assessment

Land contamination is assessed through the identification and assessment of Potential Contaminant Linkages (PCLs). The approach in the following section is in accordance with the Contaminated Land Exposure Assessment (CLEA) model produced by DEFRA and the Environment Agency and as outlined in the DEFRA/Environment Agency Land Contamination Risk Management Guidance (LCRM) (DEFRA / Environment Agency, 2020).

The LCRM provides a technical framework for identifying and remediating contamination through the application of a risk management process. The assessment involves the development of a conceptual site model (CM) which describes the source-pathway-receptor relationship between potential sources of contamination and associated contaminants from both on-site and off-site sources, receptors to such contamination and potential pathways between the two. If all three are present or considered likely to be present, they are described as PCLs which can be subject to the risk assessment process.

The question of whether risk is unacceptable in any particular case involves scientific and technical assessments together with appropriate criteria by which to judge the risk and conclude the level of risk which would be unacceptable.

The assessment framework and guidance given within the LCRM has been applied to this Preliminary Land Contamination Assessment (PLCA). The PLCA comprises a desk study review, development of a preliminary conceptual site model (PCSM), and a qualitative risk assessment.

It should be noted that under current health and safety legislation, construction and maintenance workers are required to carry out appropriate risk assessments and instigate appropriate mitigating measures to protect themselves, other human receptors and the environment from contamination which may be present. Such risks must be adequately mitigated by the measures required under current legislation, specifically the Construction Design Management (CDM) Regulations which requires that potential risks to human health and the environment from construction activities are appropriately identified and all necessary steps taken to eliminate / manage that risk. On this basis, it been assumed that personal protective equipment (PPE) and health and safety best practices will be adopted during the construction works and acute risks to construction workers / site visitors have therefore not been considered as part of this assessment.

Based on the historical maps and the desk study information summarised in previous sections of this report, potential sources of contamination have been identified as outlined within Table 7-1. The list of activities and contaminants of concern listed should not be considered exhaustive and provides a guide to the likely range of contaminants which may be present at or surrounding the site.

Table 7-1: Potential Sources of Contamination

On-site or off-site	Potential sources of Contamination	Contaminants of Concern
On-site	Made Ground associated with, previous road development, the railways and roads crossing the site.	A range of metals, inorganic and organic contaminants including: Arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, zinc, vanadium, asbestos and asbestos containing materials (ACMs) Total Petroleum Hydrocarbons (TPHs), Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), solvents, acids, Semi volatile Organic compounds (SVOCs), and Volatile Organic compounds (VOCs). Ground gas including carbon dioxide, methane, hydrogen sulphide and carbon monoxide, with the potential for low oxygen levels. Potential for hydrocarbon vapours.
	Contaminated soil associated with Chemical Manure manufacturing & Malthouse	Inorganic and organic contaminants such as metals, asbestos / ACMs, TPHs, PAHs, PCBs, solvents, acids, SVOCs, and VOCs. Organic matter likely to be present with the potential for biological contaminants. Ground gas including carbon dioxide, methane, hydrogen sulphide and carbon monoxide, with the potential for low oxygen levels.
Off-site	Made Ground associated with development in the area	A range of metals, inorganic and organic contaminants including: Arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, zinc, vanadium, asbestos / ACMs, TPHs, PAHs, PCBs, solvents, acids, SVOCs, VOCs. Biological contaminants, ammonia, pH. Ground gas including carbon dioxide, methane, hydrogen sulphide and carbon monoxide, with the potential for low oxygen levels.
	Sewage Works (inc. sludge beds, filter beds and tanks), and Landfill	
	Historic Pollution Incidents	TPHs, PAHs, SVOCs, and VOCs, metals.
	Electricity sub-station	Metals, TPHs, PAHs, PCBs.
	Mill (inc. infilled mill pond)	Metals, TPHs, PAHs, SVOCs, VOCs, and potential for asbestos / ACMs, and ground gas.
	Nursery, Farmland around the route options including the potential for unmapped farmers tips.	Herbicides, pesticides.
	Brewery	Metals, TPHs, PAHs, SVOCs, VOCs, and potential for asbestos / ACMs, and ground gas.

	Foundry	Metals, TPHs, PAHs, SVOCs, VOCs, and potential for asbestos / ACMs, and ground gas.
	Malthouse	Inorganic and organic contaminants such as metals, asbestos / ACMs, TPHs, PAHs, PCBs, solvents, acids, SVOCs, and VOCs. Organic matter likely to be present with the potential for biological contaminants. Ground gas including carbon dioxide, methane, hydrogen sulphide and carbon monoxide, with the potential for low oxygen levels.
	Bleaching house	A range of metals, inorganic and organic contaminants including: Arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, zinc, vanadium, asbestos / ACMs, TPHs, PAHs, PCBs, solvents, acids, SVOCs, VOCs. Biological contaminants, ammonia, pH
	Wicker Works	Metals, TPHs, PAHs, SVOCs, VOCs, and potential for asbestos / ACMs, and ground gas.
	Boiler works	A range of metals, inorganic and organic contaminants including: Arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, zinc, vanadium, asbestos / ACMs, TPHs, PAHs, PCBs, solvents, acids, SVOCs, VOCs. Biological contaminants, ammonia, pH
	Scrap Yard	A range of metals, inorganic and organic contaminants including: Arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, zinc, vanadium, asbestos / ACMs, TPHs, PAHs, PCBs, solvents, acids, SVOCs, VOCs. Biological contaminants, ammonia, pH
	Lorry Park	Inorganic and organic contaminants such as metals, TPHs, PAHs, PCBs, solvents, acids, SVOCs, and VOCs.
	Bus depot	Inorganic and organic contaminants such as metals, TPHs, PAHs, PCBs, solvents, acids, SVOCs, and VOCs.
	British Sugar Mill	A range of metals, inorganic and organic contaminants including: Arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, zinc, vanadium, asbestos / ACMs, TPHs, PAHs, PCBs, solvents, acids, SVOCs, VOCs. Biological contaminants, ammonia, pH
	Petrol filling stations	Inorganic and organic contaminants such as metals, TPHs, PAHs, PCBs, solvents, acids, SVOCs, and VOCs.

Table 7-2 summarises the potential receptors and pathways currently within the route options and potentially associated with the construction and operation of the route options.

Table 7-2: Potential Receptors and Pathways

Potential Receptors	Pathways
Human Receptors on site (current and future): Construction/ maintenance workers; Road Users.	Dermal contact with and/or ingestion of contaminants in soil, soil-derived dusts and water. Inhalation of contaminants in soils/dust including asbestos fibres. Inhalation of ground gases and/or vapours.
Human Receptors off-site (current and future): Member of the public accessing the surrounding area for work or recreation; Residents.	Dermal contact with and/or ingestion of contaminants in windblown soil-derived dusts and water which may have migrated off-site. Inhalation of contaminants in windblown dust including asbestos fibres. Inhalation of ground gases and/or vapours which may have migrated off-site.
Controlled Water Receptors (on and off-site): Secondary A Superficial Aquifer; Secondary B Bedrock Aquifer; River Trent, Old Trent Dyke (Spring) and drains. Kings Marina Smeatons Lakes	Discharge of contaminants entrained in surface water runoff followed by overland flow and discharge. Leaching and migration of contaminants (free and dissolved phase) from soils in the unsaturated zone into groundwater in underlying superficial aquifer. Migration from the superficial groundwater to deeper bedrock aquifer. Lateral migration of contaminants in groundwater with discharge to surface water as base flow. Migration of contaminants via preferential pathways such as service runs, existing and retained subsurface structures, existing and proposed foundations, proposed drainage.
Property Receptors on-site: Existing road network infrastructure; Proposed new infrastructure including services.	Direct contact of contaminants in soil and/or groundwater with buried service. Migration of groundwater, ground gases or vapours along preferential pathways including permeable ground, service trenches and service entry points and accumulation in enclosed spaces such as service ducts or access points.
Property Receptors/ scheduled monuments / listed buildings off-site: Existing structures and services (including housing); Pets; Crops and livestock.	Migration of groundwater, ground gases or vapours along preferential pathways including permeable ground, service trenches and service entry points and accumulation in enclosed spaces such as buildings, service ducts or access points. Ingestion / inhalation of contaminants in waters / dust / vapours by pets and livestock. Uptake through groundwater or air / dust for crops.
Scheduled monuments / Listed buildings	

In order to identify PCLs to human health, controlled waters and property, a preliminary CSM has been produced and is summarised in Table 7-3 below. A preliminary qualitative assessment of the identified PCLs has been undertaken, in accordance with the CIRIA C552 report (CIRIA, 2001), with the PCLs given a risk rating based on the current condition of the proposed works areas and the proposed end use.

Table 7-3: Preliminary Conceptual Site Model

Source	Receptor	Pathway	Consequence	Probability	Risk
On-site: Made Ground associated with previous road development, the railways and roads crossing the site. Contaminated soil associated with Chemical Manure manufacturing & Malthouse.	**Human Health:** On-site users of the road / pedestrians	Dermal contact with and ingestion of contaminants in soil, soil-derived dust and water. Inhalation of contaminants in soil, soil-derived dust, fibres and vapours.	**Medium**	**Unlikely** Post works, the site will comprise hardstanding road surfaces and pavement minimising potential for end users to come into direct contact with soils or for dust to be generated. Ground gases are unlikely to be a significant concern as no enclosed structures are proposed as part of the scheme.	**Low**
	Human Health: Construction / maintenance workers		**Medium**	**Unlikely** Future maintenance on the site may require localised excavation with potential for workers to come into direct contact with soils or inhale soil derived dusts. This work is likely to be short term and infrequent. Works will be risk assessed and best practice controls are likely to be used (e.g. gloves, and protective clothing) minimising potential for exposure.	**Low**
	Human Health: Off-site users of residential properties, farms and roads.	Off-site migration of contaminants in soil derived dust and run-off followed by dermal contact / inhalation / ingestion	**Medium**	**Unlikely** The future site will comprise hardstanding and consequently soils will be encapsulated beneath these impermeable surfaces thus removing the potential for generation of soil derived dusts.	**Low**
	Controlled Waters: On-site surface water features (River Trent, Old Trent Dyke, drains)	Lateral migration of dissolved phase contaminants in groundwater to surface water; Lateral migration of dissolved phase	**Mild**	**Likely** The majority of the site is not located in close proximity to surface water courses however sections of the proposed route cross the River Trent, Old Trent Dyke and drainage channels. The construction works are likely to result in disturbance of shallow unsaturated soils which may result in the release of contaminants in unsaturated	**Moderate / Low**

		contaminants via preferential pathways such as drains; Migration of contaminants in surface water runoff.		Made Ground soils with potential migration to surface water. Where working in close proximity to watercourses, site best practice procedures require implementation of mitigation to prevent silt entering the watercourse.	
	Controlled Waters: Off-site surface water features (River Trent, Old Trent Dyke, drains)		**Mild**	**Likely** The construction works are likely to result in disturbance of shallow unsaturated soils which may result in the release of contaminants in unsaturated Made Ground soils with potential migration to surface water. Best practice procedures require implementation to minimise leaching of unsaturated soils in excavations and stockpiles.	**Moderate /Low**
	Controlled Waters: Groundwater in underlying Secondary A Superficial aquifer and Secondary B Bedrock aquifer	Leaching or dissolution of contaminants in soils and subsequent migration of contaminants in groundwater; Vertical migration of dissolved phase contaminants to the underlying groundwater.	**Mild**	**Likely** The works are likely to result in disturbance of soils during excavation and construction which may result in the release of contaminants in unsaturated Made Ground soils with potential vertical migration to groundwater.	**Moderate / Low**
	Property Receptors: Existing and future below ground infrastructure.	Direct contact of contaminated soils/water with infrastructure, services and structures and subsequent chemical attack.	**Mild**	**Unlikely** Current and future below ground infrastructure is assumed to have been / will be constructed to appropriate standards for the site to withstand attack from soil chemistry.	**Very Low**

	Scheduled Monuments / Listed buildings	Leaching or dissolution of contaminants in soils and subsequent migration of contaminants in groundwater; Direct contact of contaminated soils/water with monuments / buildings,	**Mild**	**Low Likelihood** The construction works are likely to result in disturbance of shallow unsaturated soils which may result in the release of contaminants in unsaturated Made Ground soils with potential lateral migration. However, it is anticipated that the impact to the identified receptors shall be mild at worst and the implementation of best practice procedures should minimise leaching of unsaturated soils in excavations and stockpiles and subsequently reduce the likelihood of impact on identified receptors.	**Low**
Off-site: Made Ground associated with previous development. Historical and present day contaminative land uses including sewage works, historical pollution incidents, electricity sub-station, mills, brewery, foundries, malthouse, bleaching house, boiler works, depots, sugar mill, etc.	**Human Health:** On-site users of the road / pedestrians	Dermal contact / ingestion of contaminants in groundwater within excavations	**Medium**	**Unlikely** Post works, the site will comprise hardstanding road surfaces and pavement minimising potential for end users to come into direct contact with contaminated groundwater.	**Low**
	Human Health: On-site future maintenance workers.		**Medium**	**Unlikely** Potentially contaminated groundwater may migrate to the site from off-site sources with the potential for direct contact in excavations. This work is likely to be short term and infrequent. Works will be risk assessed and best practice controls are likely to be used (e.g. gloves, and protective clothing) minimising potential for exposure.	**Low**
	Controlled Waters: On-site surface water features (River Trent, Old Trent Dyke, drains)	Lateral migration of dissolved phase contaminants in groundwater to surface water;	**Medium**	**Low Likelihood** Potentially contaminated groundwater may migrate to the site from off-site sources, potentially affecting surface water features on site	**Moderate / Low**
	Controlled Waters: Groundwater in underlying Secondary A Superficial	Lateral migration of dissolved phase contaminants in	**Medium**	**Low Likelihood** Potentially contaminated groundwater may migrate to the site from off-site sources.	**Moderate / Low**

	aquifer and Secondary B Bedrock aquifer	groundwater to surface water; Migration of contaminants in surface water runoff.			
	Property Receptors: Existing and future below ground infrastructure.	Direct contact of migration contaminated groundwater within infrastructure, services and structures; Migration of ground gas / vapour.	**Mild**	**Unlikely** Current and future below ground infrastructure is assumed to have been / will be constructed to appropriate standards for the site to withstand attack from soil chemistry. Ground gases may be generated from areas of infilled ground. Ground gas has the potential to migrate to site in permeable strata. Considering the distance of the nearest historical landfill is over 500 m from the site, it is unlikely significant landfill ground gas would reach the site. There are understood to not be any enclosed structures proposed as part of the scheme and infrastructure would likely be vented and not routinely accessed.	**Very Low**

Based on the completed PCSM and review of historical information, a number of potential pollutant linkages have been identified, predominantly relating to controlled waters risk.

As such, it is recommended that a ground investigation is completed to delineate point sources of contamination on site, produce an updated assessment of risk to identified receptors and to determine potential geo-environmental constraints with respect to the proposed route options and to inform the need for any remediation on the scheme.

7.1. Waste Classification and Re-use

If material is proposed to be removed or re-used off-site or reused on-site as part of the works, it will require appropriate classification and / or sorting to demonstrate suitability. The actual material to be excavated should be analysed and assessed as suitable for reuse by assessing potential risk to human and controlled water receptors. There should also be a clear requirement for reuse in the scheme design and may require consideration as part of a materials management plan or environmental permit.

A MMP facilitates the legal reuse of excavated materials generated by the project in accordance with the requirements of the CL:AIRE Definition of Waste: Code of Practice (DoWCoP), V2, 2011.

It is the Contractor's responsibility to appropriately classify material excavated and ensure adequate testing is completed.

8. Geotechnical Risk Register

For the potential solutions currently under consideration, it is recommended the scheme be classified as Geotechnical Category 2: projects concerning conventional types of geotechnical activities, with no unusual or difficult ground conditions and involving no abnormal geotechnical risks [1].

The general scheme area is relatively low lying and Alluvial deposits are present for a significant proportion of the existing alignment and surrounding ground, particularly to the west.

The majority of the existing corridor is within a Flood Zone 3.

The existing route is built on embankments up to 13m high within the area of Alluvial ground and flood zones. A viaduct approximately 320m long is also traversing this area. Several structures are present along the route, including those that cross the River Trent, East Coast Mainline and Nottingham-Lincoln railway line.

Ground conditions and potential geotechnical hazards are to be carefully considered for proposed works to existing geotechnical assets or areas interfacing existing infrastructure.

Consideration is to be given at future stages to mitigate all geotechnical risks, including those associated with construction on compressible ground and areas of flood zone.

Potential geotechnical hazards identified in association with the scheme are summarised in the geotechnical risk register presented in Table 8-5. The risk is assessed by interaction of an Impact Classification (see Table 8-1) and Likelihood Classification (see Table 8-2) to determine the risk level, as shown in Table 8-3. Associated Designer Actions are detailed in Table 8-4.

Table 8-1: Impact Classification

Impact	Risk	Cost	Time	Reputation	Health & Safety	Environment
1 – Very Low	Negligible	Negligible	Negligible effect on programme	Negligible	Negligible	Negligible
2 – Low	Significant	>1% budget	>5% effect on programme	Minor effect on local company image/business relationship mildly affected	Minor injury	Minor environmental incident
3 – Medium	Serious	>10% budget	>12% effect on programme	Local media exposure/business relationship affected	Major injury	Environmental incident requiring management input
4 – High	Threat to future work and client relations	>20% budget	>25% effect on programme	Nationwide media exposure/business relationship greatly affected	Fatality	Environmental incident leading to prosecution or protestor action
5 – Very High	Threat to business survival and credibility	>50% budget	>50% effect on programme	Permanent nationwide effect on company image/significant impact on business relationship	Multiple fatalities	Major environmental incident with irreversible effects and threat to public health or protected natural resource

Table 8-2: Risk Classification

Likelihood		Probability
1	Negligible/Improbable	1
2	Unlikely/Remote	2
3	Likely/Possible	3
4	Probable	4
5	Very likely/Almost certain	5

Table 8-3: Risk Matrix

	Impacted					
Likelihood		1	2	3	4	5
	1	N	N	N	A	A
	2	N	A	A	H	H
	3	A	H	H	S	S
	4	H	H	S	S	S
	5	H	H	S	S	S

Table 8-4: Risk Classification

Risk level	Description	Action by Designer
N	Negligible	None
A	Acceptable	Check that risks cannot be further reduced by simple design changes
H	High	Amend design to reduce risk or seek alternative option. Only accept option if justifiable on other grounds
S	Severe	

Table 8-5: Risk Assessment

No	Hazard		Consequence	Impact	Likelihood	Current Risk	Risk Type*	Potential Control Measures	Impact	Likelihood	Residual Risk
1	Striking buried services	Known presence of buried electricity, gas, telecom and water/sewer services	Injury/Death and/or cost of repair to services	4	3	S	C, T. R. H&S	Statutory services plans obtained and reviewed prior to GI works Consultation with service providers Diversions of affected services planned as part of the design	4	2	A
2	Earthwork Instability – possible catastrophic collapse	A thin layer of very soft clay occurs across the entire floodplain at approx. 2m depth Identified by historic GI [13].	Settlement and instability issues in earthworks and structures; lateral loading of piles at structures.	3	4	S	C, T, R, H&S	Foundation and/or ground improvement to be designed accordingly (excavate and replace, ground improvement, surcharge, or similar).	3	2	A
3	Excessive settlement of the approach embankment to Nether Lock Viaduct foundation piles and abutment not founded on competent stratum	Deep alluvium channel at Nether Lock. Deep channel of very soft clay; approx. 150m wide and 6m deep identified by historic GI and feedback report.	Increased settlement of earthworks; Possible impact on Nottingham to Lincoln railway line and existing structures.	3	4	S	C, T, R, H&S	GI to be undertaken to identify depth of alluvium at proposed location of works. Piled foundations for structures and approach embankment	3	2	A

No	Hazard		Consequence	Impact	Likelihood	Current Risk	Risk Type*	Potential Control Measures	Impact	Likelihood	Residual Risk
	Earthwork surcharge lead to movement of the adjacent railway line		Greater depth to founding stratum for piles					Install monitoring in to measure lateral and vertical displacement of the ground close to the railway.			
4	Localised differential settlement leading to earthwork and carriageway repairs .	The floodplain contains many alluvial channels (relict meanders of the River Trent). Localised and highly variable ground conditions within alluvium on River Trent floodplain	Differential and/or excessive settlements where variable thickness of soft clay occur in close proximity.	2	4	H	C, T, R, H&S	Site specific GI to be carried out to determine the extent and depth of relict channels. Review historic mapping of meander channels. Locally excavate and replace or develop design detail to deal with this issue.	1	2	N
5	Groundwater flooding as a result of removal of alluvial clay.	Clay may act as a semi-permeable layer containing groundwater within sands and gravels below. If removed groundwater can flow upwards to surface during periods of flood.	Groundwater flooding of excavations and construction difficulties.	3	3	H	C, T, R, E, H&S	Prevent groundwater flowing upwards to surface by using impermeable membrane or clay layer in design.	3	2	A
6	Localised deep soft ground due to historic borrow pits.	Records of borrow pits adjacent to and beneath A46, from	Increased differential settlement	2	3	H		Use historic mapping to identify location of borrow pits. Targeted GI to establish backfill material	2	2	A

No	Hazard		Consequence	Impact	Likelihood	Current Risk	Risk Type*	Potential Control Measures	Impact	Likelihood	Residual Risk
		construction of Great North Road and A46. Potential for borrow pits backfilled with poor quality alluvium material						and to inform design if A46 affected.			
7	Clash with existing buried/hidden structural elements e.g. ground anchors	Existing H piles, ground anchors, sheet piles are known to have been installed for the A46 works.	Damage to buried elements that will compromising existing structures	3	3	H	C, T, R, H&S	Identify location of existing hidden structural elements. Avoid with GI and be aware of their presence during design and construction.	3	2	A
8	Difficulty progressing borehole through the existing A46 embankments	Embankment known to comprise rockfill and cemented PFA	GI unable to progress through earthwork if rockfall encountered unexpectedly.	1	5	H	C, T, R	Establish extents of rockfill prior to drilling works on site. Use appropriate drilling methods.	1	2	N
9	Localised undermining of the earthwork/carriageway due to loss of uncemented PFA	PFA is known to have been used in the A46 embankments. This may not be cemented and could blow away leading to erosion beneath the carriageway	Localised repair work and/or temporary lane closure	2	2	A	C, T. R. H&S	Undertake site specific GI to determine location of PFA and what state the PFA is (cemented or not). Awareness during construction, do not leave exposed	2	1	N
10	Flooding of excavations	Potentially high groundwater level	Difficulty to form excavations and	2	3	H	C, T, R, E, H&S	Establish comprehensive groundwater model and	2	2	A

No	Hazard		Consequence	Impact	Likelihood	Current Risk	Risk Type*	Potential Control Measures	Impact	Likelihood	Residual Risk
			formation for foundation in cohesive materials					monitoring in advance of the design and construction phases Plane dewatering of excavations			
11	Worsening existing geotechnical assets which are in poor condition		Failure of existing slopes, potential impact on land take	3	3	H	C, T, R, H&S	Site walkover suggests existing earthworks are stable. Further condition assessment during GI and construction Monitoring may be used where suitable.	3	2	A
12	Flooding of excavation works	Within identified flood zone areas.	Flooding of temporary works or excavations. Flooding of road causing serviceability issues	3	3	H	C, T, R, E, H&S	Check historic flood maps and plan accordingly for any potential flooding	3	2	A
13	Smaller volume of acceptable site won fill than expected		Alluvium and River Terrace Deposits may not be suitable for reuse, therefore increasing quantity of import and disposal	3	3	H	C, T, E	GI to determine the ground conditions and material properties for suitability of reuse.	3	2	A

No	Hazard		Consequence	Impact	Likelihood	Current Risk	Risk Type*	Potential Control Measures	Impact	Likelihood	Residual Risk
								Minimise removal of Alluvium by using ground improvement. Reconditioning of the fill Allow for incorporation of poorer cohesive material into the works (e.g. landscaping/shallower slopes) Earthworks balance to be calculated			
14	Greater depth to competent Merica mudstone	Variable weathering profile	Insufficient capacity of foundations Deeper foundations/re-design.	3	3	H	C, T, R, H&S	Undertake site specific GI to identify weathering profile at locations where piles are anticipated Undertake pile load tests	3	2	A
15	Chemical attack on buried steel and concrete	Alluvium was classified as aggressive to buried steel. Gypsum and Mercia mudstone can be aggressive to buried concrete	Earlier degrading structural integrity of buried steel and concrete.	3	3	H	C, T. R. H&S	Undertake site specific GI and appropriate chemical testing in accordance with BRE Special Digest Use sacrificial steel and protective measures	3	2	A

No	Hazard		Consequence	Impact	Likelihood	Current Risk	Risk Type*	Potential Control Measures	Impact	Likelihood	Residual Risk
16	Ground Heave	Gypsum can be present in the Mercia mudstone, although is likely to be at a depth that will not impact the works significantly.	Differential settlement	2	2	A	C, T. R. H&S	Undertake site specific GI to determine prevalence of gypsum Mitigate by adopting tappropriate design solutions	2	1	N
17	Contaminated ground conditions (heavy metals and hydrocarbons)	Several potential sources of contamination have been identified	Creating new pathways of contamination. Exposure of workforce and road users to contaminated ground or groundwater	3	3	H	C, E, R, H&S	GI to determine existing levels of contamination. Determine source and potential pathways, and contain	3	2	A
18	Destroying archaeological artefacts	The site is known to be of archaeological importance	Destruction of important archaeological artefacts	3	2	A	C, T. R.	Archaeological studies Archaeological watching brief specified for the GI and construction works	3	1	N

* C = Cost, T = Time, E = Environment, R = Reputation, H&S = Health and Safety

9. References

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Appendices

Appendix A. Photographs from site walkover

Figure 1 – Looking south towards Farndon Roundabout at southern end of scheme.

Figure 2 – Looking north, A46 viaduct over River Trent at Farndon end of the scheme.

Figure 3 – Looking east, access beneath viaduct over River Trent at southern end of scheme.

Figure 4 – Access track leading to to area beneath viaduct over River Trent, from B6166, Farndon.

Figure 5 – Looking south over River Trent from viaduct wing wall, Farndon.

Figure 6 – Possible access point to fields directly from A46, on eastern side of road. Photograph taken looking east.

Figure 7 – Underpass beneath A46, looking east, mid-way between River Trent and Nottingham to Lincoln railway line. Possible access route via Newark town centre / Ropewalk Farm.

Figure 8 – General earthwork overview, looking south, between River Trent viaduct and Nottingham to Lincoln railway viaduct. Note flooded fields.

Figure 9 – A46 bridge over Nottingham to Lincoln railway line, Bridge NOB1/53A looking north.

Figure 10 – Looking south, bridge NOB1/53A over Nottingham to Lincoln railway.

Figure 11 – Typical view of earthworks between Cattle Market roundabout and Nottingham to Lincoln railway, looking south.

Figure 12 – Looking north towards Cattle Market roundabout from lay by.

Figure 13 - Fields north of lay by, immediately south of Cattle Market Roundabout, looking towards A617.

Figure 14 - A617 looking east towards Cattle Market Roundabout and Sugar Works

Figure 15 - Great North Road A616 looking south towards Cattle Market Roundabout from near Sugar Works.

Figure 16 - Bridge 61A over Nottingham to Lincoln railway line looking north towards Newark Crossing.

Figure 17 - Field between Nottingham to Lincoln railway line and A46 earthwork looking west.

Figure 18 - Beneath Nether Lock viaduct over River Trent / East Coast Main Line looking north.

Figure 19 - Access point adjacent to level crossing (sewage works access). Looking south.

Figure 20 - Level crossing access to sewage works. Looking north,

Figure 21 - A46 underpass (access to sewage works)

Figure 22 - Access point adjacent to level crossing (sewage works access). Looking north.

Figure 23 - Access road to sewage works (public footpath) leading from Quibell's Lane

Figure 24 - Wooded earthwork slopes between A46 and Nottingham to Lincoln railway line, looking north. Adjacent to sewage works.

Figure 25 - A46 carriageway looking south towards viaduct over River Trent.

Figure 26 - Probable flood compensation area to north of A46 adjacent to Nottingham to Lincoln railway line.

Figure 27 - Potential access from A46 to fields north of road near Bridge House.

Figure 28 - Potential access route to fields adjacent to A46 near Bridge House, looking west.

Figure 29 - Potential access to fields to north of A46. Underpass leading to Winthorpe Road.

Figure 30 - Potential access road from A46 looking north towards Bridge House / A1 road.

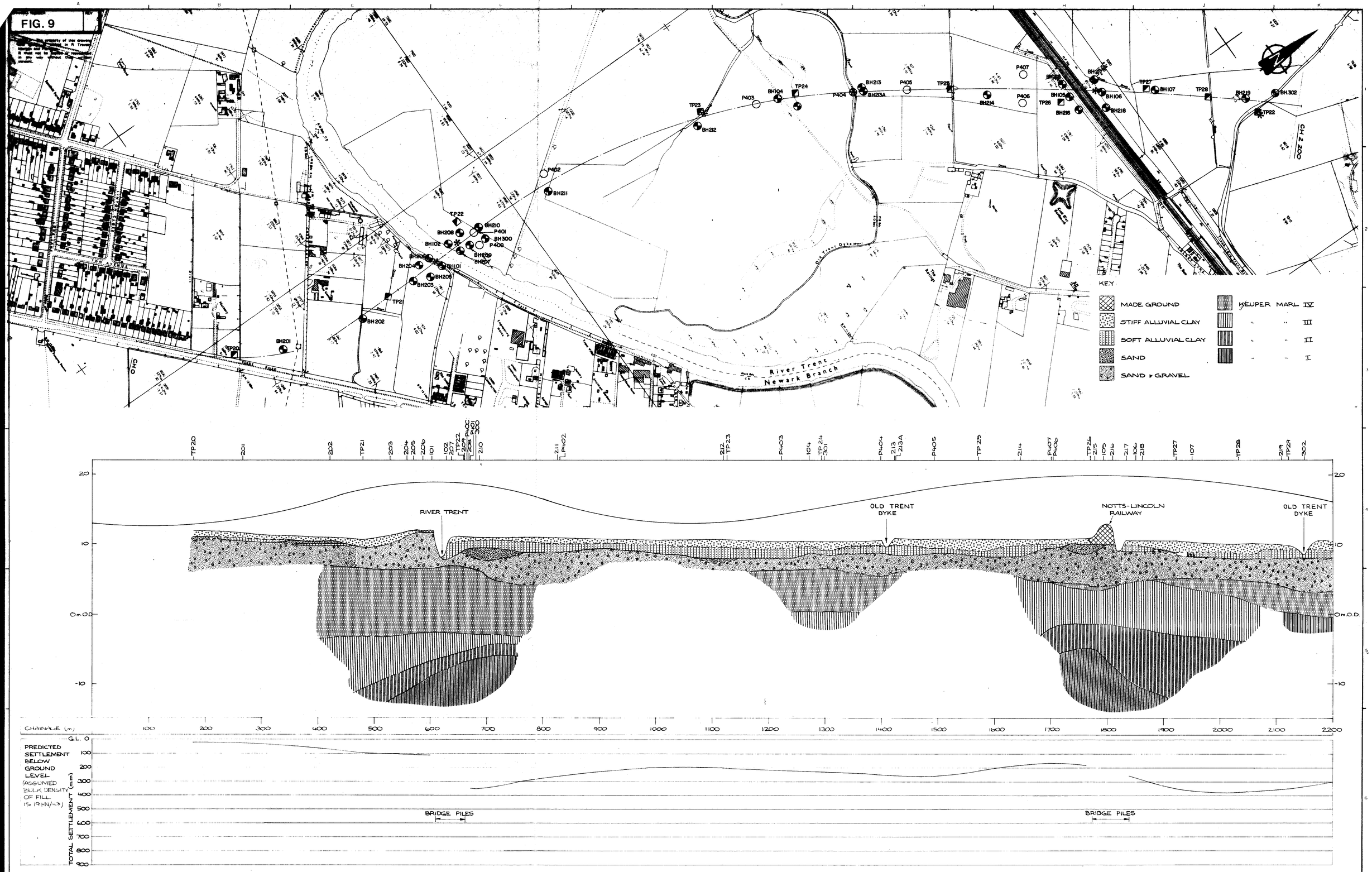
Figure 31 - Access point to fields north of petrol garage at Winthorpe

Figure 32 - Looking south from Winthorpe Roundabout.

Appendix B. Extracts from Geotechnical Report on A46 Newark Relief Road, Department of Transport East Midland Regional Office, 1985

Fig. 2 Areas for ground treatment and embankment construction

FIG. 9

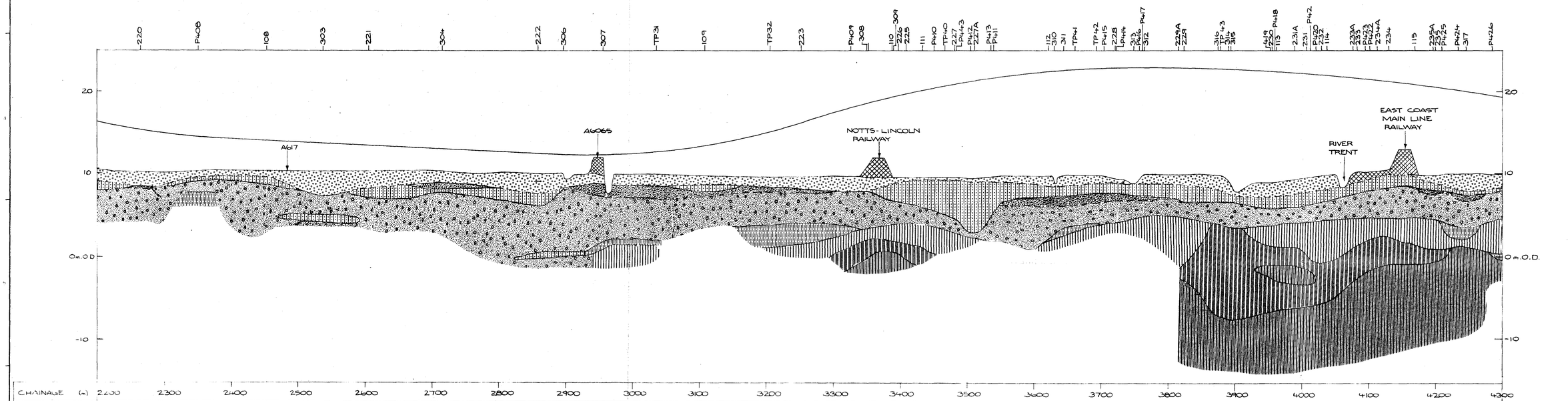


KEY

- BOREHOLES
- DUTCH CONE SOUNDINGS
- TRIAL PITS
- RESISTIVITY AND REDOX POTENTIAL TESTS

Fig. 9 Roadworks - Earthworks
Plan and Longitudinal Section
Ch. 0 - CH. 2 200

FIG. 10

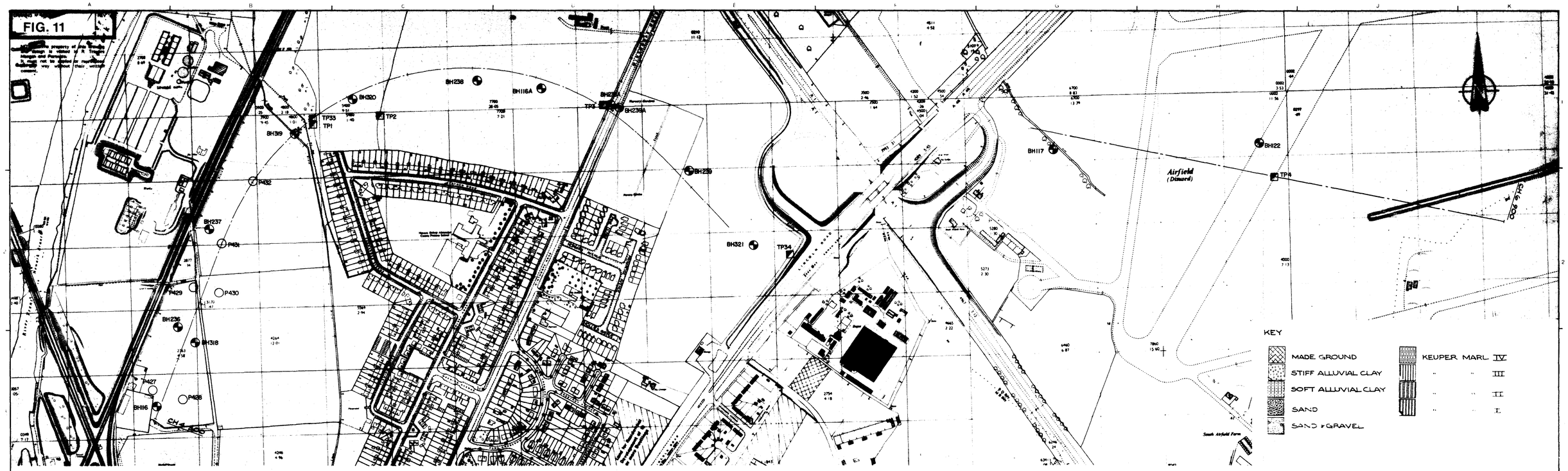


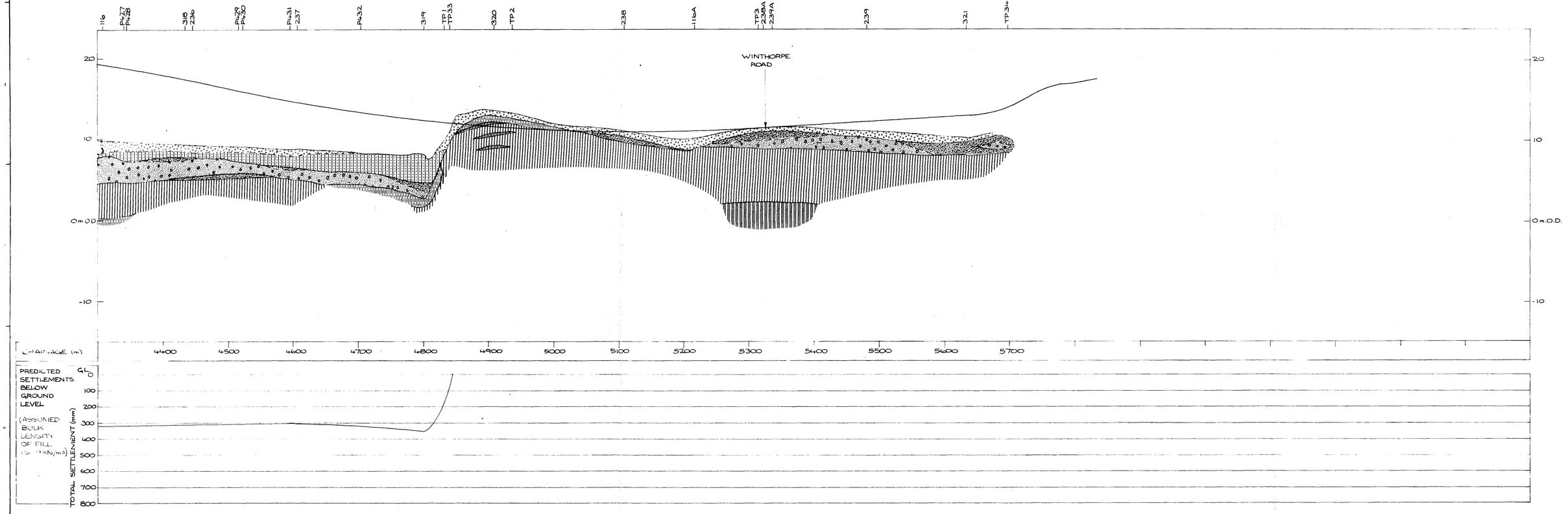
KEY

- BOREHOLES
- DUTCH CONE SOUNDINGS
- TRIAL PITS
- * RESISTIVITY AND REDOX POTENTIAL TESTS

Fig. 10 Roadworks - Earthworks
Plan and Longitudinal Section
CH. 2 200 - CH. 4 300

FIG. 11





KEY

- BOREHOLES
- DUTCH CONE SOUNDINGS
- TRIAL PITS
- RESISTIVITY AND REDOX POTENTIAL TESTS

Fig. 11 Roadworks - Earthworks
Plan and Longitudinal Section
CH. 4 300 - CH. 5 850

Sampling		Properties			Strata			
Depth	Type	Strength kN m²	w %	SPT N	Description	Depth	Level	Legend
					TOPSOIL	G.L	10.64	
0.5	D					0.4	10.2	
0.5–1.0	U(17)				Firm brown silty CLAY.			
						0.8	9.8	
1.2	D				Very soft brown very sandy CLAY/clayey SAND with occasional small gravels.			
1.5	D							
1.5–2.0	CBD			8				
1.9	W							
						2.4	8.2	
2.5–3.0	CB			23	Medium-dense becoming dense brown medium-coarse SAND and GRAVEL with occasional cobbles.			
3.5	D							
3.5–4.0	CB			35				
4.5	D							
3.5–4.0	CB			33				
						5.4	5.2	
5.5–6.0	U(31)				Firm red-brown and grey silty CLAY with angular fragments of weak red-brown mudstone.			
6.2	D							
7.0–7.5	U(41)				(Zone III Marl)			
8.0	D							
8.5–9.0	U(42)							
9.5	D							
					Continued over from 10.0	10.0	0.6	

Drilling

Type	From	To	Size	Fluid
Shell and Auger	G.L	10.0	0.15	

Ground Water

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
1.6	Slight seepage		19.6.78	NIL	NIL	NIL
2.6	Rose to 1.9 in 20 minutes		19.6.78	12.0	9.0	1.6

Remarks

Borehole Record

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Project Midland Road Construction Unit
A46 Newark Relief Road

Contract S1876

Borehole 214

Sheet 1 of 2

EX1

Sampling		Properties			Strata			
Depth	Type	Strength kN m²	w %	SPT N	Description	Depth	Level	Legend
10.0–10.4	U(60)				Continued from 10.0	10.0	0.6	
					As above			
11.0	D							
11.7–12.1	U(70)							
12.0	D					12.0	-1.4	
					End of Borehole.			

Drilling					Ground Water						
Type	From	To	Size	Fluid	Struck	Behaviour	Sealed	Date	Hole	Cased	Water
Shell and Auger	10.0	12.0	0.15	-							

Remarks

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A46 Newark Relief Road

Contract S1876

Borehole 214

Sheet 2 of 2

EX1

Sampling			Properties		Strata			
Depth	Type	Strength kN m²	w %	SPT N	Description	Depth	Level	Legend
						G.L	9.42	
0.3–0.8	U(36)				TOPSOIL.	0.3	9.1	
0.8	D							
0.9–1.4	U(18)	40	51 52 51		Soft brown mottled grey silty CLAY.			
1.4	D							
1.5–2.0	U(15)		57					
1.6	W		57 58					
2.0	D		57			2.0	7.4	
2.0–2.5	U(10)B		52					
2.5–3.0	SD			2	Very soft light grey mottled brown silty organic CLAY.			
3.2	D							
3.5–4.0	SD			2				
4.2	D							
4.5–5.0	SD			7	Very soft dark grey very organic silty CLAY/ clayey SILT with fragments of decaying vegetation.	4.4	5.0	
5.0	D		20		Dark brown clayey medium–coarse SAND and rounded GRAVEL.	4.9	4.5	
5.3	D					5.3	4.1	
5.5–6.0	SD			18	Firm red-brown silty CLAY with angular fragments of weak mudstone.			
6.5	D		20		(Zone III Marl)			
7.0–7.5	SD		21	29				
8.0			28					
8.5–9.0	SD			24				
9.1	D					9.1	0.3	
9.5	D				As below			
9.5	FLUID RETURN	CORE RECOVERY	FI	RQD	Continued over from 10.0	10.0	-0.6	
DRILL RUN								

Drilling

Type	From	To	Size	Fluid
Shell and Auger	G.L	9.5	0.15	-
Rotary Core	9.5	10.0	0.07	water

Ground Water

Struck	Behaviour	Sealed	Date	Hole	Cased	Water
2.5	Rose rapidly to 1.6		17.5.78	-	-	-
	Ingress continued in Marl.		18.5.78	10.5	10.5	1.6
			18.5.78	13.5	10.5	1.5

Remarks Chisel 9.1 - 9.5 - 1 hour.

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A46 Newark Relief Road

Contract S1876

Borehole 227

Sheet 1 of 2

EX1

Sampling		Properties			Strata			
Depth	Type	Strength kN m²	w %	SPT N	Description	Depth	Level	Legend
	100%	60%	-	NIL	Continued from 10.0 Very broken weak red-brown MUDSTONE with occasional thin gypsum veins .	10.0	-0.6	
10.5	100%	100%	20+	20%	(Zone II Marl)	11.0	-1.6	
11.0	100%	100%	5	60%	Strong light grey and red-brown mottled silty MUDSTONE with thin veins of white fibrous gypsum and thin broken bands (11.6 and 11.8m) (Zone I Marl with bands of Zone II)			
12.5	100%	100%	6	85%				
13.5					End of Borehole.	13.5	-4.1	

Drilling					Ground Water						
Type	From	To	Size	Fluid	Struck	Behaviour	Sealed	Date	Hole	Cased	Water
Rotary Core	10.0	13.5	0.07	water							

Remarks

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Contract S1876

Borehole 227

Sheet 2 of 2

EX1

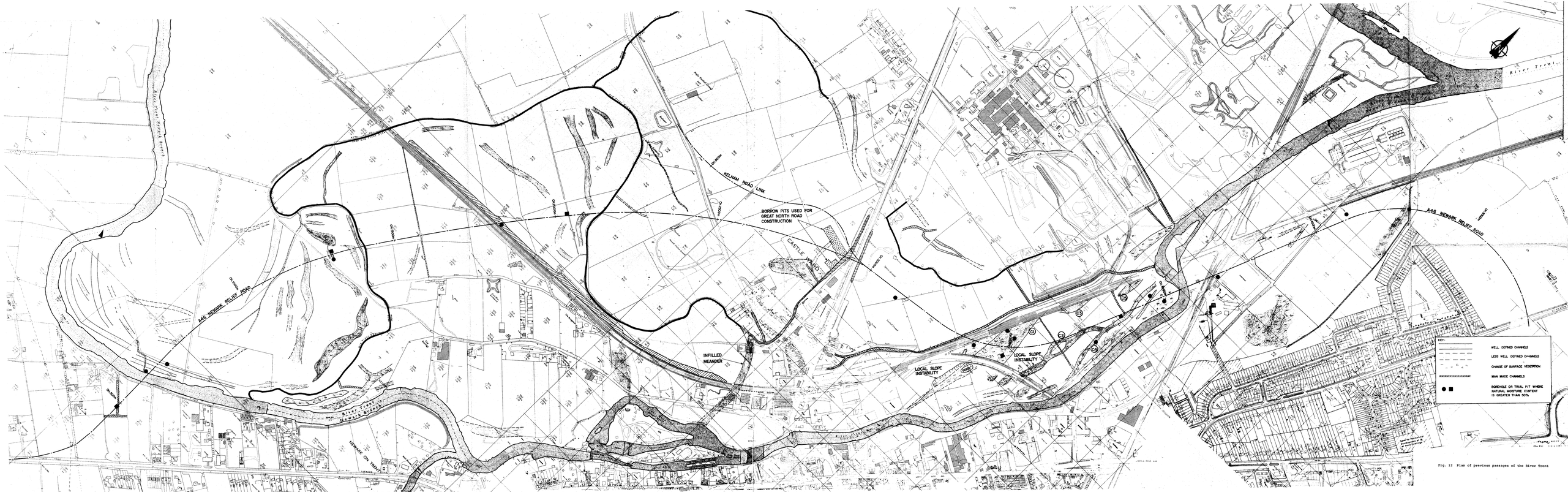
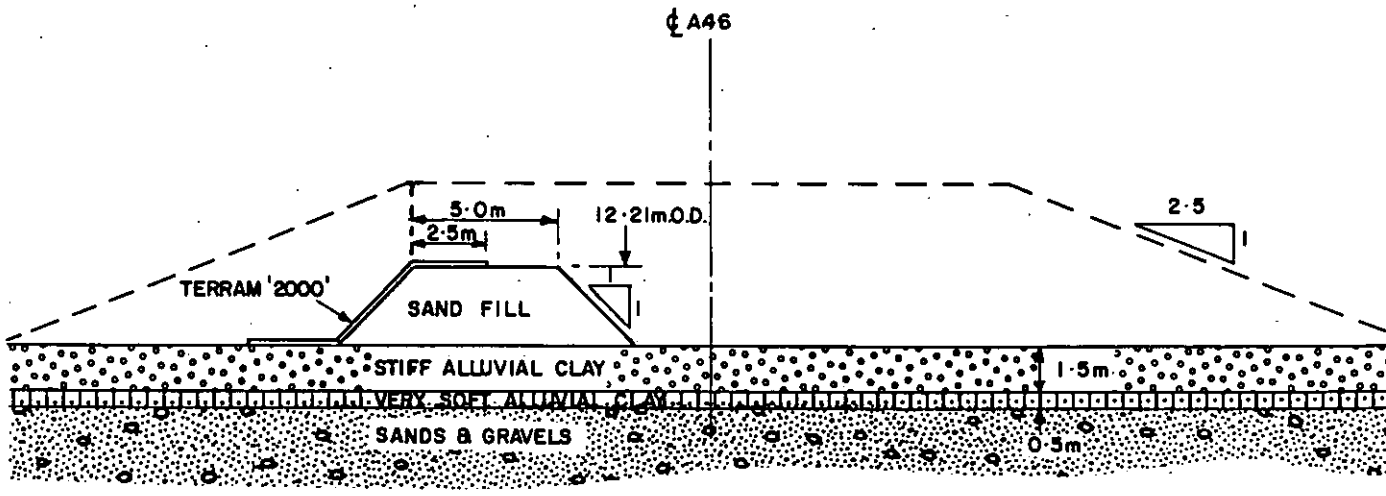
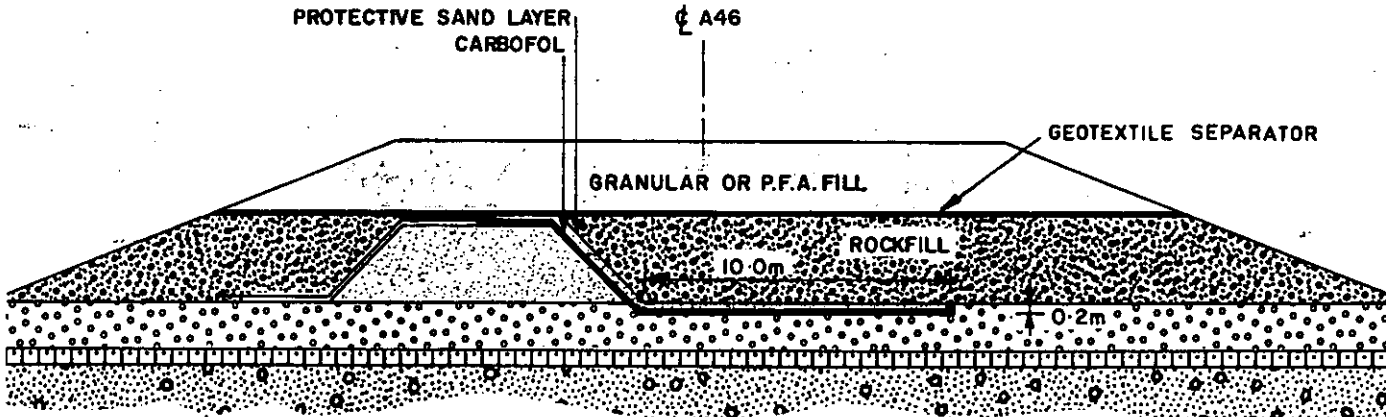


Fig. 12 Plan of previous passages of the River Trent



STEP 1: A. CONSTRUCT SAND FILL SUB-BERM
B. PLACE SEPERATOR GEOTEXTILE (TERRAM '2000' OR SIMILAR)



STEP 2: A. PLACE IMPERMEABLE MEMBRANE (CARBOFOL OR SIMILAR)
B. COVER WITH PROTECTIVE SAND LAYER
C. COMPLETE MAIN EMBANKMENT

Fig. 16 Details of flood protection measures in main embankments, ch. 3000 - 3375m.

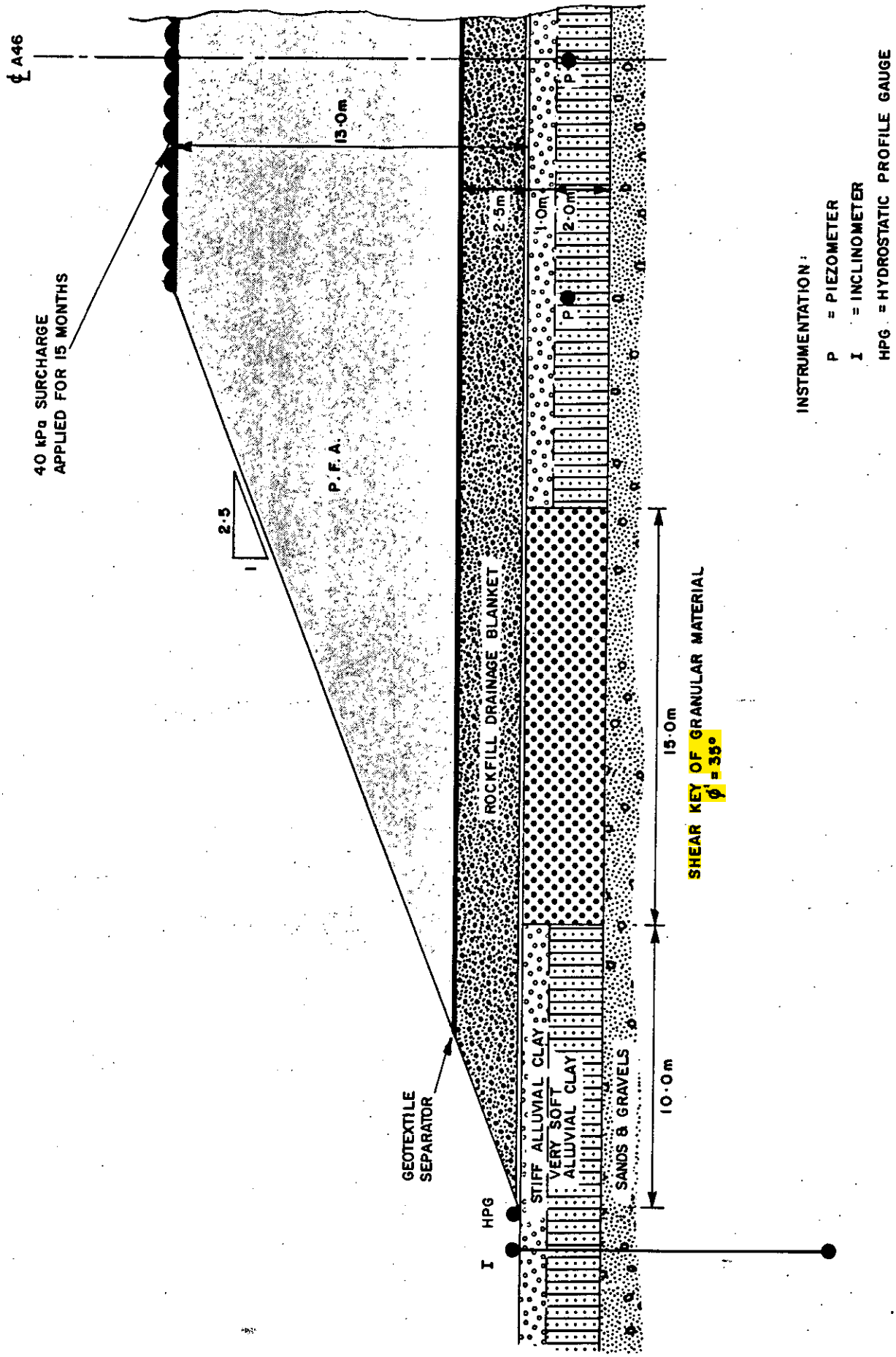


Fig. 18 Recommended method for improving stability, settlements and lateral movements at Nether Lock.

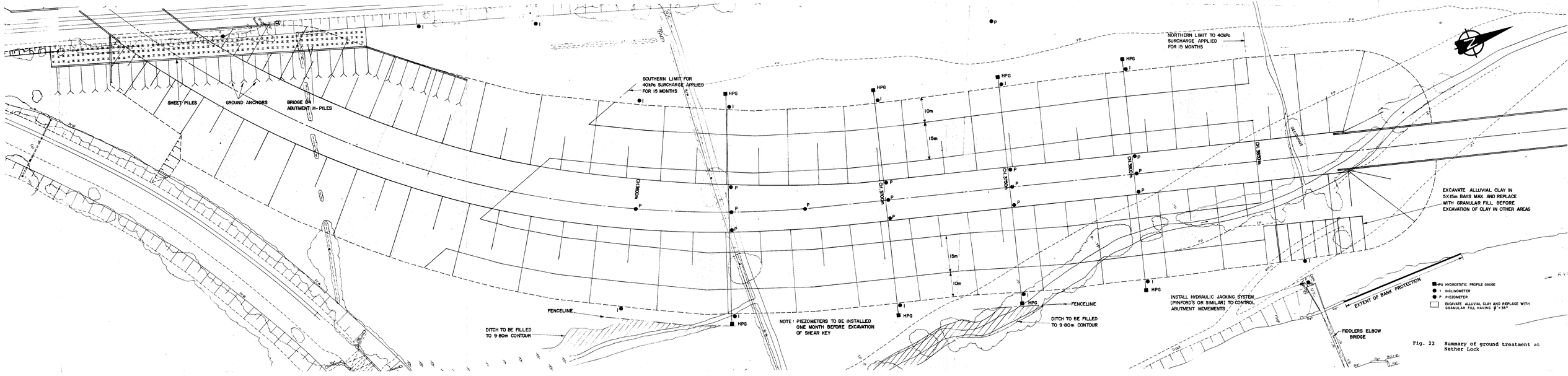


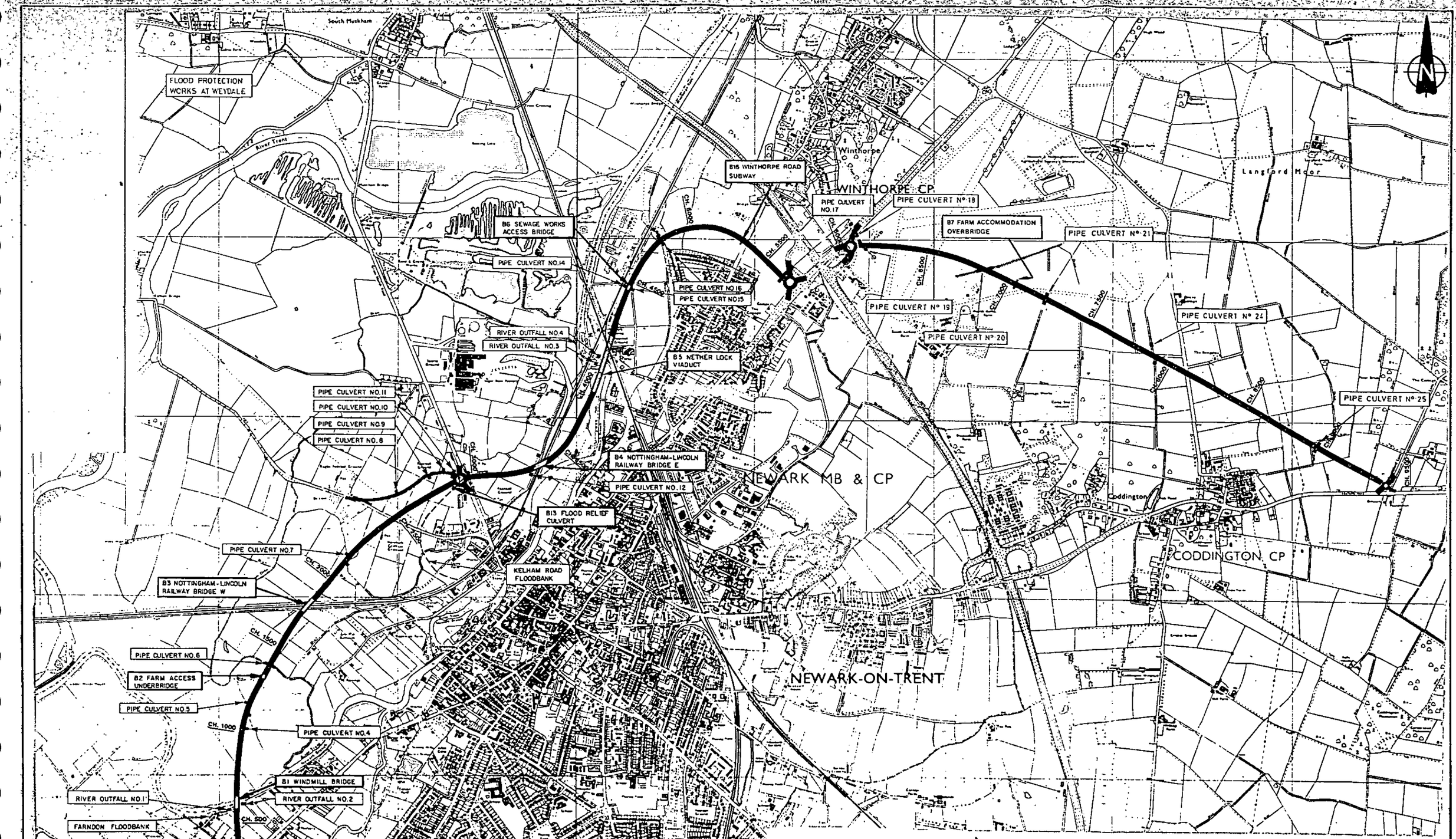
Fig. 22 Summary of ground treatment at Nether Lock

TABLE 1. PROPERTIES OF SOILS

Deposit	c_u kN/m^2	c' kN/m^2	ϕ' (deg)	Unit Weight kN/m^3	Water Content %	C_v m^2/year
Clay crust	70	0	30	18.6	22	4
Soft clay	13	0	30	17.7	40	1
Gravels	-	0	30	21.5	-	-
Keuper IV	70	0	30	19.8	25	0.6 - 460
Keuper III	100	0	35	19.5	16	0.1 - 2000

the upper limits to the C_v for Keuper Marl are the highest measured values; in many cases consolidation took place faster than could be measured.

Appendix C. Extracts from Geotechnical Feedback Report on Newark Relief Road, Department of Transport East Midland Regional Office, 1991



NEWARK RELIEF ROAD

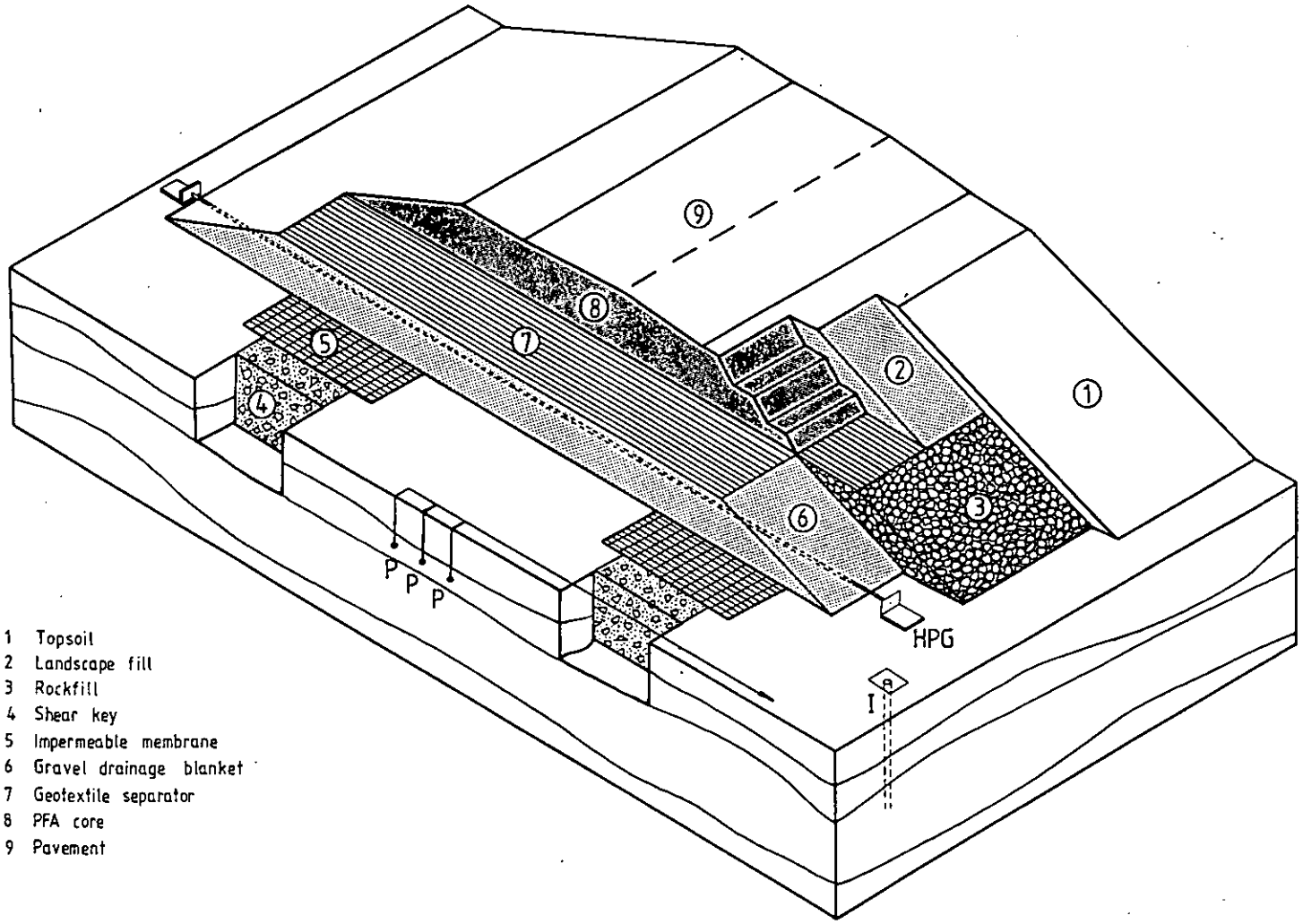
KEY PLAN

Travers Morgan One Ltd

TRAVERS MORGAN

DRAWN	CHECKED	PASSED	DATE	SCALE	DRAWING NUMBER	REV
				1:20 000	FIGURE 2	

TM A3



1 Topsoil
2 Landscape fill
3 Rockfill
4 Shear key
5 Impermeable membrane
6 Gravel drainage blanket
7 Geotextile separator
8 PFA core
9 Pavement

NEWARK RELIEF ROAD

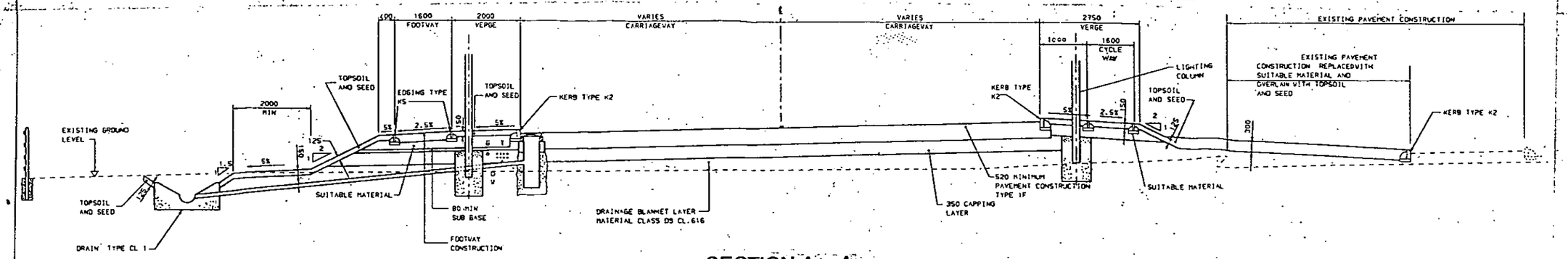
TYPICAL EMBANKMENT CROSS SECTION

Travers Morgan One Ltd

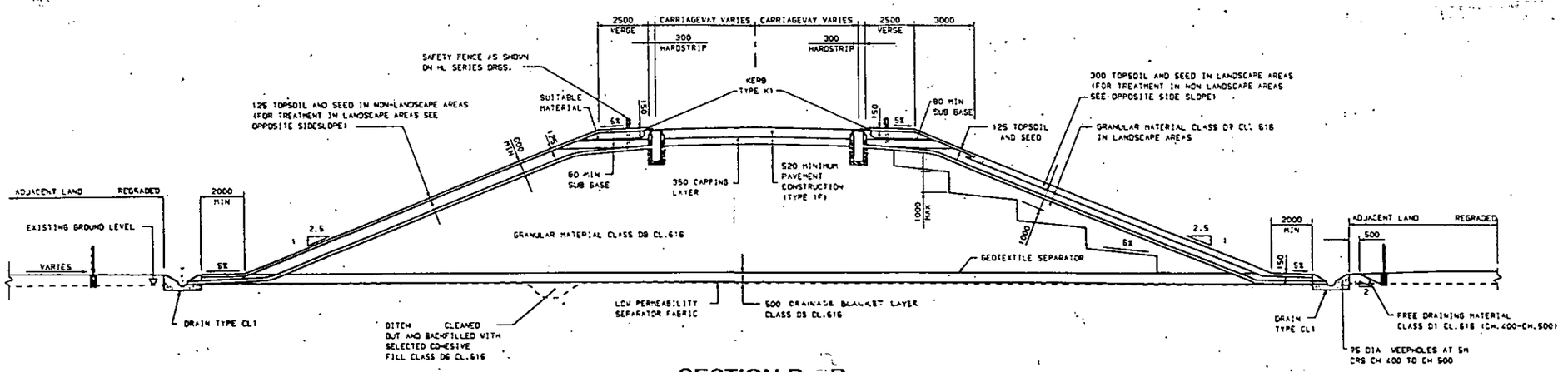
TRAVERS MORGAN

DRAWN	CHECKED	PASSED	DATE	SCALES	DRAWING NUMBER	REV
					FIGURE 3	

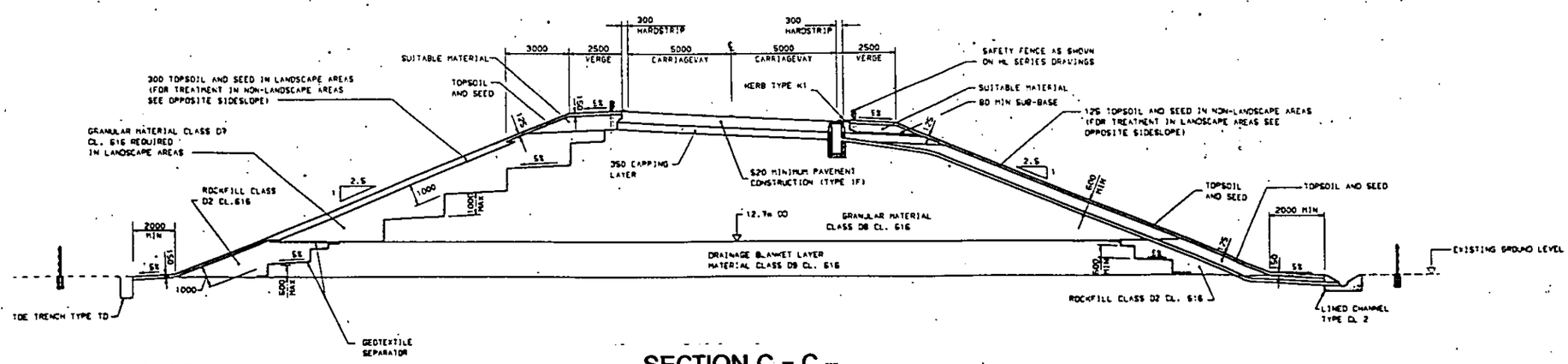
TM A3



SECTION A – A



SECTION B – B



SECTION C – C

NEWARK RELIEF ROAD

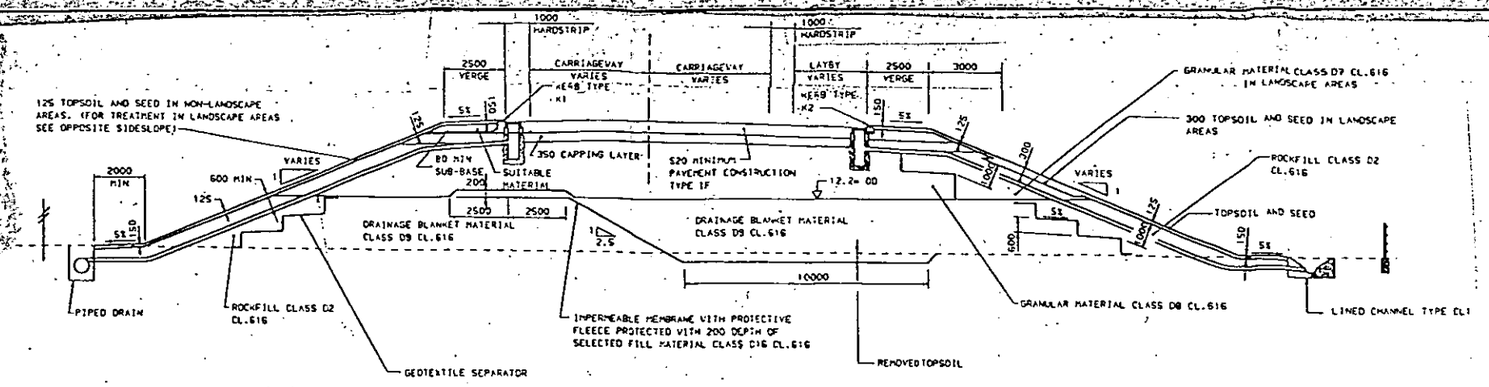
EARTHWORKS CROSS SECTIONS

Travers Morgan One Ltd

TRAVERS MORGAN

DRAWN	CHECKED	PASSED	DATE	SCALES	DRAWING NUMBER	REV
				N.T.S.	FIGURE 13	

TM A3



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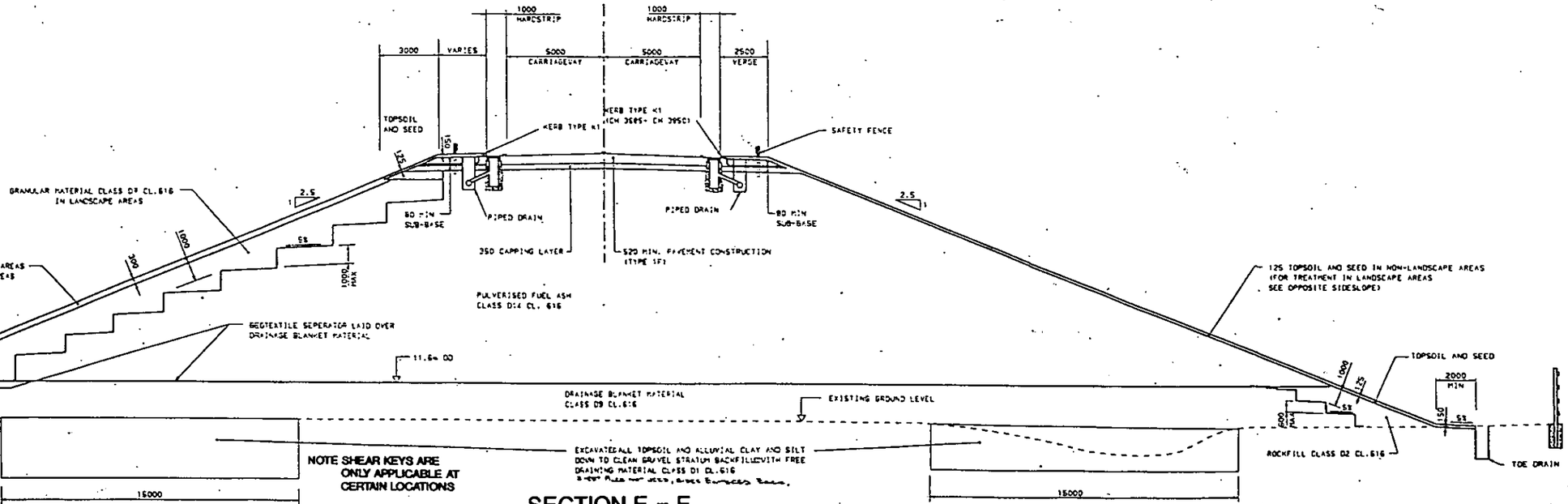

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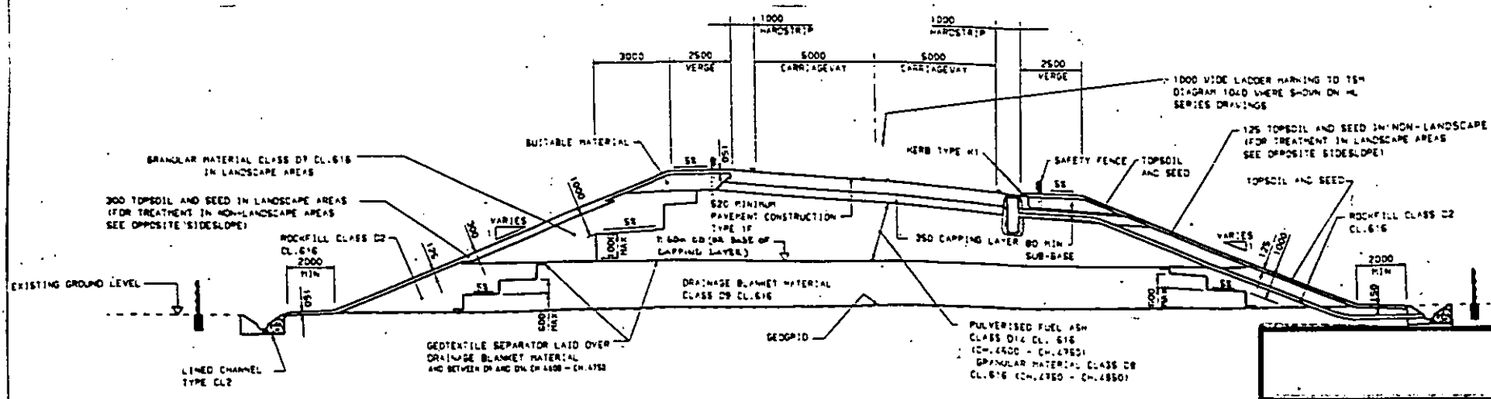


SECTION F - F

NEWARK RELIEF ROAD

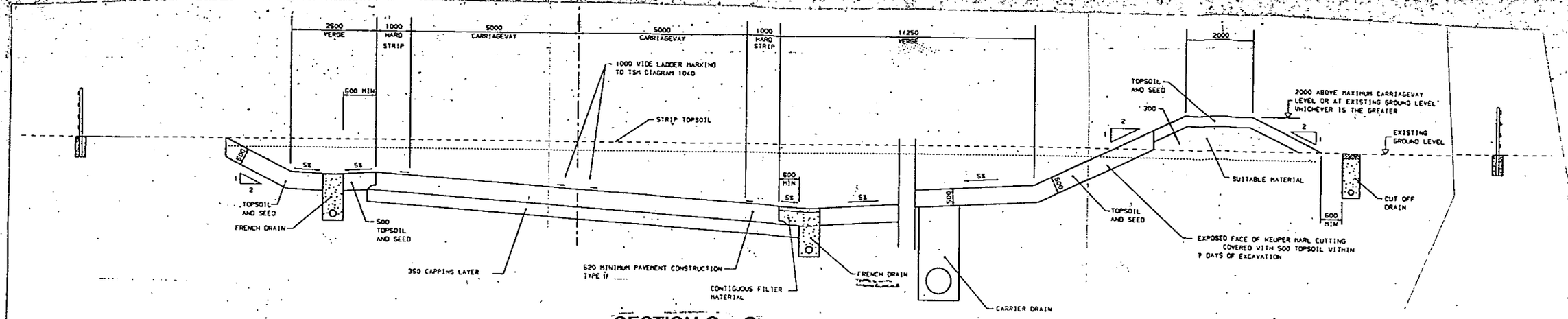
EARTHWORKS CROSS SECTIONS

Travers Morgan One Ltd

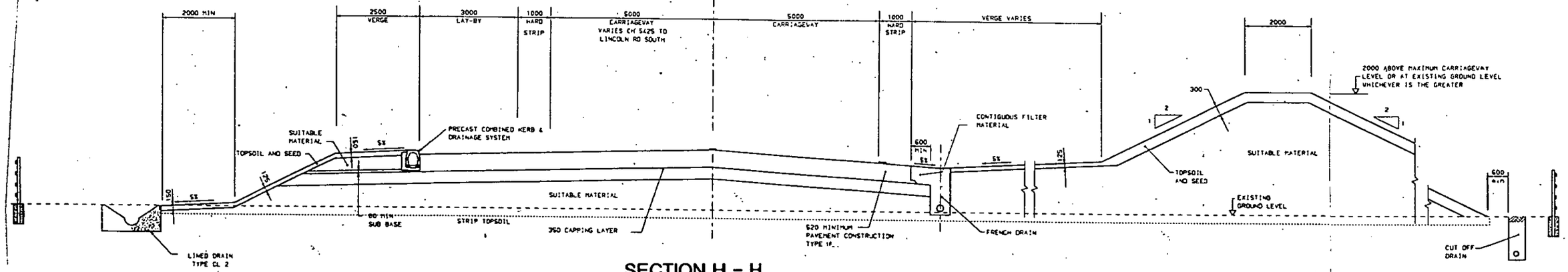
TRAVERS MORGAN

DRAWN	CHECKED	PASSED	DATE	SCALES	DRAWING NUMBER	REV
				N.T.S.	FIGURE 14	

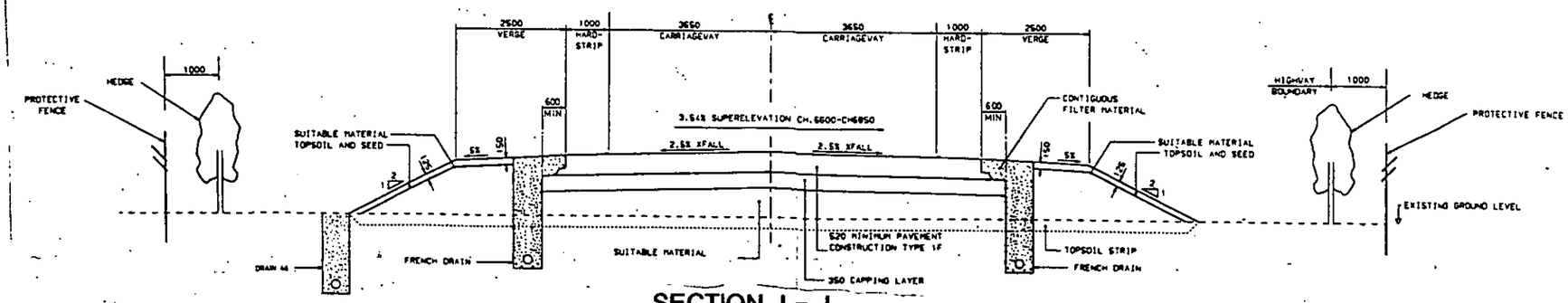
TM A3



SECTION G - G



SECTION H - H



SECTION J - J

NEWARK RELIEF ROAD

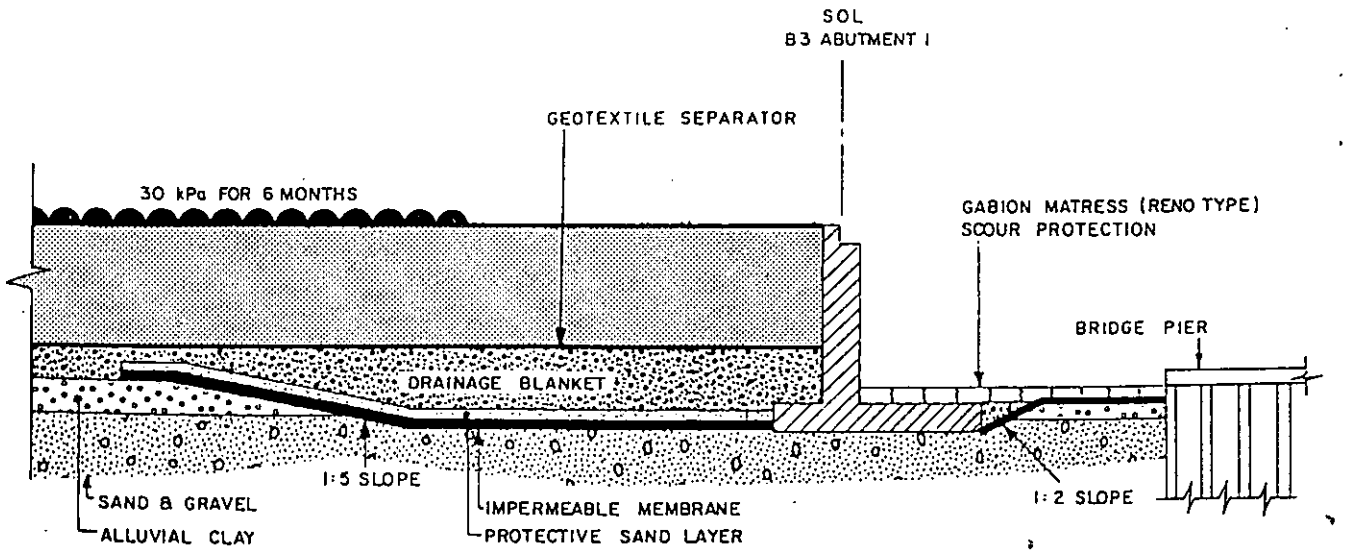
EARTHWORKS CROSS SECTIONS

Travers Morgan One Ltd

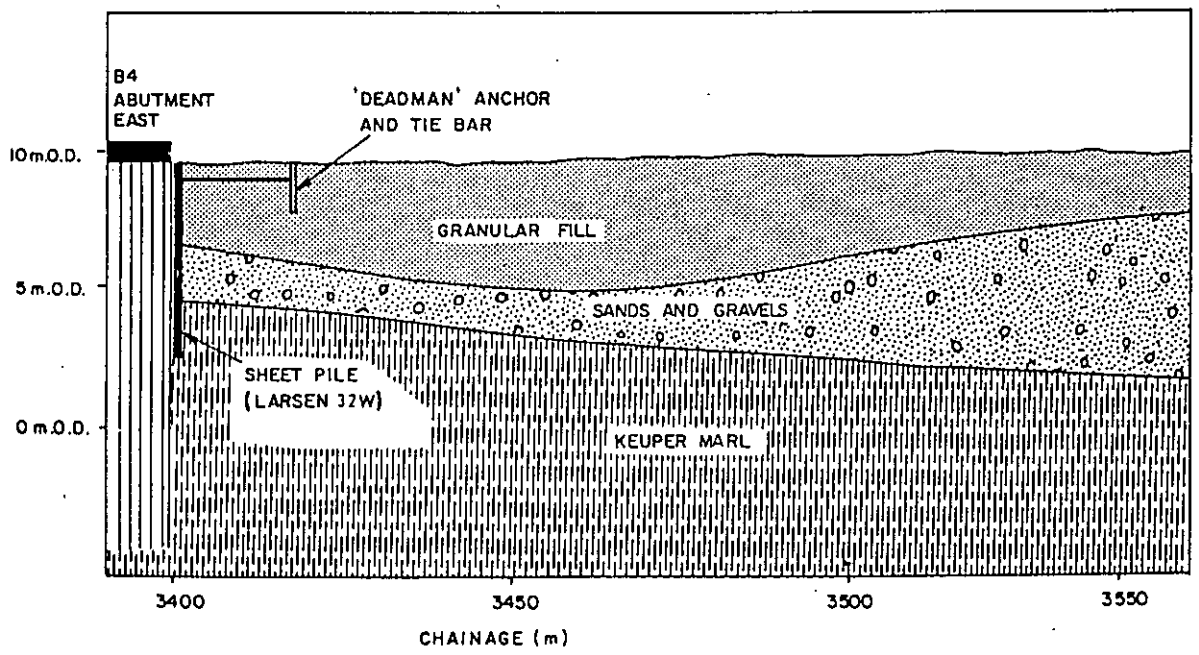
TRAVERS MORGAN

DRAWN	CHECKED	PASSED	DATE	SCALES	DRAWING NUMBER	REV
				N.T.S.	FIGURE 15	

TM A3



(a) DETAIL OF BRIDGE B3 SOUTH ABUTMENT SHOWING IMPERMEABLE MEMBRANE



(b) BRIDGE B4 NORTH ABUTMENT SHOWING ANCHORS SHEET PILES AND GROUND

NEWARK RELIEF ROAD

REMOVAL OF ALLUVIAL CLAY ON BRIDGE APPROACHES

Travers Morgan One Ltd

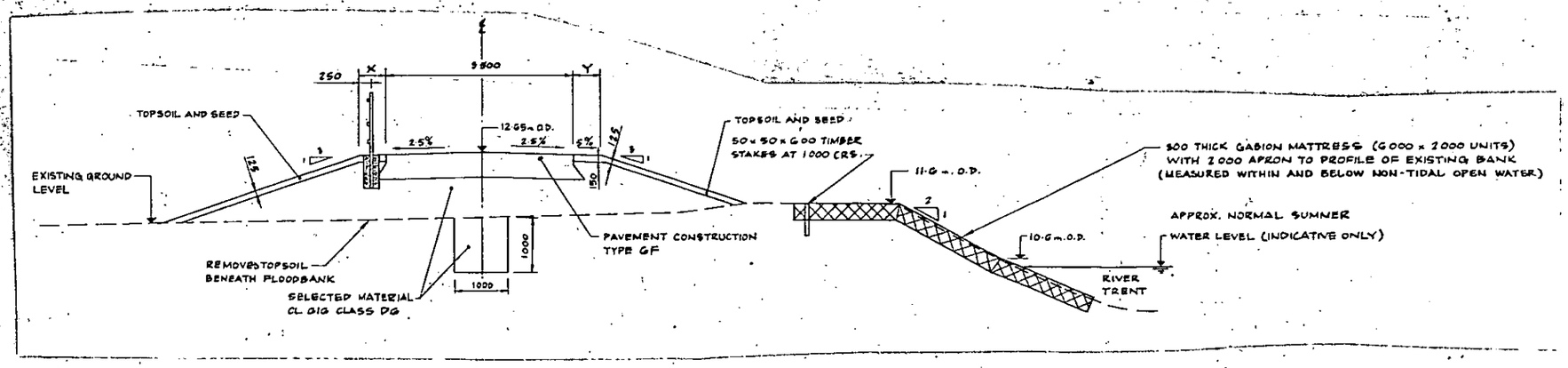
TRAVERS MORGAN

DRAWN	CHECKED	PASSED	DATE	SCALES	DRAWING NUMBER	REV
				N.T.S.	FIGURE 4	

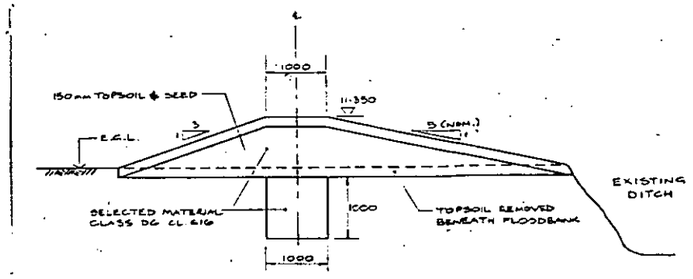
TM A4

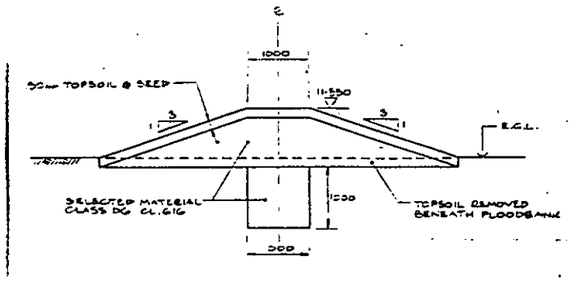
NOTES

1. SECTION OF ROAD EMBANKMENT BETWEEN GREAT NORTH ROAD ROUNDABOUT AND BRIDGE B4 ALSO FORMS PART OF KELHAM ROAD FLOODBANK SCHEME AND IS SHOWN IN FIGURE 14.
2. ALL FLOODBANK CREST LEVELS 0.5m ABOVE 1 IN 100 YEAR FLOOD LEVEL. (c. 0.3m AT WEYDALE)

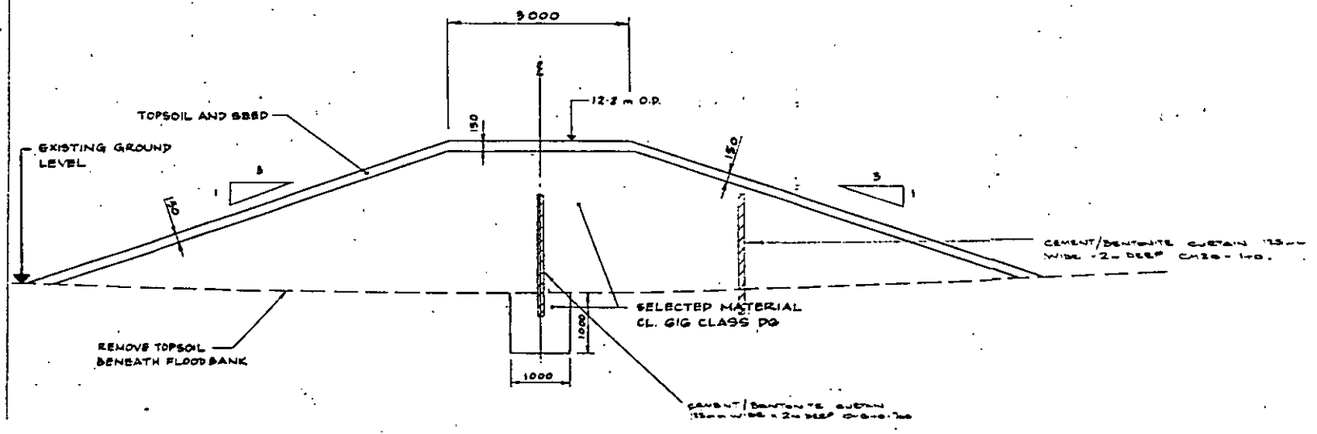


FARNDON FLOODBANK





WEYDALE FLOODBANK



KELHAM ROAD FLOODBANK

NEWARK RELIEF ROAD

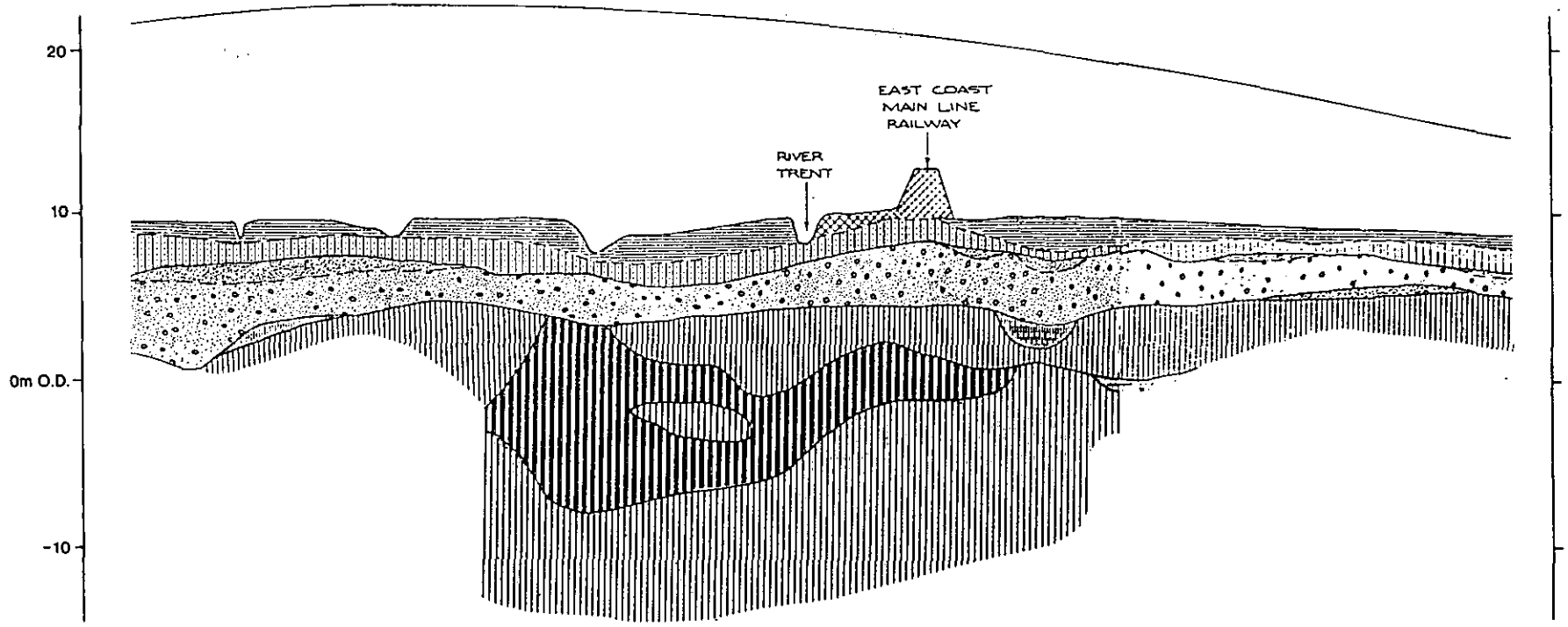
TYPICAL FLOODBANK CROSS SECTIONS

Travers Morgan One Ltd

TRAVERS MORGAN

DRAWN	CHECKED	PASSED	DATE	SCALES	DRAWING NUMBER	REV
				1:100	FIGURE 5	

TM A3



CHAINAGE	3600	3700	3800	3850	3900	3925	4000	4100	4175	4200	4222	4288	4300	4400	4425	4436	4500
SIDE SLOPE	1 : 2.5						BRIDGE B6 WETHERLOCK VIADUCT			1:2.5						BRIDGE B7	1:2.5
SURCHARGE	40 kPa									-							-
WAIT PERIOD (NOTE 1)	39m (400)												35I (350)				35I (350)
EMBANKMENT TYPE (NOTE 2)	PFA FILL SECTION E-E.									PFA FILL SECTION E-E							PFA FILL SECTION E-E.
FOUNDATION REQUIREMENT	15m SHEAR KEYS			REMOVE OF CLAY. GRAN (D) REPLACEM'T						PILED STRUCT.		REMOVE + GRAN (D) FILL + IMPROVE	-				-
SPECIAL MEASURES	SPECIAL EXCAVATION SEQUENCE ADJACENT TO FIDDLERS ELBOW. FOOTBRIDGE.												FILL RATE RESTRICTED TO 1.0m RISE (1.5m FOR PFA) IN ANY 30 DAY PERIOD				
													EXCAVATIONS FOR TOE DRAINS NOT PERMITTED UNTIL 60 DAYS AFTER EMB. COMP.				

CUT LINE CH - 4600

NOTES:

1. FIGURE GIVEN IS ACTUAL WAIT PERIOD BETWEEN COMPLETION OF EMBANKMENT TO FORMATION. FIGURE IN PARENTHESES IS CORRESPONDING WAIT PERIOD AS ORIGINALLY SPECIFIED IN THE CONTRACT.
2. SECTIONS NOTED ARE SHOWN ON FIGURES 13 - 15.

KEY 'A'

- MADE GROUND
- STIFF ALLUVIAL CLAY
- SOFT ALLUVIAL CLAY
- SAND
- SAND & GRAVEL
- KEUPER MARL IV
- " " III
- " " II
- " " I

CHAINAGE 3550 – 4600

NEWARK RELIEF ROAD

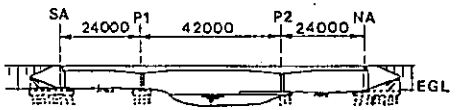
EARTHWORKS LONGITUDINAL SECTION CH. 3550–4600

Travers Morgan One Ltd

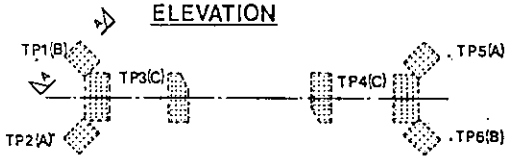
TRAVERS MORGAN

DRAWN	CHECKED	PASSED	DATE	SCALES	DRAWING NUMBER	REV
				N.T.S.	FIGURE 9	

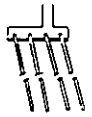
TM A3



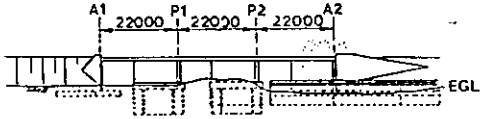
ELEVATION



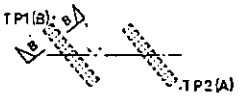
PLAN ON PILES



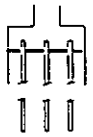
BRIDGE B1



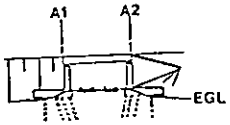
ELEVATION



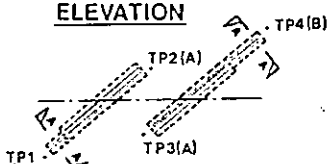
PLAN ON PILES



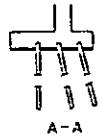
BRIDGE B3



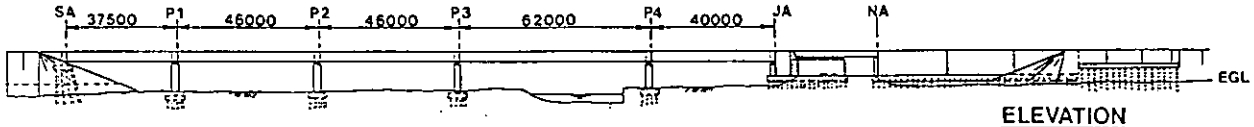
ELEVATION



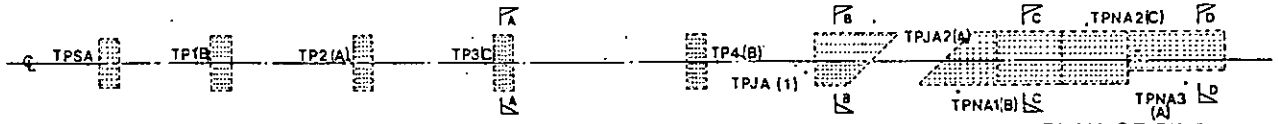
PLAN ON PILES



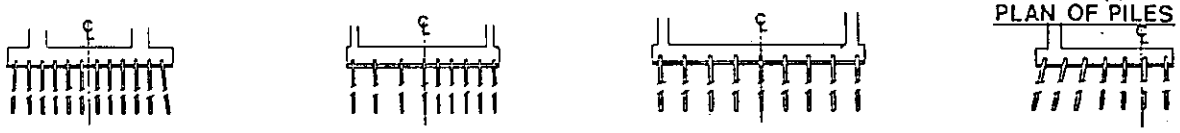
BRIDGE B4



ELEVATION



PLAN OF PILES



BRIDGE B5 (NETHER LOCK VIADUCT)

NOTATION

TP 2 (A)

- TEST TYPE SEE TABLE 2
- PILE NUMBER
- TRIAL PILE

NEWARK RELIEF ROAD

FOUNDATION ARRANGEMENTS FOR MAJOR BRIDGES

Travers Morgan One Ltd

TRAVERS MORGAN

DRAWN	CHECKED	PASSED	DATE	SCALES	DRAWING NUMBER	REV
				N.T.S.	FIGURE 16	