A57 Link Roads
TR010034
6.5 Environmental Statement
Appendix 9.1 Preliminary Sources Study Report

APFP Regulation Regulation 5(2)(a)

Planning Act 2008 Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

June 2021

Working on behalf of Highways England

A57/A628 TRANS PENNINE UPGRADE PROGRAMME

Preliminary Sources Study Report

HE551473-ARC-HGT-ZZZ-RP-GE-2001

JUNE 2017

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ARCADIS *working on behalf of* highways england

A57/A628 Trans Pennine Upgrade Programme

Preliminary Sources Study Report

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APPENDICES

1 Introduction

1.1 Preliminary Sources Study Report

This Preliminary Sources Study Report (PSSR) is a desk study of available geotechnical data in close vicinity to route options presented to Highways England to address the transport related problems in and around the town of Mottram, the A628 Pennine road, and the A61 carriageway. It should be noted that the development of the A61 has been dropped from the scheme, but the findings for the A61 have been retained in this report for future works.

This PSSR generally considers a corridor of 100m either side of the centreline of the scheme. Some features are discussed which are at a greater distance from the centreline, either due to their importance in setting the regional context of the scheme, or where there is considered to be potential for them to either impact or to be impacted by the proposed scheme.

1.2 Scheme Title

The scheme is titled 'A57/A628 Trans Pennine Upgrade Programme' (TPUP) and this Preliminary Sources Study Report (PSSR) has been produced by Arcadis UK in accordance with the proposal set out in the Statement of Intent (SoI) prepared by Arcadis UK in June 2016, a copy of which is included in Appendix A. Section 5.3 of the Statement of Intent details the geotechnical reports that will be produced in line with Highways Agency (HA) Standard HD22/08, Managing Geotechnical Risk (Ref.01). This report presents the findings of the PSSR for the scheme which covers the geological, geotechnical, geomorphological, hydrological and geo-environmental aspects of the scheme and the contamination risks together with a preliminary engineering assessment and likely hazards to construction.

1.3 Scheme Proposals and Previous Studies

1.3.1 Scheme Proposal

The TPUP scheme is classified as a category 3 project due to the unusual and complex nature of the geotechnical activities involved. These activities include a 190m long tunnel beneath a part of Mottram Village and associated wing walls with entry and exit portals, a deep cutting and the associated effects of dewatering, the widening of the carriageway to form two climbing lanes along the A648 (T) in the Peak District National Park and the dualling of the A61 carriageway in an area of high historic mining activity.

The key objectives of the scheme for development of A57/A628 Trans-Pennine Upgrade Programme, as agreed in feasibility study stage 1 includes:

- **Connectivity** – improving the connectivity between Manchester and Sheffield through reduction in journey times and improved journey-time reliability
- **Environmental** – avoiding unacceptable impacts on the natural environment and landscape in the Peak District National Park, and optimising environmental opportunities
- **Societal** – improving air quality and reducing noise impacts, and addressing the levels of severance on the Trans-Pennine routes in urban areas

- **Capacity** – reducing delays and queues that occur, and improving the performance of junctions on the routes
- **Resilience** – improving the resilience of the routes through reductions in the number of incidents and reduction of their impacts
- **Safety** – reductions in the number of accidents and reductions in their impacts.

The scope of the A57/A628 Trans Pennine Upgrade Programme involves a number of developments Including the Mottram Moor Link Road/ A57 (T) to A57 Link Road. This development consists of two options (option 0 and option 5) both starting from the new exit off the M67/A560 towards Mottram Village where the tunnel will be constructed, both options run c190m beneath the Mottram Village, heading southeast and finishing at the A57 Brookfield Road. The two options vary in direction and radius. Option 5 heads southeast at a radius smaller than that of Option 0. Both proposed routes pass over farmlands as they approach the A57.

Two sections of climbing lane are proposed as an overtaking facility on the A628 (T) corridor, by either cutting into the adjacent ground to the north or by extending the southern side with fill to provide a three lane single carriage way. The first suitable location (Location 1) commences approximately 200m east of Woodhead Bridge and continues in an easterly direction for approximately 1300m. The second location (Location 2) commences 1550m west of Salter's Brook Bridge and continues in an easterly direction for approximately 1050m.

It is also proposed to complete the dualling of the A61 between the M1 junction 36 and the Westwood Roundabout, for a length of approximately 1,500m. Two options for online widening (Options 1 and 2) within the existing highway boundary have been proposed, together with potential improvements to Westwood Roundabout.

1.3.2 Previous Studies

A full list of previous studies for all three schemes can be found in Appendix B. Below are details of some of the more relevant document and ground investigations relating the project.

1.3.2.1 Mottram Moor Link Road (Option 0 and 5)

A ground investigation report (GIR) was completed by Hyder Consulting in 2006 (Ref.02). The report takes into consideration three historic ground investigations, details of which follow below.

Between October 1994 and February 1995, Soil Mechanics Limited (SML) undertook a ground investigation for the A57/A68 Mottram to Tintwistle Bypass, comprising 157no boreholes (rotary and cable percussive) and 70no mechanically dug trial pits. Between November and December 2003, Norwest Holst Soil Engineering Limited (NHSEL) carried out a supplementary ground investigation in the vicinity of Mottram Village comprising 25no boreholes (rotary and cable percussive) and 2no mechanically excavated trial pits. These works were to characterise further the geology and ground water regime in the area of the Cut and Cover Tunnel.

Further to these works, Fugro Engineering Services Limited (FES) undertook a third ground investigation from Mottram-in-Longdendale to Tintwistle along the proposed A57/A68 Bypass. The ground investigation was undertaken between September and November 2005 comprising 57no boreholes (rotary and cable percussive) and 75no mechanically dug trial pits.

All three ground investigations predominantly focus on the route from the M67 roundabout through Mottram-in-Longdendale past Artfield reservoir and north-east to Townhead farm on the A628.

1.3.2.2 A628 (T) Climbing Lanes

Due to the A628 (T) being located within the Peak District National Park, there is limited ground investigation available. However, in 2010 a GIR was issued by WSP, available online at HA GDMS No: 24320 (Ref.03). The ground investigation was limited to three trial pits.

1.3.2.3 A61 Dualling

A Ground Investigation Report (GIR) was produced by WSP in November 2014, available online at HA GDMS No: 28134 (Ref.04). The ground investigation is located at the A61/A616 roundabout. More details can be found in Section 5.5.2.

1.4 Location and Extent of Study Area

As mentioned in Section 1.2 the scope of the A57/A628 Trans Pennine Upgrade Programme involves three main developments. These include the Mottram Moor Link Road/ A57 (T) to A57 Link Road, the A628 Climbing Lanes, and finally the A61 Dualling. Below are details for each development. An overall drawing showing all three location can be found in HE551473-ARC-GEN-ZZZ-DR-D-2001.

1.4.1 Mottram Moor Link Road (Option 0)

For route alignment and chainages please see drawing no. HE551473-ARC-HGN-HML-ZZZ-DR-D-2025 to 2029. Please note that for option 0 the chainage on the drawings has been split into three sections to help with describing the alignment.

Section Reference	Chainage (m)	Route Description
M67 Terminal Roundabout to Roe Cross Road	0 (section 1) to 180 (section 2)	Option 0 starts at a new exit off the M67/A560 roundabout. The route heads north east approaching Mottram village. Within this section two roundabouts have been proposed. These are known as the “Cricket Ground Roundabout” and “Roe Cross Road Roundabout”. These two roundabouts provide a link road to the north of the main alignment that will allow traffic to flow between the proposed route and the A6018. The new route passes under the A6018 in Mottram tunnel. From the M67/A560 roundabout the route is built on an embankment with a maximum height of 5.5m above ground level. As the route approaches Mottram it reaches grade level, and finally

Section Reference	Chainage (m)	Route Description
		enters a cutting to pass into the tunnel with a maximum depth of 12.0m bgl at the western tunnel portal.
Roe Cross Road to Old Hall Lane (Mottram Village)	180 (section 2) to 350 (section 2).	Mottram tunnel runs beneath the village for roughly 185m. The road level of the tunnel starts at roughly 12.0m bgl on the western end, and continues to reduce in elevation to roughly 18m bgl on the eastern edge.
Old Hall Lane to Mottram Moor Roundabout	350 (section 2).to 1027 (section 2)	After passing below Mottram, the route emerges into a rock cutting, estimated to be roughly 18.0m deep. The route turns towards the south east as it heads downhill towards the A57. The majority of the route will be in a cutting. However as it approaches the A57 the route will transition to an embankment as it approaches a new roundabout, “Mottram Moor Roundabout”. The “Mottram Moor Roundabout” will primarily be built at grade, and will allow for traffic flow between the proposed route at the A57.
Mottram Moor Roundabout to A57 Roundabout	0 (section 3) to 1182 (section 3)	After the “Mottram Moor Roundabout” the route continues south east-east, crosses the River Etherow and ends with the “A57 Roundabout”. This last stretch of the proposed route crosses agricultural land where the majority of the route will be built on embankments up to a maximum height of 10.0m above ground level.

1.4.2 Mottram Moor Link Road (Option 5)

For route alignment and chainages please see drawing no. HE551473-ARC-HGN-HML-ZZZ-DR-D-2030 to 2033.

Section Reference	Chainage (m)	Route Description
M67 Terminal Roundabout to Roe Cross Road	0 to 730	Option 5 starts at a new exit off the M67/A560 roundabout. The route heads northeast, approaching Mottram village. This part of the proposed route is similar to Option 0. However, there is a larger radius in Option 5. As with Option 0, there are two roundabouts, the “Cricket Ground Roundabout” and the “Roe Cross Road Roundabout”. These two roundabouts will allow traffic to flow between the proposed route

Section Reference	Chainage (m)	Route Description
		and the A6018. The route up to this section will be constructed on an embankment approximately 5.0m above existing ground level. As the route approaches Mottram it reaches grade level, and finally enters a cutting to pass below ground level with a maximum depth of 10.0m bgl at the tunnel portal.
Roe Cross Road to Old Hall Lane (Mottram Village)	730 to 1460	Mottram tunnel runs beneath the village for roughly 190m. The road level of the tunnel starts at roughly 10.0m bgl on the western end, and continues to reduce in elevation to roughly 12m bgl on the eastern edge.
Old Hall Lane to Mottram Moor Roundabout	1460 to 2190	After passing below Mottram, the route emerges into a rock cutting, estimated to roughly be 8m deep. Option 5 curves southeast at a horizontal radius smaller than that of Option 0. The proposed route passes over farmland as it approaches the A57. The majority of the route will be in cut. However, as it approaches the A57 the route will transition to an embankment. A new roundabout, "Mottram Moor Roundabout", will be constructed south of the existing A57. The route passes over the existing A57 before meeting the new Mottram Moor roundabout.
Mottram Moor Roundabout to A57 Roundabout	2190 to 2907.82	From here the route continues south east, crossing more farm land, meets Woolley Bridge Road and ends at the "A57 Roundabout".

1.4.3 A628 (T) Climbing Lanes

The A628 passes over the Pennines, connecting Greater Manchester to South Yorkshire, by means of the Woodhead Pass. It is predominantly of single carriageway construction encompassing both the east and westbound carriageways. Two sections of the A628 (T) corridor have been identified to provide climbing lanes for the eastbound traffic where the carriageway gradient is approximately 4%. Both sites are located within the area of the Peak District National Park.

Location 1 is located approximately 27km east of Manchester and 16m south-west of Huddersfield, centred on approximate National Grid Reference (NGR) E410480 N399730, commencing approximately 200m east of Woodhead Bridge and continues in an easterly direction for approximately 1230m. Location 2 is located approximately 2km east of Location 1, centred at approximate NGR E412900 N399730, commencing 1550m west of Salter's Brook Bridge and continues in an easterly direction for approximately 1250m. The two climbing lanes are shown on drawing HE550691-HYD-HGN-HRR-0-DR-D-1012 found in Appendix A.

Section Reference	Chainage (m)	Route Description
Climbing Lanes (Location 1)	1022 - 2250	Option 1 is located approximately 200m east of Woodhead Bridge and continues in an easterly direction for approximately 1230m.
Climbing Lanes (Location 2)	3750 - 5000	Option 2 is located approximately 1550m west of Salter's Rock Bridge and continues in an easterly direction for approximately 1250m.

1.4.4 A61 Dualling

The dual carriageway extension of the A61 lies roughly 15km east of the Pennines and lies directly south of the town of Tankersley. The A61 is located west of the M1 at junction 36. It has been proposed to extend the current dual carriageway road all the way through to the first roundabout intersection with the A616. Currently there are two options available for the A61 Dualling. Both options are very similar with only minor adjustments to the alignment for different pedestrian walkways

Currently the A61 route passes from the M1 through a residential area, a natural woodland and, finally, an industrial estate before joining the A616.

2 Sources of Information

2.1 Limits of Consideration

This PSSR generally considers a corridor of 100m either side of the centreline of the scheme. Some features are discussed which are at a greater distance from the centreline, either due to their importance in setting the regional context of the scheme, or where there is considered to be potential for them to either impact or to be impacted by the proposed scheme.

The proposed routes for Option 0 and 5 have already been subject to previous site investigation studies along parts of the routes. The previous studies were focused on the Mottram Hollingworth Tintwistle (MHT) scheme, and target a similar area to option 0 and 5 from the M67 roundabout to just east of Mottram village.

For the A628 climbing lanes there is limited ground investigation due to the road being located within a national park. However a recent study at location 2 was carried out for proposed remediation work for the road.

To date no previous ground investigation is known for the A61 dualling route. However a recent investigation was carried out for the A61/A616 roundabout, investigating the potential for mining shafts and adits.

The PSSR will review the available information in relation to the ground conditions for all sections and route options.

2.2 Highways Agency Geotechnical Data Management System (HAGDMS)

Appendix B of this report lists all the reports that have been retrieved from HA GDMS which are relevant to this scheme and the three proposed developments. Many of these reports contain detailed information on the ground and groundwater conditions for the proposed developments.

It should be noted that HA GDMS is a live system and should be regularly checked in advance of detailed design and construction for any updates.

2.3 British Geological Survey (BGS)

Desk study geological information has been obtained from the following BGS Maps Sheets:

- 1:50,000 Sheet 86 Glossop, Bedrock and Superficial, 2012 (Ref.05)
- 1:50,000 Sheet 87 Barnsley, Bedrock and Superficial, 2008 (Ref.06)

A search of the BGS Geology Interactive map (Ref.07) was also used to confirm the geology for the 3 proposed developments. Details of the geology can be found in Section 4.7.

2.4 Landmark (Environmental Data Base)

The site history and that of the surrounding areas have been researched from information obtained from the historical maps within the Envirocheck reports. These reports were acquired from Landmark. The maps date from 1892 to 1996 and comprise 1:2,500 and 1:10,560 scale Ordnance Survey Maps (Ref.08).

2.5 The Environment Agency

As part of this report hydrogeological information has been obtained from the Environment Agency (EA) online website "What's in my backyard?" (Ref.09)

As part of the flood risk assessment, information has been obtained from the EA's online interactive "Flood Map for Planning" map (Ref.10).

2.6 Records of Mining

A search of the Coal Authority "Interactive Map" website (Ref.11) was used to identify if the 2 main developments and the A61 areas fall within "Coal Mining Reporting Areas". Following on from this an initial assessment, based on a "Non – Residential Mining Report", was carried out.

A search of the BGS 'Mining Plans Portal' website (Ref.12) has been undertaken to determine the existence of any non-coal mines in the study area.

BGS Mineral Resources mapping has been reviewed to identify mineral resources and areas of active or inactive extractions. Three maps cover the area of the Scheme:

- Greater Manchester (2006)
- Peak District National Park (1995)
- South Yorkshire (2006)

Historical and current Ordnance Survey (OS) mapping has also been reviewed to locate any relevant mines or quarries in the study area.

2.7 Zetica Unexploded Ordinance (UXO)

To mitigate the risk of encountering an unexploded ordinance (UXO), an initial search of the Zetica "UXO Risk Map" website (http://www.zetica.com/uxb_downloads.htm) was carried out. This was then followed by a Zetica "Pre-Desk Study Assessment" to confirm the findings from the risk map.

2.8 Utility Service Provider

No utility services search was undertaken for this report. Any reference to utilities has been taken form the Hyder GIR (Ref.02) and drawing NH50845-1405-01.

3 Field Studies

No field studies have been undertaken in conjunction with the preparation of this report.

4 Site Description

4.1 Landscape and Topography

The location, description and extent of the scheme is summarised in Section 1.3 of this report which also details how the scheme is broken down into sub sections for ease of reporting purposes. The location and topography of each sub section are detailed below.

4.1.1 Mottram Moor Link Road (Option 0)

Section Reference	Chainage (m)	Landscape and Topography
M67 Terminal Roundabout to Roe Cross Road	0 (section 1) to 180 (section 2)	Between the M67 roundabout and Mottram village, the proposed route crosses mainly agricultural land. The tie in at the M67 roundabout has an existing elevation of 198m AOD. As the route progresses north east to Roe Cross Road and the tunnel portal, the ground undulates but gradually rises to an elevation of 212m AOD. From chainage 520, the proposed route crosses over Hurstclough Brook. The brook passes under both the “Cricket Ground Roundabout” and the “Roe Cross Road Roundabout”. It should be noted that a cricket ground is located south of the route at chainage 720.
Roe Cross Road to Old Hall Lane (Mottram Village)	180 (section 2) to 350 (section 2).	Mottram tunnel runs beneath the village for roughly 185m. Both the eastern and western tunnel portals are located within deep cuttings on agricultural land. Above ground, and covering the tunnel footprint, is a residential area. At the time of writing the PSSR, it is believed that Highways England own all of the properties above the tunnel footprint but not all properties within the likely extent of a battered excavation that could be required for an open cut construction technique..
Old Hall Lane to Mottram Moor Roundabout	350 (section 2).to 1027 (section 2)	The existing ground level at the eastern portal is estimated to be 212m AOD. As the route turns towards the south east, the elevation drops rapidly to 168m AOD at “Mottram Moor Roundabout”. The proposed route is mainly within agricultural land, and crosses a small un-named water course.

Section Reference	Chainage (m)	Landscape and Topography
Mottram Moor Roundabout to A57 Roundabout	0 (section 3) to 1182 (section 3)	From "Mottram Moor Roundabout" to the "A57 Roundabout" the proposed route heads down hill in a south east direction. The elevation drops from 168m AOD at "Mottram Moor Roundabout" to 120m ADO at the "A57 Roundabout" tie in. The proposed route crosses over Carrhouse Lane and the River Etherow as well as various other small water courses.

4.1.2 Mottram Moor Link Road (Option 5)

Section Reference	Chainage (m)	Landscape and Topography
M67 Terminal Roundabout to Roe Cross Road	0 to 730	Between chainage 0 to 890 Option 5 is very similar to Option 0. The only variation is a minor adjustment to the radius of the road as it approaches Mottram Village.
Roe Cross Road to Old Hall Lane (Mottram Village)	730 to 1460	Same as Option 0 but the tunnel length is about 190m.
Old Hall Lane to Mottram Moor Roundabout	1460 to 2190	The existing ground level at the eastern portal is estimated to be 212m AOD. As the route heads east, it crosses a small unknown water course, after which the route heads south east to join the A57 just before Coach Road at chainage 1950. The natural land undulates but reduces in elevation towards the A57. The centre of Mottram Moor Roundabout is located at chainage 2050 with an existing elevation of 145.7m AOD and proposed level of 150m AOD. This part of the route crosses agricultural land.
Mottram Moor Roundabout to A57 Roundabout	2190 to 2907.89	The final section of Option 5 passes through agricultural land. The natural ground level reduces in elevation from 145.7m AOD at "Mottram Moor Roundabout" to 119.5m AOD at "A57 Roundabout". The proposed route crosses over the River Etherow, as well as various other small water courses.

4.1.3 A628 (T) Climbing Lanes

Section Reference	Chainage (m)	Landscape and Topography
Climbing Lanes (Location 1)	1022 - 2250	Location 1 of the A628 climbing lanes is within the northern half of the Peak District National Park. On the northern upside of the route, is natural mountainside, which is either used for grazing or natural land. Down side of the route, the existing ground level drops steeply towards Woodhead Reservoir or a small river at the base of the valley.
Climbing Lanes (location 2)	3750 - 5000	Location 2 of the A628 climbing lanes is within the northern half of the Peak District National Park. On the northern upside of the route the natural ground level rises steeply. The ground is left natural and has areas of rock exposure. Down side of the route, the existing ground level drops steeply towards a small river at the base of the valley.

4.1.4 A61 Dualling

For reference please see drawing no. HE551473-ARC-HML-A61-DR-D-2001 to 2006.

Chainage 0 starts at the A61/A616 roundabout and has an estimated elevation of 156m AOD. As the carriageway progresses north east, it is surrounded by a woodland area up to Ch.150 where the elevation is 160m AOD.

At Ch.525 the A61 encounters the Wentworth Way and Church Lane Junction. The elevation at this junction is estimated to be 164m AOD. Up to this point the northern carriageway runs alongside the Wentworth Industrial Estate and the southern carriageway runs alongside agricultural land and a small industrial estate near the junction.

The A61 carriageway passes through woodland up to Ch.1100, at Westwood New Road junction, where the elevation is 152m AOD. From Ch.1100 to Ch.1500 (end of the development at New Road Bridge) the A61 is surrounded by agricultural land. The elevation continues to drop to 141m AOD at New Rd Bridge.

4.2 Historical Development

The site history and that of the surrounding area has been researched from information obtained from the historical maps within the Envirocheck reports which have been placed in GIS viewer. The maps date from 1892 to 1996 and comprise 1:2,500 and 1:10,560 scale Ordnance Survey Maps. It is not the intention of this section to provide a full history of each study area, but to identify those past uses within each area that could have resulted in changes to the ground conditions or contamination of the soils and affect the proposed route options.

4.2.1 Mottram Moor Link Road (Option 0 and 5)

The earliest maps of this area (circa 1892) show that the proposed route options lie mainly within agricultural land with a number of farmsteads and established roads throughout the study area. Mottram is shown to the south, Roe Cross to the north and Hollingworth to the east.

Noticeable features within the study area at this time include a quarry near Roe Cross (200m north), Mottram Old Mill (Woollen) which is located adjacent to the proposed western roundabout of both options. To the north west (approximately 500m) is Harropedge Quarry and to the east approximately 700m off the proposed route options lies the Manchester Sheffield & Lincolnshire Railway. Several mills and quarries are located in the built up areas within the study area.

In 1910, a small gas works can be seen approximately 200m to the south of the western end of Option 5 near Hollingworth. A Bleach Works and associated tanks and Mersey Mills are located adjacent to River Etherow to the east of the route options. Light industry (Wadding Manufactory) is indicated to the north in Lower Roe Cross.

In 1950, additional industrial activities (Rhodes Mill (disused) and Longendale Works) are shown to the east of the study area near Woolley Bridge and the Bleach Works. A sewage works can be seen approximately 300m to the south of the proposed route options in Longdendale.

By 1983 residential development in Mottram and Hollingworth has significantly increased. The industry to the north in Lower Roe Cross is no longer shown. A garage is located in the vicinity of the gas works is no longer indicated.

4.2.2 A628 (T) Climbing Lanes

A road has been present in the location of the proposed climbing lane routes since circa 1872. The surrounding areas are open land on either side of the valley with Pikenaze Moor, Ironbower Moss and Longside Moss to the north. The Great Central Railway can be seen to the south. The railway enters the Woodhead tunnel between the two proposed climbing lane locations.

The Woodhead Reservoir is to the south west and west of the western climbing lane. A number of quarries can be seen within the study area including one at the eastern end of the western proposed climbing lane.

In 1911, filter beds can be seen to the south of the western proposed climbing route on the opposite side of the Etherow River.

No significant development changes have occurred since 1911.

4.2.3 A61 Dualling (no longer part of the scheme)

The earliest maps (1893 – 1894) show that the proposed route option is mainly wooded or agricultural land. However, to the south, Tankersley Colliery and Reservoirs associated with the Colliery are indicated approximately 150m from the western end of the route option. Railway lines from the colliery are shown running northwards and across the route option to the east of A61/A616 roundabout. Other features within the study area include Coke Ovens, Whorncliffe Silkstone Colliery (north), Brick Fields (north), Silkstone Colliery and associated tramway (north west), Tankersley Farm and Rockingham Gas Works (north of eastern end of route). An Ironstone open cast working appears in the western end of the route option in the location of the roundabout from as early as 1854 to 1906. Between 1906 and 1931 the open cast mine is filled in and the "Westwood Main Road" is constructed. Several air shafts are also shown in this area at this time.

By 1956 the A61 has been constructed. An area of open cast mining is shown 1km to the north west and many of the above features are still present. On the 1965 / 1966 edition the two collieries within the study area are no longer present but spoil heaps are located in their vicinity. The railway line is still present as are buildings associated with Whorncliffe Silkstone Colliery.

The northern alignment of the A61 is indicated to have changed in the early 1980s to follow the current route. The railway line is now shown as disused. By the early 1990s, the A616 has been constructed and the roundabout at the western end of the route option has been built, joining the two roads.

The Wentworth Industrial Park can be seen north of the route option to the north west. Disused tips and spoil heaps are indicated to the north and south of the route option within the study area.

4.3 Hydrology

The following hydrogeological conditions exist in the study areas and have been derived from publicly available information from the Environment Agency (EA) website (Ref.09). The information is recorded in the project GIS. The following sections summarise the superficial and bedrock geology.

4.3.1 Mottram Moor Link Road (Option 0 and 5)

The EA website indicates that, where superficial deposits (Till) are present within the study area, they are designated as an Unproductive Stratum. This covers the majority of the study area. However, there are areas near to the "Cricket Ground Roundabout" and at the eastern end of both Route Options 0 and 5 which are designated as Secondary A Aquifers. This relates to Alluvium and Head deposits which are present in these areas.

The bedrock beneath the area is designated as a Secondary A Aquifer. Secondary A Aquifers are described as 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.

The study area is not within a groundwater Source Protection Zone.

4.3.2 A628 (T) Climbing Lanes

The EA website (Ref.09) indicates that, where superficial deposits (Peat) are present within the study area, they are designated as an Unproductive Stratum. No superficial deposits are present beneath the proposed climbing lanes. However, peat deposits are present along both sides of the valleys to the north and south.

To the south of the western climbing lane, and on the opposite side of the lake, there is an area of Head deposits which is designated as a Secondary Undifferentiated Aquifer with pockets of Secondary A aquifer which relates to Alluvium deposits. Secondary Undifferentiated Aquifer is a designation assigned in cases where it has not been possible to attribute the rock type to either category A or B. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

The bedrock across the study area is designated as a Secondary A Aquifer.

The study area is not within a groundwater Source Protection Zone.

4.3.3 A61 Dualling (no longer part of the scheme)

The EA website (Ref.09) indicates that the bedrock in this study area is designated as a Secondary A Aquifer. The BGS (Ref.07) does not record any superficial deposits at the site indicative that they are thin (typically less than 1m) to absent

The study area is not within a groundwater Source Protection Zone.

4.4 Flood Risk

The environment agency (EA) “Flood Map for Planning” (Ref.10) was used to give an initial assessment on the level of flood risk associated with each of the three developments. Flood Zones are defined for areas believed to be at risk. The Flood Zone definitions are set out in the National Planning Policy Guidance and state:

- Flood Zone 1 - land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%)
- Flood Zone 2 - land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year
- Flood Zone 3 - land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year

Note: These flood zones refer to the probability of river and sea flooding, ignoring the presence of manmade flood defences.

The following sections summarise the information found.

4.4.1 Mottram Moor Link Road (Option 0 and 5)

Only the far eastern extent of the proposed alignment for both Option 0 and 5 are considered to be a risk from flooding. Where the proposed alignment crosses the Etherow River, this area is highlighted as Flood Zone 2 and Flood Zone 3.

4.4.2 A628 (T) Climbing Lanes

Neither Location 1 nor Location 2 is located with a Flood Zone. However, both locations are located in close proximity to a Flood Zone 3 area associated with the River Etherow, which is at a lower level.

4.4.3 A61 Dualling (no longer part of the scheme)

The A61 dualling is located in an area not highlighted as at risk of flooding.

4.5 Man-made Features

4.5.1 Mottram Moor Link Road (Option 0 and Option 5)

As noted in the Hyder 2006 Geotechnical Report, a number of man-made features have been identified in close vicinity of Option 0 and Option alignment.

A former woollen mill and associated millpond, located just west of Mottram has been identified. The remains of a stone building are still visible on the ground. The northern part of the proposed embankment partly overlies the footprint of this feature.

4.5.2 A628 (T) Climbing Lanes

4.5.2.1 Location 1

As no fieldwork, has been carried out for this part of the scheme. Basic information has been provided using Google Earth Pro (Ref.13).

With no "As built" drawings available to date, it is assumed that the eastbound carriageway is in cuttings and the westbound is on embankments. In various locations along the route, a Vehicle Restraint System can be found on the westbound carriage.

As the A628 (T) is located in a National Park, it is expected to have little or no manmade structures around it.

4.5.2.2 Location 2

The following is an extract from a Value Management Report produced by A-One + in 2015 (Ref.14), focusing on an area within Location 2 of the A628 (T) climbing lanes.

"*The carriageway runs on sidelong ground cut into the slope. The eastbound carriageway is in cuttings and the westbound on embankments. Low masonry retaining walls support the toe of the cut slope on the north side of the route. The embankment slopes on the south side of the route have historically been subject to localised instability problems.*

The eastbound earthwork is around 1.5km long in total, increasingly in height to the west with a maximum slope of 10.7m high and slope angles of approximate 37°. The westbound earthwork extends a distance of approximately 1.6km with slope heights ranging from 2.1m at 21° to the horizontal to a maximum slope of 35m at 36°. There is no hard shoulder or hardened strip along the edge of the carriageway.

The boundaries to the highway in this area are marked by wire fences and dry stone walls, the latter in poor condition, adjacent to the eastbound carriageway and a Vehicle Restraint System (VRS) and a simple wire fence on the westbound carriageway.

Carriageway drainage along this section of the route comprises gully pot drains in the margin of the eastbound and (rarely) westbound carriageway. These drains discharge directly onto the natural hillslope or embankment slopes located to the south of the route, via pipes and drystone masonry culverts."

4.5.3 A61 Dualling (no longer part of the scheme)

Starting near the A61/A616 roundabout at Ch.50 is a disused railway underbridge, with a masonry wall running along the top. Located at Ch.250 on the northern carriageway is a VOSA weighbridge. Highways England are still to confirm if this will remain in place.

Towards the end of the scheme near Ch.1500 is an underbridge for New Road. Running along the scheme are various vehicle restraint systems and sign posts for the Wentworth Way, Church Lane and Westwood New Road Junctions.

It should be noted that a detailed survey was not carried out for the inspection of man-made structures. There is, therefore, the potential for other structures such as culverts and drainage systems.

4.6 Geomorphology

4.6.1 Mottram Moor Link Road (Option 0 and 5)

Section Reference	Chainage (m)	Features
M67 Terminal Roundabout to Roe Cross Road	0 (section 1) to 180 (section 2)	No features were identified at the tie in to M67 roundabout. However, a number of features along the route were identified in the Hyder 2006 report: An air shaft associated with United Utilities Longdendale Aqueduct Mottram Tunnel (which crosses the route at approximate Ch.250m) is located approximately 50m north of the road at approximate Ch.180m. Various watercourses run from north to south across the route. Sunken pond features are evident off the road line at Ch.120m, Ch.200m, Ch.400m Ch.600m and Ch.650m. Sunken features are evident at Ch.220-225m and Ch.680-700m under the line of the proposed road. Areas of boggy ground particularly around Ch.50m and around Ch.800-850m. The former Mill Pond associated with former Woollen Mill (Ch.675m) lies at Ch.700m. Terracing along existing west side-slope of Roe Cross Road indicates surface creep and shallow instability.

Section Reference	Chainage (m)	Features
Roe Cross Road to Old Hall Lane (Mottram Village)	180 (section 2) to 350 (section 2).	Numerous springs appear in this area following heavy rain. The surface trace of fault is evident at Ch.1025m as a change in ground level between Tollemarche Close and Old Hall Lane. There is a steep break in slope (Ch.1075m)
Old Hall Lane to Mottram Moor Roundabout	350 (section 2).to 1027 (section 2)	There is a sunken area with a pond and boggy ground (Ch.1310m) with 'issues' entering from possible old stone-lined land drains. There is a depression with boggy ground and stream (possibly linked to land-drainage) at Ch.1250 – south of route.
Roe Cross Road roundabout	0 (section 3) to 1182 (section 3)	There are spoil heaps of quarry waste and disused buildings. There is a well and possibly a dry stream channel behind the northeast quarry face. There is evidence of former working between the stream and the back face of the quarry.

4.6.2 A628 (T) Climbing Lanes

As no survey was undertaken for this part of the scheme, details of the geomorphology around the climbing lanes cannot be provided.

4.6.3 A61 Dualling (no longer part of the scheme)

As no survey was undertaken for this part of the scheme, details on the geomorphology around the A61 cannot be provided.

4.7 Geology

4.7.1 Superficial Geology

4.7.1.1 Mottram Moor Link Road (Option 0)

The British Geological Survey data indicates that the superficial geology underlying this section of the site the site as predominantly Devensian Till with a small section immediately south-west of the Cricket Ground Roundabout identified as Alluvium of clay, silt, sand and gravel. The BGS viewer describes the Alluvium as "*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 Till deposits are described by the BGS as "*comprises gravel, sand and clay depending on upslope source and distance from source. Poorly sorted and poorly stratified deposits formed mostly by solifluction and/or hill wash and soil creep. Essentially comprises sand and gravel, locally with lenses of silt, clay or peat and organic material…*"

Towards the A57 roundabout, the superficial geology changes from Devensian Till to Quaternary Head deposits.

The geology changes from Head deposits to Alluvium of Clays and silts to the southeast of the A57 roundabout and onwards to the end of this part of the proposed works.

4.7.1.2 Mottram Moor Link Road (Option 5)

According to the BGS mapping, the superficial geology for this option does not vary from that of Option 0.

4.7.1.3 A628 (T) Climbing Lanes

The BGS mapping shows extensive areas of peat approximately 90m to the south and 250m to the north of the site, neither of which should impact on the works. The historic exploratory holes, record this peat to overlie clayey silty sand with fine gravel of sandstone and silty clay deposits, peat is proved to 2m depth.

The BGS (1:50,000 series map) does not record any superficial deposits at the site, indicating that they are thin (typically less than 1m) to absent. Any superficial deposits present are expected to comprise colluvium derived from downslope displacement of weathered bedrock materials.

4.7.1.4 A61 Dualling (no longer part of the scheme)

The British Geological Society mapping has not identified any superficial Geology within this section of the proposed development, suggesting they are thin (<1m) to absent.

4.7.2 Bedrock Geology

4.7.2.1 Mottram Moor Link Road (Option 0)

Figure 1 represents the bedrock Geology underlying Mottram Moor Link Road option 0. This figure is taken from the GIS data provided by Landmark Ltd (Ref 08).

Figure 1: Option 0 BGS 1:50k Bedrock Geology

M67 terminal roundabout to Roe Cross Road

The bedrock geology underlying the western part of this section of the alignment comprises Fletcher Bank Grit or Sandstone described by the BGS as "*Sandstone and pebbly sandstone, coarse-grained with angular grains, with quartz and quartzite pebbles, massive and current-bedded, and subordinate beds of mudstone and coal*."

The eastern section of this part of the alignment is underlain by Marsden Formation of Mudstone and Siltstone described by the BGS as "*Fine- to very coarse-grained and pebbly feldspathic sandstone, interbedded with grey siltstone and mudstone, and subordinate marine black shales, thin coals and seatearths*".

Roe Cross Road to Old Hall Lane (Mottram Village)

The bedrock geology along this section of the alignment varies from Marsden Formation of Mudstone and Siltstone in the west to Fletcher Bank Grit or Sandstone in the east.

It is believed that the variable nature of the bedrock geology within this section of the alignment is as a result of a fault within the bedrock. The fault has a northwest to southeast orientation, passing though the Mottram village with Marsden Formation on the southwest side and Fletcher Bank Grit or Sandstone on the northeast side.

The Hyder Interpretative report, 2006 states that "*the fault is more complex, and there is abundant evidence for a wide zone of disturbance…This includes the irregular rockhead profile, polished and slickensided fracture surfaces, and the presence of fault breccia. In addition, the old 1:10,560 County Series geological mapping shows an area of 'contorted strata' on the north east side of the fault, immediately south of the alignment. The evidence suggests the zone of disturbance associated with the fault may be on the order of 100m wide."* The presence of this fault has been confirmed by the three ground investigations.

Old Hall Lane to Mottram Moor roundabout

The bedrock geology across this section of the alignment changes from Marsden formation into Fletcher Bank Grit as it crosses the fault. From Old Hall lane the Geology changes From Fletcher Bank Grit to Marsden Formation (Mudstone and Siltstone), reaching Fletcher Bank Grit towards Mottram Moor roundabout.

Mottram Moor roundabout to the A57 Roundabout

From Mottram Moor roundabout to the A57 roundabout the bedrock geology changes from Fletcher Bank Grit to Marsden Formation (Mudstone and Siltstone).

The A57 roundabout lies on the Marsden Formation with a small section to the north lying on the Fletcher Bank Grit formation.

4.7.2.2 Mottram Moor Link Road (Option 5)

Figure 2 represents the bedrock Geology underlying Mottram Moor Link Road option 5. The figure is produced from the data provided by the Landmark Ltd (Ref 08).

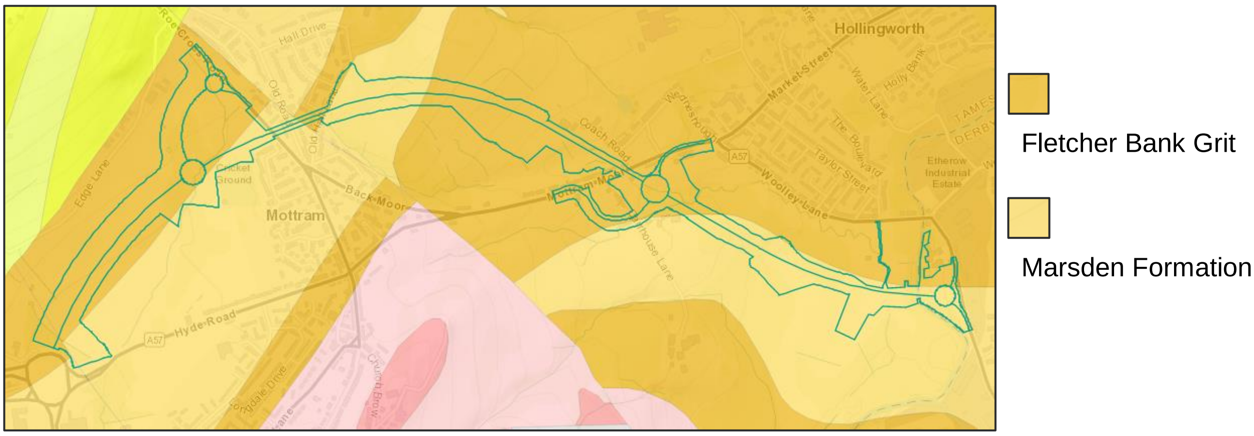

Figure 2: Option 5 BGS 1:50K Bedrock Geology

M67 terminal roundabout to Roe Cross Road

The bedrock Geology underlying this section of the alignment comprises Fletcher Bank Grit (Sandstone).

Roe Cross Road to Old Hall Lane (Mottram Village)

The bedrock geology underlying this part of the alignment is identical to that of Option 0. The western section of this part of the alignment is identified by the BGS as underlain by Marsden Formation of Mudstone and Siltstone while the eastern section of this part is underlain by Fletcher Bank Grit or Sandstone.

Old Hall Lane to Mottram Moor Roundabout

The bedrock geology across this section of the alignment changes from Marsden formation into Fletcher Bank Grit as it crosses the fault. The tunnel exit in this option is underlain by Fletcher Bank Grit formation.

Mottram Moor roundabout to the A57 Roundabout

Similar to Option 0 From Mottram Moor roundabout the underlying bedrock geology changes from Fletcher Bank Grit or Sandstone to Marsden Formation (Mudstone and Siltstone) and the A57 roundabout lies on the Marsden Formation with a small section to the north lying on the Fletcher Bank Grit formation

4.7.2.3 A628 (T) Climbing Lanes

Figures 3 and 4 represent the bedrock Geology at Location 1 and Location 2 as provided by Landmark Ltd (Ref 08).

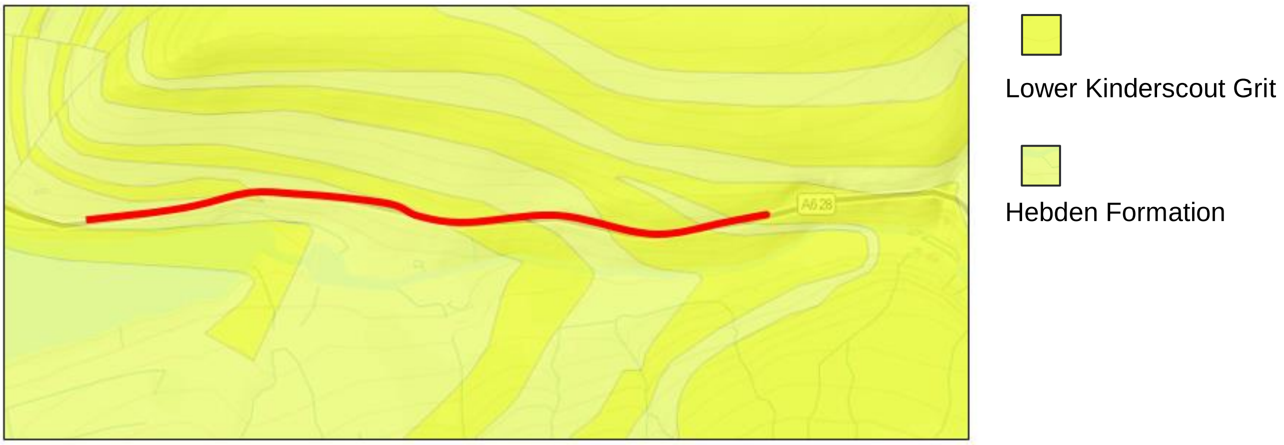

Figure 3: Climbing Lanes, Location 1 BGS 1:50K Bedrock Geology

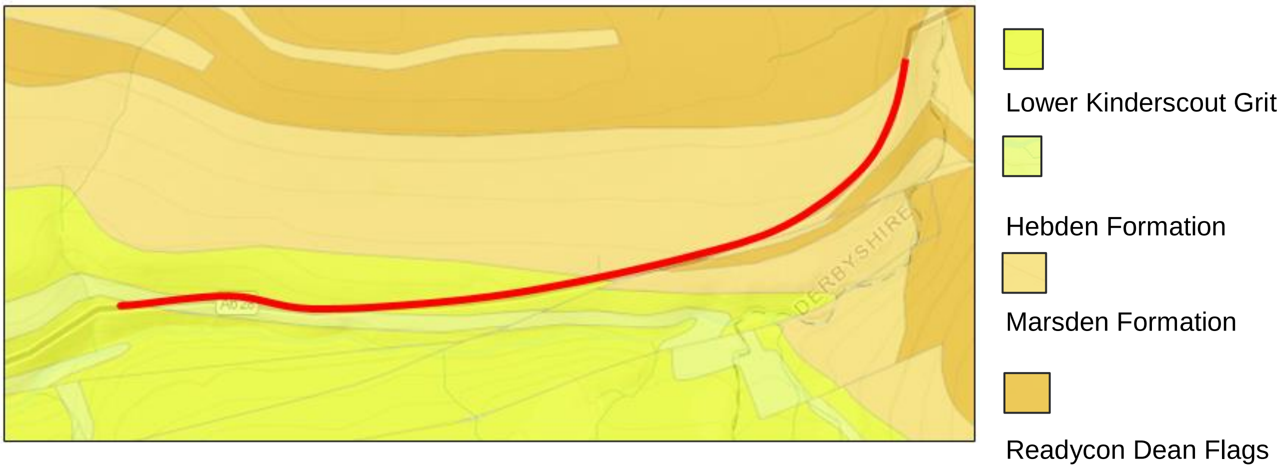

Figure 4: Climbing Lanes, Location 2 BGS 1:50K Bedrock Geology

Location 1

The underlying bedrock along this route is the Hebden Formation of Mudstone and Siltstone in the west and Lower Kinderscout Grit of Sandstone in the east. The Hebden Formation is a Kinderscoutian bedrock described by the BGS as "*Fine- to very coarse-grained and pebbly, feldspathic sandstone interbedded with grey siltstone and mudstone, with subordinate marine black shales, thin coals and seatearths*". The Hebden Formation is previously known as the as "Kinderscout Formation".

Location 2

The bedrock geology underlying this option changes west to east of the location from Hebden Formation of Mudstone and Siltstone, to Lower Kinderscout Grit, to Marsden Formation of Mudstone and Siltstone and terminating in Readycon Dean Flags Formation of Sandstone.

No description has been provided by the BGS for the Readycon Dean Flags Formation, however the parent unit, Millstone Grit Group, has been described as "*Fine- to very coarse-grained feldspathic sandstones, interbedded with grey siltstones and mudstones, with subordinate marine shaly mudstone, claystone, coals and seatearths*"

There is a fault in the bedrock located towards the eastern end of this location which could have an impact on the variation in bedrock geology towards the east. The fault has a slight northeast to southwest orientation with Marsden Formation located to the northwest and Readycon Dean Flags Formation of Sandstone located southeast of the fault.

4.7.2.4 A61 Dualling (no longer part of the scheme)

Junction 36 is underlain by the Pennine Middle Coal Measures Formation of Mudstone, Siltstone and Sandstone changing to Pennine Middle Coal Measures Formation (Sandstone) towards Tankersley. Moving southwest, the bedrock geology changes to Pennine Middle Coal Measures Formation (Mudstone and Sandstone) before changing to Pennine Lower Coal Measures Formation of Sandstone.

Near Church Lane the bedrock geology changes from the Pennine Lower Coal Measures Formation of Mudstone, Siltstone and Sandstone to Pennine Lower Coal Measures Formation of Sandstone. The A61 roundabout is underlain by the Pennine Lower Coal Measures Formation (Mudstone, Siltstone and Sandstone).

The variability in the bedrock geology could be a result of a number of faults at bedrock present in this area. The first fault is located across Tankersley, cutting through the A61 with a northwest to southeast orientation. Located northeast of this fault lies Pennine Middle Coal Measure (mudstone, Siltstone and Sandstone) Formation, and southwest lies Pennine Middle Coal Measure (Sandstone).

There are 3no faults within 320m of the A61 roundabout, identified as coal seams with a northwest to southeast orientation. The coal seems lie within the boundary of Pennine Lower Coal Measure (Mudstone, siltstone and Sandstone) and Pennine Lower Coal Measure (Sandstone).

Figure 5 represents the bedrock geology for the A61 as provided by the Landmark Ltd (Ref 08).

Pennine Lower Coal Measures (Mudstone, Siltstone and Sandstone)

Pennine Lower Coal Measure (Sandstone)

Pennine Middle Coal Measure (Mudstone, Siltstone and Sandstone)

Pennine Middle Coal Measure (Sandstone)

Figure 5: A61 Dualling, BGS 1:50K Bedrock Geology

4.8 Coal Mining

4.8.1 Mottram Moor Link Road (Option 0)

4.8.1.1 Coal Authority Report

A Coal Authority Report obtained on the 09 August 2016 (Report No: 51001235020001) indicates that two mine entries are within, or within 20 meters of the boundary of the alignment. The approximate positions and full report can be found in Appendix C.

The following is an extract from the Hyder Geotechnical (Ref.02), which indicated that the risk of shallow coal mining is low, and the two mining entries shown relate to the same Longdendale aqueduct airshaft.

"*Coal Authority Coal Mining Report Reference 00181061-04 (15 October 2004) indicates the presence of two shafts near the western end of the route, at about Ch.180m. The northernmost of these two shafts (Mine Entry Ref: 398395-002) corresponds to the location of an air shaft on the United Utilities' Longdendale Aqueduct Mottram Tunnel, described below. The second shaft (Mine Entry Ref: 398395-003) is shown about 27m south south-east of the first. Reference to the Coal Authority Mine Entry Data Sheets Reference 398395-002 and –003 indicate the sources of this information to be:*

- *1/2500 OS 1st – 4th editions and 1:10,560 Geological Survey ¼ sheet (Mine Entry Reference 398395-002)*
- *1/2500 OS 1st edition (Mine Entry Reference 398395-003).*

Two shafts are shown at this location on the 1st Edition County Series topographic mapping published between 1872 and 1882, although subsequent revisions (from 1899 onwards) show only one shaft. Geological survey *mapping carried out between 1925-1926, which is based on the 1911 revision of the County Series topographic map (IGS, 1926a), shows numerous abandoned coal mine shafts, but not at the site in question where a single 'air shaft' only is shown. The map does, however, show Coal Measures strata underlying this section of the route. The 1st Edition County Series topographic mapping apparently omits the easternmost of the four shafts on the United Utilities aqueduct, and it is possible that representation of a second shaft at Ch.180m is simply a cartographic error, corrected on later editions. No features are apparent on aerial photography corresponding with the position of the second shaft.*

As discussed in Section 5.2.3 and above, it is concluded that the current 1:50,000 geological mapping (BGS, 1981) should take precedence over the old County Series mapping (BGS, 1926a). This is because the three ground investigations indicate that the 1981 map is more accurate. The probability of there being coal working beneath this section of the route is considered to be low, as the coal strata found in ground investigation No.3 (Fugro 2005) are too thin for mining extraction (0.01 to 0.2m thick, see section 5.2.3)."

4.8.2 Mottram Moor Link Road (Option 5)

4.8.2.1 Coal Authority Report

A Coal Authority Report obtained on 09 August 2016 (Report No: 51001235033001) indicates that two mine entries are within, or within 20 meters of, the boundary of the proposed alignment. The approximate positions and full report can be found in Appendix C.

See section 4.8.1.1 above on associated risk with the mine entries.

4.8.3 A628 (T) Climbing Lanes

4.8.3.1 Coal Authority Report

A Coal Authority Report obtained on the 09 of August 2016 (Location 1, Report No: 21001234995001 and Location 2, Report No: 51001235009001) indicates that both location 1 and 2 are in areas of no past, present or future underground coal mining.

There are no know coal mine entries within, or with 20m of the alignment of location 1 and 2.

4.8.4 A61 Dualling (no longer part of the scheme)

4.8.4.1 Coal Authority Report

A Coal Authority Report obtained on 10 August 2016 indicates that the site is in an area that could be affected by underground mining in 8 seams of coal at shallow to 340m depth and last worked in 1972. The property is in an area that could be affected by underground mining in 1 seam of ironstone at shallow depth and last worked in 1828.

The Coal Authority report indicates that there are 15 mine entries within, or within 100m of, the A61 alignment. An extract from the Coal Authority, summarising the details of the shafts are given in Table 1. The full report and location of each shaft can be found in Appendix C. Only two mining shafts are within a notifiable distance of the A61 such that they require further investigation. Shafts 434399-003 and 434399-008 are within 30m of the A61 road.

***Table 1*: A61 Coal Mine Entries (Extract from Report)**

Mine Entry Reference	Comments
433399-055	Has been excavated by opencast mining
433398-045	No treatment details Mine entry 433398-045 was conveyed to Secretary of State for Transport in 1994
433399-046	Was found filled and subsequently capped at rock head with 4.5m square concrete by By-Pass Contractors in 1986.
433398-034	Has been filled to an unknown specification
434399-008 *1	No treatment details
433399-031	Has been filled to an unknown specification and has probably been removed tosome extent by opencast mining
433399-010	Is filled and was capped to NCB specifications in 1986
433399-009	No treatment details
434399-004	434399-004 was capped with concrete to a design by IMC consultants on behalf of the Coal Authority in 1995.
433399-030.	Is filled to an unknown specification
433399-056	No treatment details. Mine entry 433399-056 was conveyed to Secretary of State for Transport in 1994.
433399-008	433399-008 is capped with a 3.8m square x 0.2m thick concrete raft seated on elevated brickwork. At the centre of the raft is a 1.1m square plinth housing a vent pipe. The brickwork was repaired by the Coal Authority in March 2012 and the shaft is now periodically inspected by the Authority.
433398-046	No treatment details.
433399-011	No treatment details.

Mine Entry Reference	Comments
	Mine entry 433399-011 was conveyed to Secretary of State for Transport in 1994.
434399-003 *1	No treatment details.
***(*1)** Mine shaft within 30m of the A61 road.*	

With two mine shafts within close proximity to the A61, it is recommended that a more detailed assessment of these mine shafts should be carried out by the Coal Authority. It is possible that they have been capped and sealed off for the construction of the A61, but there are no details provided in the initial Coal Authority report.

4.9 Landfills, geo-environmental Issues and possible contamination Issues

The following types of potential contaminated land have been identified from a review of historical maps for the study areas and are discussed in more detail in the historical development Section 4.2 above.

The following potential sources of contamination are identified:

- Landfills
- Farms / agricultural land
- Collieries / associated spoil heaps
- Quarries (potentially now infilled)
- Industry – Works / Mills/ Gas Works
- Industrial estates

4.9.1 Mottram Moor Link Road (Option 0 and 5)

Eight landfills are identified within 1 km of the route alignment. The two closest landfill sites to Option 0 and 5 are;

- One landfill (Land adjacent to Woolley land Gas Works) is located to the east of Mottram Moor Roundabout on Option 5. This landfill accepted waste including inert waste.
- There is a small landfill (Carrhouse Road) located between Option 0 and Option 5 and
- A disused railway line 115m east of the eastern end of both route options.

The other landfill sites are over 350m from the proposed route options.

4.9.2 A628 (T) Climbing Lanes

No landfills are present within 1 km around the proposed climbing lanes.

4.9.3 A61 Dualling (no longer part of the scheme)

A total of five landfills are present within 1 km of the area around the A61 dualling alignment. Three landfill sites are located between 400m and 600m of the western end of the route option, whilst the others are located between 500m and 650m to the north of the eastern end of the route option.

To assist the detail environmental assessment for the scheme the Environmental Study Report, HE551473-ARC-EGN-ZZZ-RP-EN-2001, Sept 2016 has been produced and should be reviewed form more information.

4.10 Ground Hazards

4.10.1 Mottram Moor Link Road (Option 0 and 5)

The risk for collapsible ground has been identified as very low along both alignments. No collapsible ground hazard has been identified along a strip east of the M67 roundabout to the Cricket Ground roundabout, and at the A57 roundabout.

No compressible ground hazard has been identified along a strip east of the M67 roundabout to the Cricket Ground roundabout, and at the A57 roundabout.

The potential risk for landslides has been identified as generally very low. However, Option 0 crosses a low risk zone before reaching the A57 roundabout.

From the M67 roundabout the route crosses a low risk area of running sand. Both alignments are generally a very low risk area, with Option 0 passing a no hazard area before reaching the A57 roundabout.

Option 0 and Option 5 are generally at a very low risk of shrinking or swelling clay hazard. However, the A57 roundabout has been identified as a low hazard.

The drift deposits along both options are identified as "*Low permeability drift deposits occurring at the surface and overlying Major and Minor Aquifers are head, clay-with-flints, brickearth, peat, river terrace deposits and marine and estuarine alluvium*".

4.10.2 A628 (T) Climbing Lanes

4.10.2.1 Location 1

The potential risk of collapsible ground has been identified as very low.

The potential for landslide ground stability hazard varies from east to west of the route between high to very low.

The potential for shrinking and swelling clay hazard changes from no hazard to very low from east to west of the route.

Cadding Wood immediately north of the proposed route, located at the eastern section of the route is named as a recorded mineral site for Sandstone.

The drift deposits along both options are identified as "*Low permeability drift deposits occurring at the surface and overlying Major and Minor Aquifers are head, clay-with-flints, brickearth, peat, river terrace deposits and marine and estuarine alluvium*".

4.10.2.2 Location 2

The potential risk of collapsible ground has been identified as very low. No hazard of compressible ground has been identified.

The southern edge of the road has been subject to a number of repairs due to downslope movements, generally caused by water flow over and through the ground in some form.

The potential for landslide ground stability hazard has been identified as very low north of the route and high immediately south of the route.

North of the route the potential for shrinking or swelling clay ground hazard is "none", changing to very low south of the route.

There is a natural cavity approximately 265m southwest of the proposed route. This cavity is identified as fissures due to cambering of Millstone Grit Group.

The drift deposits along both options are identified as "*Low permeability drift deposits occurring at the surface and overlying Major and Minor Aquifers are head, clay-with-flints, brickearth, peat, river terrace deposits and marine and estuarine alluvium*".

4.10.3 A61 Dualling (no longer part of the scheme)

Artificial ground has been identified along the route just south of the Wentworth Office Park, as infilled ground.

The A61 route is identified as being under very low risk of collapsible ground hazard.

No hazard is generally identified for the potential for compressible ground. However, moderate risk is identified just south of the Wentworth Office Park.

The potential for landslide ground stability changes from no hazard to low and moderate hazard along the A61 from northeast to southwest.

No hazard of potential for running sand is generally identified along the route. However, a very low risk is identified south of Wentworth Office Park.

The potential for shrinking or swelling clay hazard varies between no hazards to very low hazard recurrently.

A recorded mineral site has been identified within close proximity of the route. The Potter Holes Bells Pits with coal as its commodity (Pennine Lower Coal Measures) is located at Tankersley adjacent to the A61.

4.11 Unexploded Ordnance (UXO)

4.11.1 Mottram Moor Link Road (Option 0 and 5)

A preliminary Zetica (Ref.15) UXO assessment was undertaken for the proposed route of Option 0 and Option 5 (Appendix D). An extract from the report states:

"*No readily available records of bombing or other significant military activity on the Site have been found. It is considered that the Site is likely to have a low Unexploded Ordnance (UXO) hazard level. A detailed desk study, whilst always prudent, is likely to do no more than confirm a low UXO hazard level for the Site.*"

It is therefore recommended that no further work is required on UXO assessments for Option 0 and Option 5.

4.11.2 A628 (T) Climbing Lanes

A preliminary Zetica (Ref.15) UXO assessment was undertaken for the proposed route of the A628 Climbing Lanes (Appendix D). An extract from the report states:

"No readily available records of bombing or other significant military activity on the Site have been found. It is considered that the Site is likely to have a low Unexploded Ordnance (UXO) hazard level. A detailed desk study, whilst always prudent, is likely to do no more than confirm a low UXO hazard level for the Site."

It is therefore recommended that no further work is required on UXO assessments for the Climbing Lanes.

4.11.3 A61 Dualling (no longer part of the scheme)

A preliminary Zetica (Ref.15) UXO assessment was undertaken for the proposed route for the A61 dualling (Appendix D). An extract from the report states:

"*No readily available records have been found indicating that any significant bombing occurred on the Site, which was in an area with a very low WWII bombing density. No other significant military activity is recorded on the Site. It is considered that the Site is likely to have a low Unexploded Ordnance (UXO) hazard level. A detailed desk study, whilst always prudent, is likely to do no more than confirm a low UXO hazard level for the Site."*

It is therefore recommended that no further work is required on a UXO assessment for the A61 dualling.

4.12 Utilities

With reference to the Hyder 2006 report "A57/A628 Mottram to Tintwistle Bypass and A628/A616 Route Restraint Measures", four air shafts associated with United Utilities' Longdendale Aqueducts Mottram tunnel are identified. The line of this aqueduct tunnel crosses the route obliquely between Ch.180m and Ch.320m.

The aqueducts is described to be at or close to surface where it crosses the alignment to the east of the valley of Hurstclough Brook which is visible on aerial photographs as a soil-covered linear mound. The alignment is on an embankment at this location and the effect on the aqueduct tunnel will need to be assessed.

An air shaft associated with United Utilities' Arnfield Floodwater Tunnel, is located about 130m north of Ch.3750m. The aqueduct tunnel crosses the route at approximate Ch.3910m.

Hyder carried out a geomorphological survey in November 2005 which identified a number of manholes, flood tunnels, footbridges and overhead cables along various section of the proposed development. The findings from this survey are presented in their Geotechnical Report from 2006.

No survey has been undertaken from Mottram Roundabout to the A57 roundabout and therefore no information is available on the utilities within that section of the proposed development.

Drawing no. NH50845-1405-01 shows current and proposed series for Mottram village. It should be noted that this drawing was produced in 2005. Therefore, an updated drawing would be required to show any recent changes.

4.13 Earthworks Instability

The HA GDMS website (http://www.HA GDMS.com) (Ref.16) contains records of defects recorded during the principal inspections of the earthworks. A review of the HA GDMS database found a large number of instability related defects along the A628 (T) Climbing Lanes. A total of 35 No. defects were recorded. No earthwork defects are recorded for roads associated with the Mottram Moor Bypass and the A61 Dualling. Note that the HA GDMS database is a live system and should be checked in advance of detailed design and construction for any updates.

The instability related defects are summarised within Appendix E.

5 Ground Conditions

5.1 Introduction

This section of the PSSR presents a preliminary assessment of the expected ground conditions for the proposed developments along the scheme. Section 5.2 to 5.5 below present the expected ground conditions and where possible likely engineering properties of strata encountered for each of the proposed developments based on available data presented in sections 2 to 4 of this report and relevant historical reports available from HA GDMS.

The text below is taken from the Hyder interpretative report (Fef.02), 2006 summarising the ground conditions discussed within that report.

5.2 Mottram Moor Link Road (Option 0)

5.2.1 Recent Geology

5.2.1.1 Made Ground

Made ground was encountered along several locations of the proposed alignment options. The interpretative reports produced by Hyder (2006) and Mott McDonald (2005) report on the location and the variability of the material encountered during the historic ground investigations to date. The detail and distribution of the identified materials on site is discussed below:

M67 Terminal Roundabout to Roe Cross Road

Made ground was encountered along the M67 tie-in, in BH1 and BH2, extending to 4.80m and 6.40m below ground level (bgl). The Made Ground encountered was cohesive, consisting of soft to firm sandy or slightly sandy clay with occasional fine to coarse gravel and cobbles of sandstone, concrete and brick. At Ch. 100m, exploratory hole TP300 encountered 1.7m of Made Ground comprising sandy gravelly clay. The made ground is thought to be related to the access ramp from the existing Hyde Road.

Made ground, probably associated with the former Woollen Mill (identified from the historic Ordnance survey maps), was encountered from Ch.350 to Ch.750m. The thickness of the Made Ground was between 1.4m and 1.8m thick and generally comprised light brown to black gravelly sand, black slightly sandy slightly gravelly silt and firm grey to brown slightly sandy slightly gravelly clay. The gravel included coal, brick, limestone and sandstone. Made Ground within the footprint of the former reservoirs associated with the Woollen Mill (WS307) was approximately 0.9m thick comprising black clay and grey brown and red brown slightly sandy, slightly gravelly clay. The gravel included sandstone, coal and wood.

At this section of the route, the borehole logs indicate that the superficial geology is overlain by up to 3.7m of Made Ground.

Roe Cross Roundabout

A site walkover was carried out on 13th January 2005 for the Roe Cross Road about and at the disused Roe Cross Quarry. Soil heaps were identified and recorded as brown very sandy clay with occasional cobbles and broken tiles of unknown thickness. Domestic refuse was also noted in this location.

Organic and Peat deposits

Organic deposits were encountered at various locations during the historic investigations. The locations and descriptions of these materials are discussed below.

M67 Terminal Roundabout to Roe Cross Road

At the M67 tie-in, cohesive organic material was encountered with a thickness of 0.3m comprising black and brown very silty clay with some peat and occasional sand. Towards Roe Cross Road this material proved to have a thickness of 0.6m to 0.7m comprising very soft to soft brown mottled black clay with peat and firm dark brown sandy gravelly clay. This material was noted in BH14, BH33 and TP300.

BH15 discovered a layer of peat 1.5m thick, described as very soft black peat with much organic material and frequent roots.

Between Ch.650m and Ch750m the organic material comprised soft to firm brown/black slightly sandy slightly gravelly clay with some lenses of fibrous peat and/or decomposed organic material and roots. The thickness of this organic material ranged between 0.2m to 0.95m and was encountered in WS303 to 05 and WS308-09.

Peat was encountered as a soft fibrous sandy peat or clayey peat with abundant wood and roots with moderate organic odour in WS305 with a thickness of 0.2m to 0.4m.

5.2.1.2 Alluvial deposits

The text below is taken from the Hyder interpretative report, 2006 (Ref.02), summarising the geological descriptions and location of the Alluvium deposits.

The alluvium encountered across the site varied in thicknesses between 0.1m and 3.8m thick and was found at depths 0.1m to 5.5m bgl. The alluvium is classified as cohesive and granular. The locations and descriptions are discussed below.

M67 Terminal Roundabout to Roe Cross Road

Both cohesive and granular alluvial deposits were encountered north of the M67 roundabout in BH15. Granular deposits with thickness of 0.7m and cohesive material with thickness of 3.6m to a depth of 4.3m below 1.5m of peat were encountered. The granular units overlie the cohesive soils and consist of orange brown slightly silty slightly clayey sand with medium to coarse gravel of sandstone and quartzite. The cohesive units consists of very soft very clayey silt with sandstone gravel.

Cohesive units were encountered in BH17 and BH30 as soft to firm grey orange and brown slightly sandy slightly gravelly clay with gravels of sandstone and siltstone. The thickness was proved to be between 1.2m and 1.4m from depth of 0.3m.

In Trial pits TP6 and TP9 the cohesive units encountered consist of light grey clayey silt with sub-rounded to sub-angular fine to coarse gravel of sandstone. The thickness of this unit is 0.1m at a depth 0.1m to 0.3m.

5.2.2 Quaternary Geology

5.2.2.1 Glacial deposits

Glacial deposits were widespread and include cohesive Glacial Till, Granular Glacial Deposits (sands and gravels), and Laminated Glacial Clays.

M67 Terminal Roundabout to Roe Cross Road

Cohesive Glacial Tills were present to a depth of 35m although significant deposits of Glacial Sands and Gravels up to 11m thick and occasional beds of Laminated Glacial Clay were also present in this section of the route.

The extent of the Till was only proven in BH12 and BH19 at 35m and 36m respectively. These levels correspond to a rock head level of approximately 163m AOD. No other borehole proved the extent of the Till.

Laminated Glacial Clays, interbedded with Till and Granular Glacial Deposits were encountered at depths 9.8m bgl to 11.40m bgl in BH5, 3.20m to 4.35m bgl in BH10 and 4.75m to 6.50m bgl in BH14. These deposits typically comprise soft to firm thinly to thickly laminated silty and sandy clay, with occasional fine sand partings and rare fine to medium gravel.

The base of cohesive Glacial deposits generally increases in a north-easterly direction along this section of the alignment, being "*31m in BH20 (Ch.95m), 22m in BH210 (Ch.761m), 25.3m in BH211 (Ch.808m), and 16m in BH37 (Ch.876m) adjacent to Roe Cross Road*". The full thickness of the Cohesive Glacial Till was not proven in the central part of the alignment.

Significant thicknesses of Granular Glacial deposits were present in this section with a thickness of 3.90m to 16.5m in BH3 and 4.5m to 11.70m in BH6. These deposits occur overlying or interbedded with Cohesive Glacial Till, extending to depths up to 14mbgl. Thin beds of Granular Glacial Deposits (0.5m to 0.7m thick) were encountered interbedded with Cohesive Glacial Till in boreholes BH210 and BH211.

Roe Cross Road to old Hall Lane (Mottram Village)

The Glacial Till in this section varies in thickness overlain by up to 3.70m of Made Ground. As identified in the Hyder, 2006 report, "*The Till varies in thickness from about 18m under Roe Cross Road (BH36, BH212) to zero under Old Hall Lane (BH46). Where encountered, the base of the Till varies from 1.6m to 22.4m depth. Borehole logs indicate pockets of silt and sand*".

Cohesive Glacial Till, interbedded with thin Granular Glacial deposits were encountered in BH300 and BH301. The thickness of this material ranged between 0.7m and 9.0m comprising firm slightly sandy, slightly gravelly clay with occasional cobbles. The gravel includes sandstone, mudstone and rare coal.

A thin bed of Granular Glacial Deposits with a thickness of 0.25m surrounded by Cohesive Glacial Till was encountered in BH300.

5.2.3 Groundwater

Groundwater monitoring has been undertaken during all historic ground investigations. The information obtained on the groundwater profile during the monitoring has been summarised in the Hyder 2006 report. The ground-water conditions for this section of proposed development are taken from the Hyder 2006 report and can be found in **Table 2**. It should be noted that the Groundwater profile from Mottram Moor Roundabout to the A57 roundabout has been covered in the Mott McDonald Geotechnical Interpretative Report, 2005.

Table 2: Groundwater data Option 0

Section reference	Chainage (m)	Geology and topography	Groundwater levels
M67 terminal to Roe Cross Road	0 (section 1) to 180 (section 2)	The bedrock is overlain by a considerable thickness of Glacial Till. Glacial Till is more than 25m thick in the west but thins to the east as Roe Cross Road is approached. The Till contains sand and gravel material as a thick continuous unit. 22.4m of Till identified above bedrock in BH36 on Roe Cross Road	The Glacial sand and gravel unit in the west is water bearing. Groundwater levels are located below ground surface, within the sand and gravel unit. Multiple water strikes are common within the thick Till. Groundwater levels commonly show a typical seasonal variation with a comparatively small annual range of less than 1m (BH3, 7, 10) superimposed on an inter-annual fluctuation relating to total annual recharge. Perched groundwater is identified in most boreholes, even where sand and gravel deposits are not recorded. Multiple water strikes are common within the thick Till. Groundwater levels in the Till situated at low topographical elevation commonly show a typical seasonal variation with a comparatively small annual range of less than 1m (e.g. BH16-18). Groundwater levels within the Till become increasingly erratic and generally increase with topography towards the western tunnel portal at Mottram (i.e. from BH18 to 33). Water strikes are recorded within the Till in BH20 and 36 although no strikes are recorded in the underlying bedrock. This implies the water table situated at considerable depth within the bedrock aquifer (i.e. less than 185.7mAOD at BH36). This is particularly low considering the elevation of proximal watercourses but is greater than the elevation of the River Etherow to the south. Groundwater levels and groundwater strike levels in the Till are variable and are situated at or near the ground surface in a number of boreholes (BH16, 17). The absence of strike could be due to low mass permeability or the drilling method. Artesian conditions are not generally observed in the Till.

Section reference	Chainage (m)	Geology and topography	Groundwater levels
Roe Cross Road to Old Hall Lane (Mottram Village)	180 (section 2) to 350 (section 2).	Glacial Till is generally thick (more than 10 m at BH38, BH208 and BH212), although thins to less 3 m at Boreholes BH209 and 47 at Old Hall Road in the east. The bedrock-till interface around Mottram has a valley-ridge structure but the elevation of the interface generally increases along the line of the proposed tunnel. To the south of the tunnel the elevation of the interface declines towards the River Etherow in the valley below. A fault of uncertain (probably north-south) orientation passes through the proposed position of the Mottram cut and fill tunnel at approximatelyCh.975m.	Two groundwater systems can be tentatively defined, possibly separated by the structural feature (i.e. fault) identified in the vicinity of the tunnel. This division does not appear to be associated with the valley-ridge geological structure. Western side of Mottram: Groundwater levels in the bedrock aquifer are low (From BH210, 211 and 208 monitoring data) or boreholes were dry on completion (BH217, 214 and 219). High groundwater levels in this area are restricted to perched groundwater in the Till, where levels can approach the ground surface (e.g. BH33) but more commonly occur at depth (BH37, 40 205, 212). At some boreholes no water strikes are recorded in the Till. The hydrogeology of the Till is complex and the lateral continuity of water bearing horizons cannot be determined. Eastern side of Mottram: High groundwater levels are observed in the bedrock aquifer. The groundwater level declines to the south indicating discharge to adjacent rivers or other receptors to the south. Localised areas of artesian groundwater occur in this area (BH201, 44, 45, 207). In non-artesian regions, groundwater levels are variably confined or unconfined by the overlying Till. Variations in groundwater level are erratic with large variations in groundwater levels possible, superimposed on a poor seasonal trend, reflecting the complex confined but fractured aquifer hydrogeology characteristic of this area.

Section reference	Chainage (m)	Geology and topography	Groundwater levels
Old Hall Lane to Mottram Moor Roundabout	350 (section 2).to 1027 (section 2)	Glacial Till overlying the bedrock aquifer is of variable thickness. Till is comparatively thin along the ridge of bedrock, becoming substantially thicker to the southeast as the interface deepens.	Groundwater has been observed in BHs 209A, 215, 302 and 307. As the topography reduces towards the Mottram Roundabout the groundwater level declines with a decline in topography suggesting discharge to the adjacent river. The shallowest water table recorded during monitoring was 4.3m bgl at BH306. The highest groundwater table was encountered in BH215 just south of Mottram Village where the route turns towards south east.
Mottram Moor Roundabout to A57 Roundabout	0 (section 3) to 1182 (section 3)		Groundwater declines to the south with topography. Between Mottram Moor roundabout and the A57 roundabout, groundwater was present at levels between 203.04mAOD and 181.02mAOD (0.00m to 2.80m bgl) at the completion of boring. Artesian conditions were present in borehole BH151. Monitoring results (June 2000 to April 2004) recorded average groundwater levels in BH150-1A of 194.44mAOD (1.38m bgl) and 181.02mAOD (1.15m above ground level) in borehole BH151 (artesian conditions).

5.3 Mottram Moor Link Road (Option 5)

5.3.1 Recent Geology

5.3.1.1 Made Ground

Up to the east of Mottram Village, the Option 5 alignment is identical to that of Option 0. However, from Mottram Moor Roundabout to the A57 roundabout the route changes slightly. The description and location of Made Ground in that section of the route can be found below.

Mottram Moor Roundabout to A57 Roundabout

The thickness of Made ground in this section of the route varies between 0.55m and 2.60m as noted in TP65, TP371, TP373, TP374 and BH154. An extract from the Hyder, 2006 report suggest the presence of both cohesive and granular Made Ground along this this section of the route "*In BH154 the Made Ground comprised 1.20m of angular to sub-angular fine to coarse GRAVEL of granite, siltstone and sandstone overlying 1.40m of medium dense sand with occasional sub-angular fine to medium gravel of siltstone, quartz and granite. In TP371, TP373 and TP374 the Made Ground comprised dark grey/dark brown/red sandy gravelly clay. The gravel included brick, concrete, pottery and tiles*".

5.3.2 Quaternary Geology

The deposits encountered between M67 terminal roundabout to Mottram Village are identical to those encountered at Option 0. The location and description of those found in parts of option 5 is described below.

Old Hall Lane to Mottram Moor Roundabout

This section of the alignment is underlain by Cohesive Glacial Till deposits of varying thickness from about 0.5m in BH52 (Ch.1148) to 6.7m in BH53 (Ch.1229) over this length of the route.

Glacial SAND is present between 0.7m and 2.40m depth in BH52. Glacial SAND was also encountered in BH307A between 1.2m and 3.65m depth. These are the only occurrences of Granular Glacial Deposits encountered in this part of the route.

5.3.3 Groundwater

The groundwater conditions between the M67 terminal and east of Mottram village are similar to those mentioned for Option 0. The groundwater profile for the remainder of the route is discussed below.

Table 3: Groundwater data Option 5

Section reference	Chainage (m)	Geology and topography	Groundwater levels
Old Hall Lane to Mottram Moor roundabout	1460-2190	Glacial Till overlying the bedrock aquifer is of variable thickness. Till is comparatively thin along the ridge of bedrock, becoming substantially thicker to the southeast as the interface deepens. Stream bedrock is exposed in the stream bottom. Till is also locally absent in other non-valley locations to the north of the route (e.g. BH61).	This area is characterised by high groundwater levels that generally exceed 205mAOD. The water table between Old Hall Lane and Lumb Stream was generally situated within the bedrock aquifer throughout the period of monitoring (BH213, 59 and 68), as the glacial till is generally thin along this section. Groundwater levels decline to the south or southeast following the topography (BH150A, 220 and 221). Maximum groundwater levels in the confined bedrock aquifer approach ground level but do not become artesian. Groundwater flow appears to be towards the south or southeast probably discharging to Lumb Stream. Hydrographs for all boreholes in this area are consistent and show seasonal response typical of largely unconfined aquifer superimposed on an interannual trend in groundwater levels. Groundwater levels are considerably less erratic than for boreholes penetrating the confined bedrock aquifer to the west.

5.4 A628 (T) Climbing Lanes

5.4.1 Historic Boreholes

With reference to the BGS geology viewer (Ref.07), a number of exploratory holes are available along the A628 (T). One borehole is located on the northern slope above Location 2, and two boreholes are located between Location 1 and Location 2, with one on the northern slope and the other on the southern slope.

Made ground was encountered on the southern slope to a depth of 4m bgl. This is expected to be part of the road make up as the exploratory hole was located just off the carriageway. Where superficial deposits were encountered, they are described as a light brown silty clay or an orange clayey, silty fine sand, and encountered to a maximum depth of 2m bgl.

Underlying the superficial deposits, weathered mudstone was encountered. The weathered mudstone is described as a very stiff to hard dark grey silty clay with some lithorelicts of shaley mudstone. Underlying the weathered mudstone, faintly [sic] weathered, thinly to medium bedded, open jointed sandstone was encountered to the base of all the boreholes.

5.4.2 Previous Ground Investigations

A Ground Investigation Report (GIR) was produced by WSP in December 2010, available online at HA GDMS No: 24320 (Ref.03). The GIR relates to areas between marker posts 8/8 and 8/9. This area is located between Location 1 and Location 2 of the A628 (T).

The following two tables are extracts from the WSP GIR, summarising the ground investigation and ground conditions.

Table 4: Summary of Climbing Lanes Ground Investigation

Exploratory Hole	Depth (m BGL)	Elevation (m AOD)
TP01	1.5m	315.620
TP02	1.5m	316.128
TP03	1.5m	316.505

Table 4.1 in GIR (Ref.03)

Table 5: Summary of Ground Conditions at the Climbing Lanes

Stratum	Typical Description	Depth to Base (m BGL)	Thickness (m)	Notes
Colluvium	Dark brown/yellow gravelly clay with cobbles of siltstone	1.50	1.5	Derived from the trial pit records

Stratum	Typical Description	Depth to Base (m BGL)	Thickness (m)	Notes
Kinderscout Grit	Very weak siltstone	Unproven	Unproven	Limited penetration achieved

Table 5.1.1 in GIR (Ref.03)

5.4.3 Groundwater

No groundwater was encountered in the WSP GIR (Ref.03). However, the Value Management Report produced by A One Plus in 2015 (Ref.14), focusing in an area within Location 2 of the A628 (T) states:

"Groundwater within the natural slope in the vicinity of the road will have been disrupted to some extent by the cut and fill operations for the construction of the road. There is a large area upslope of the A628 carriageway that will receive infiltration which will flow both over and below the A628 carriageway.

The available groundwater data, which again comprise both in-borehole groundwater strike and post-works standpipe piezometer monitoring data (ref Table 1.1), indicate the groundwater level in the Etherow Gorge sub-site to lie at a depth of between 0.2m and 7.5m bgl.

Given the presence of a layered bedrock aquifer system and possibly of multiple, ephemeral perched groundwater tables within the Etherow Gorge sub-site, groundwater levels have conservatively been assumed to lie at around 1.0m bgl (i.e. within the superficial deposits) for the purposes of engineered mitigation design."

5.5 A61 Dualling

5.5.1 Historic Boreholes

With reference to the BGS geology viewer (Ref.07), a number of exploratory holes are available along the A61. The southern end of the route has a dense number of exploratory holes within 50m of the road. However further north along the road, the relevant exploratory holes are up to 300m away from the alignment.

Towards the southern end, near the A61/A616 roundabout, made ground was encountered varying in depth from 3.40m bgl to 5.80m bgl. The made ground is mainly described as a soft to firm brown sandy clay with mudstone and coal fragments. Underlying the made ground, interbedded layers of mudstone (grey, highly to moderately weathered, very weak with occasional ironstone nodules), sandstone (light grey, fine grained thinly to medium bedded slightly weathered micaceous sandstone, strong to very strong) and siltstone (grey, slightly weathered moderately weak with iron staining) were encountered. Coal was encountered between 16.60m and 19.50m bgl, and had a varying thickness of 1.10m to 1.60m. Interbedded layers of mudstone, sandstone and siltstone were encountered to the base of the exploratory holes, except for one, where a collapsed mine shaft was encountered at 39.70m bgl. Remediation of the collapse mine shaft is presented in Section 5.5.3.

Towards the middle of the A61 route, where it crosses Church Lane, the nearest historic exploratory holes are located 250m north west of the road, in Wentworth Office Park. The exploratory holes are trial pits excavated to a depth ranging between 3.40m to 3.50m bgl. The trial pits encountered made ground to a maximum depth of 3.20m bgl. The made ground is described as dark grey black and brown mottled very sandy silty clay, with mudstone gravel, cobbles and boulders and occasional pockets of orange grey clay. Underlying the made ground and encountered to the base of the trial pits, was a soft to firm orange-brown sandy silty clay.

Towards the northern end of the A61, near the M1 roundabout, the closest relevant exploratory hole is 200m east of the A61, located within a M1 slip road embankment. Made ground was encountered to a depth of 0.70m bgl. The made ground was described as a dark grey sandy clay with some fine to coarse subangular gravel with brick fragments. Underlying the made ground, mudstone was encountered to the base of the borehole. The mudstone was described as a moderately to highly weathered mudstone, very weak to weak with closely spaced horizontal clay.

5.5.2 Previous Ground Investigations

A ground investigation was carried out in May 2014 by Costain to investigate the presence of mining in and around the area of the A61/A616 roundabout. A Ground Investigation Report (GIR) was produced by WSP in November 2014, HA GDMS No: 28134 (Ref.04). The following two tables are extracts from the WSP GIR, summarising the ground investigation and ground conditions.

Table 6: Summary of A61/A616 Ground Investigation

Method	Number	Depth Range (m bgl)
Cable Percussion (shell and auger)	2	1.65 – 9.10
Cable Percussion with Rotary follow on	9	5.40 – 30.00
Dynamic Cone Penetrometer (type not specified)	1	5.00
Windowless Sampler	2	5.45
Window Sampler	21	0.00 – 7.45
Mexe Cone	8	0.03 – 0.40

Table 7: Summary of Ground Conditions at the A61/A616 Roundabout

Stratum	Depth to Base of Stratum (m bgl)	Elevation of Base of Statum (m AOD)	Thickness (m)	Typical Description
Made Ground	1.30 to 11.40	153.45 to 144.47	1.30 to 11.40	Cohesive: Soft to very stiff brown through to grey/dark grey slightly sandy to sandy gravelly CLAY; Granular: Sandy fine to coarse angular to subangular GRAVEL of limestone. Or, Brown through to grey slightly sandy to sandy GRAVEL.
Concrete	0.30	155.49 to 155.49	0.30	-
Residual Soil	4.30 to 11.20	151.53 to 144.14	0.50 to 1.30	Firm to stiff grey and brown thinly laminated slightly sandy to sandy slightly gravelly to gravelly CLAY; Or, Soft to hard grey mottled orange CLAY.
Pennine Coal Measures Group	(up to 30.00)	(up to 125.57)	(up to 25.15)	Interbedded mudstone, sandstone, siltstone and coal.
No Recovery – Pennine Coal Measure	4.50 to 25.50 (25.90)	151.75 to 130.29 (129.89)	0.35 to 1.7 (3.22)	-
Voids within Pennine Coal Measure	10.60 to 25.00	145.50 to 130.34	0.60 to 4.90	-

**Brackets indicate maximum unproven depth and thickness and the minimum elevation*

5.5.3 Groundwater

Within the Costain ground investigation, there were 5 groundwater monitoring points. An extract from the WSP GIR (Ref.04) states the following on groundwater near the A61/A616 roundabout:

"*The groundwater monitoring conducted indicates that the installations were generally dry, or contained less than a 0.40m deep column of water. This indicates that the groundwater encountered is unlikely to be connected and no regional groundwater table is considered to have been encountered. Shallow groundwater, although limited, has been recorded and as such should be considered within the geotechnical design.*"

The relevant historic exploratory holes for the remaining part of the A61 did not encounter any groundwater strikes in the boreholes.

6 Preliminary Engineering Assessment

6.1 Introduction

The following sections provide an initial overview of the geotechnical conditions and their potential impact on the proposed works. These assumptions are based on the PSSR information reviewed to date and must be reviewed following a specific ground investigation.

The text below summarises the ground conditions discussed within the Hyder interpretative report, 2006 (Ref.02).

6.2 Mottram Moor Link Road (Option 0 and 5)

6.2.1 Construction

The Mottram Moor Link Road options vary in shape and route. However, both involve the construction of Roe Cross Road, Cricketers Ground and Mottram Moor Roundabouts. The scheme also involves cuts and fills associated with construction of the Mottram Tunnel. Table 6 lists the structures involved with construction of Option 0 and Option 5.

Table 8: List of structures for Option 0 and Option 5

Structure	Location	Options
Oldmill Farm Underpass GA	Between M67 and Cricket Ground roundabout	0 &5
Minor Culvert No1 GA	Between M67 and Cricket Ground roundabout	0 &5
Mottram Tunnel	Beneath Mottram	0 &5
Lumb Stream Moor Culvert GA	North of Mottram moor roundabout	0 &5
Pedestrian Underpass GA	Immediately to north of Mottram moor roundabout	0 &5
Mottram Moor South Culvert GA	Immediately to the east of Mottram moor roundabout	0 &5
Carrhouse Farm Underpass	Halfway between Mottram moor roundabout and A57 roundabout	0
River Etherow Bridge GA	East end of scheme before A57 roundabout	0 &5

A review of the historic ground investigation data, between the M67 roundabout and East of Mottram Village has confirmed a variety of ground conditions. These include cohesive Glacial Deposits to a maximum depth of 35m bgl. When considering the foundation design for culverts, care and consideration must be given to the amount of settlement likely to occur within these deposits and this should be incorporated in the design.

A high groundwater table (artesian in places) has been observed in the bedrock aquifers in the eastern part of Mottram Village declining south towards the Mottram roundabout. During the construction of the tunnel, care must be taken for the following:

- Lowering of the groundwater level for the surrounding residents and any abstraction points, for impacts on the abstraction boreholes. It is a requirement by the EA for a hydrogeological impact appraisal for dewatering/groundwater abstractions to be carried out;
- The presence of a high water table reduces the effective stress of the soil and therefore affects the stability and deformation of the excavation for the tunnel;
- Any flow out of the ground into the cutting; and
- A shift in groundwater flow direction due to the tunnel walls, and retaining features in the cutting east of Mottram

6.2.2 Made Ground

6.2.2.1 Cohesive Made Ground

A plot of natural moisture content against depth has revealed that the moisture content decreases slightly with depth in the cohesive made ground material. No overall trend of plasticity against depth has been observed within the Cohesive Made Ground Material. The majority of the cohesive Made Ground deposits are classified as clay of low to intermediate plasticity.

The four unconsolidated undrained triaxial tests in samples of cohesive Made Ground recorded shear strengths (cu) between 13kN/m^2 and 32kN/m^2 classifying the material as very soft to soft. There is no apparent increase in strength with depth.

The SPT-N values recorded in Made Ground N values generally range from 2 to 40 with one N value of 89 also recorded. This anomalously high value corresponds to a layer of cobbles and boulders within a layer of Cohesive Made Ground. Results below 4.0mbgl all relate to BH205 located someway to the north of the scheme and therefore are not considered representative of the remainder of the results. SPT N values in the cohesive made ground indicate strengths of soft to very stiff. No increase with depth was observed. Such variability is commonly associated with Made Ground and is reflected in the Particle Size Distributions obtained. The undrained shear strength of the Cohesive Made Ground has been estimated from SPT N-values using an expression established by Stroud and Butler (Stroud, 1988) as follows:

$$cu = f1 \times N \ (kN/m^2)$$

For an average plasticity index of 14% a value of 6.5 is appropriate for f1. This gives typical undrained shear strengths between 26kN/m2 and 201kN/m2 (soft to very stiff). There is no obvious increase in undrained shear strength with depth.

The coefficient of volume compressibility has been estimated using the Stroud and Butler (1975) equation to give an estimated values for m_v ranging between 0.38m^2/MN to 0.05m^2/MN, which are of the same order as the oedometer results and show significant variability.

6.2.2.2 Granular Made Ground

The SPT N values within the Granular Made Ground classify it as very loose to medium dense and locally dense. No increase with depth was observed. Such variability is commonly associated with Made Ground and is reflected in the Particle Size Distributions obtained.

The Particle Size Distribution of samples of granular Made Ground indicate that, in terms of BS5930:1999, the Made Ground is a highly variable granular deposit with varying quantities of sand, gravel and cobbles. In terms of compaction requirements in accordance with Series 600 (Highways Agency, 2004), the majority of the Made Ground would classify as a Class 1, granular fill.

The compaction tests carried out on the granular Made Ground samples revealed that the results for optimum moisture contents (OMC) range from 10% to 13% and the maximum dry density ranging from 1.94Mg/m3 to 1.83 Mg/m3 respectively.

6.2.3 Organic and Peat deposits

The Organic Deposits consist mainly of soft organic clays and pears at isolated locations. The plots of moisture content against depth show a range between 33% and 62%. The Plasticity Index plot against depth below ground level show plots between 10 and 85. No overall trend with depth was observed. The results of plasticity testing were plotted on the Casagrande Chart and indicate low and intermediate plasticity clay and extremely high plasticity silt.

The unconsolidated undrained triaxial tests recorded shear strength values (cu) between 31kN/m^2 and 160kN/m^2, with a general increase in strength with depth. This was evident in a plot of undrained shear strength with depth.

One oedometer test was carried out on a sample of Organic Deposits to determine one dimensional consolidation parameters. An m_v of 0.95m2/MN was recorded at 1.2mbgl. This classifies the material as having high compressibility (Tomlinson, 2001). The coefficient of consolidation (cv), based on the laboratory result at 1.2mbgl, is 3.45m2/yr.

6.2.4 Alluvial Deposits

The Alluvial Deposits are only found in isolated locations and the amount of laboratory tests have been limited.

Two moisture contents of 16% and 20% were recorded with liquid limits of 22% and 25%. No apparent trend against depth is observed.

The unconsolidated undrained triaxial tests recorded shear strength values (cu) between 31kN/m^2 and 107kN/m^2 with no apparent relationship with depth was noted.

SPT N-values vary from 1 to 3 in the granular Alluvial Deposits, classifying them as very loose.

The results show a generally linear increase in m_v with depth, ranging from 0.08-0.09m^2/MN at 1.5-2.5mbgl, to 0.16m^2/MN at 6mbgl. The coefficient of consolidation (cv), based on the three laboratory test results gave results of 1.41m^2/yr, 10.11m^2/yr and 4.53m^2/yr. The results indicate that cohesive Alluvial Deposits are of low to medium compressibility (Tomlinson, 2001) for a clay which is normally consolidated.

6.2.5 Glacial Deposits

6.2.5.1 Cohesive Deposits

A plot of natural moisture content against depth suggests that the test results range from 5% to 53% and showed a slight decrease with depth. The majority of the results plot between 10% and 25% with an average of 17%. The Plasticity Index ranges between 5 and 35 with one anomalous result of 95. The majority of the results plot between 10% and 20% with an average PI of 16%. No overall trend with depth is observed. The results of the plasticity testing are plotted on Casagrande, indicating a low to intermediate plasticity clay with some results outside this range. One anomalous result indicates extremely high plasticity clay.

The Particle Size Distribution plot for the cohesive Glacial Deposits shows the variability within these material with a number of samples indicating granular characteristics. In terms of Series 600 (Highways Agency, 2004) the material will be Class 2, cohesive fill.

The unconsolidated undrained triaxial tests recorded shear strength values (c_u) generally between 30kN/m^2 and 150kN/m^2 (soft to very stiff) with a general increase with increasing depth.

The results of SPT tests in cohesive Glacial Deposits show the majority of the N-values to be in the range of 5 to 30. This gives typical undrained shear strengths between 32kN/m^2 and 195kN/m^2 (very soft to very stiff). There is some increase in undrained shear strength with depth based on these results derived from the SPTs.

Unconsolidated undrained triaxial tests with pore pressure measurements determined the effective stress parameters of the cohesive Glacial Deposits:

$$c' = 0kN/m^2 \qquad \varphi' = 30°$$

Ring shear test were carried out in order to determine to the residual effective stress:

$$c_R' = 0kN/m2 \qquad \varphi_R' = 22.5°$$

Oedometer tests were carried out to determine one dimensional consolidation parameters. The results show a general linear decrease in m_v with depth. The results range from between 0.1 m^2/MN and 0.3 m^2/MN (with one value of 0.5m^2/MN) just below ground level to 0.05m^2/MN below 12mbgl indicating a clay of medium compressibility to a depth of 12m and low compressibility below this depth. The range of values of between 0.1 m^2/MN to 0.3m^2/MN of medium compressibility is too high for typical over-consolidated glacial till (Tomlinson, 2001). Typical in-situ compressibility is likely to be about half the range obtained from laboratory testing. The coefficient of consolidation (c_v) ranged from 0.22m^2/yr to 17.77m^2/yr with one value of 26.84m2/yr. The average of the laboratory test results is 3.97m^2/yr or 4.28m^2/yr including the high result.

SPT N-values typically range from 5 to 40, giving m_v values in the range 0.3m^2/MN to 0.05m^2/MN, corresponding to a clay of medium to very low compressibility to a clay of low compressibility (Tomlinson, 2001).

Compaction tests were carried out on the cohesive samples, indicating that the clay may be too wet in places for achieving maximum compaction, unless the material is allowed to be dried out.

The California Bearing Ratio (CBR) for these samples generally ranged from 1% to 14.5%.

The pressuremeter tests carried out allowed for estimation of the Shear modulus, G, and therefore calculation of Young's Modulus values for cohesive Glacial Till. Young's Modulus values of 4.4MPa to 4.8MPa at 5m and of 28.6MPa to 31.2MPa at 25m were calculated. The E values can be used to estimate settlement at the surface associated with dewatering and excavation in the vicinity of the tunnel.

6.2.5.2 Glacial Laminated Clay

The results of plasticity Index against depth indicate results of between 11% and 35% with majority plotting between 12% and 22%. No trend was observed with depth. Note that the results are likely to correspond to a mixture of the soils in the laminae.

Majority of the plasticity results plotted on a Casagrande Chart indicate a low to intermediate plasticity clay. A limited number of results show high plasticity clay and one result plots as a high plasticity silt. No apparent trend against depth is observed. The majority of the results indicate a natural moisture content 2-5% higher than the plastic limit.

The unconsolidated undrained triaxial tests recorded shear strength values (c_u) between 8kN/m^2 and 122kN/m^2 (very soft to stiff), with a general increase with increasing depth.

The SPT N values for the Glacial Laminated Clay range from 12 to 32 classifying the material as firm to stiff.

The undrained shear strength value (c_u) of these material can be estimated from the SPT and for an average plasticity of 19% the undrained shear strength is between 72kN/m^2 and 192kN/m^2. These values suggest the clay is firm to very stiff which are stronger than the laboratory results were. There is a slight increase in undrained shear strength with depth.

Unconsolidated undrained triaxial tests with pore pressure measurements were carried out to determine the effective stress parameters of the Glacial Laminated Clays. The results are plotted on an s-t plot in Figure 6.8.1 (found in Ref.02). The resulting Angles of Shearing Resistance (ϕ') are plotted against plasticity index in Figure 6.11.1 (found in Ref.02). The following effective stress parameters were determined from the graph in Figure 6.8.1 (found in Ref.02):

$$c' = 0kN/m_2 \quad \phi' = 22°$$

It should be noted, however, that the friction angle for the glacial laminated clays ranged from about 21º to about 30º.

Figure 6.8.2 (found in Ref.02) shows the result of one ring shear test carried out on one sample of Glacial Laminated Clays. The following residual effective stress result has been determined from the graph:

$$c_R' = 0kN/m^2 \quad \phi_R' = 28°$$

It should be noted, however, that residual frictions angles for other samples could be significantly lower.

This single value is higher than those reported for the Cohesive Glacial Deposits from ring shear tests, however the sampletested is for a clay of low plasticity. Reference to CIRIA C504 (Trenter, 1999) indicates that these results show a good correlation with published data for the plasticity index value measured for the sample tested. The material variability should be considered during the detailed design stage. It may be appropriate to use different parameters for design depending on the location, plasticity index, the results of this investigation and published data (Trenter, 1988)

The oedometer tests carried out samples of Glacial Laminated Clay resulted in m_v values of 0.18m^2/MN and 23m^2/MN at 10-11m bgl. These indicate the Laminated Clay to be of medium compressibility (Tomlinson, 2001). It must be noted that these values are considered high for over-consolidated clay suggesting samples were disturbed prior to testing. The coefficient of consolidation (c_v), based on the laboratory test results ranged from 2.72m^2/yr to 4.76 m^2/yr.

The SPT-N values of between 12 to 32 give m_v values in the range of 0.12m^2/MN to 0.05m^2/MN suggesting medium to low compressibility (Tomlinson,2001), indicating that the laminated clay might be less compressible in situ.

6.2.5.3 Granular deposits

The plot of natural moisture content against depth shows results ranging from 5.5% to 23% and a slight decrease in moisture content with depth.

The Particle Size Distribution plots suggest the deposits are highly variable but generally non-cohesive. However, based on Series 600 (Highways Agency, 2004) the majority of the granular glacial deposits have greater than 15% passing the 63µm sieve and are therefore classified as Class 2 (cohesive) for compaction purposes.

The SPT-N values recorded vary from 6 to 86 and are generally greater than 10, although the majority of the material can be classified as medium dense to dense.

The compaction test results of maximum dry density versus optimum moisture content indicate optimum moisture content of 12% and a maximum dry density of 1.96Mg/m^3.

Laboratory CBRs suggest a value of 2.2% which is lower than expected from granular soils and it may reflect a high clay content.

6.2.6 Sandstone

Weathered Sandstone

A plot of natural moisture content against depth in the weathered sandstone, in areas weathered to a sandy clay within the top 2.5m to 5.0m, range from 5% to 35% with an average of 8.5%. The results showed a slight decrease of moisture content with depth.

The Casagrande chart for weathered Sandstone indicate low to intermediate plasticity clays with one result of high plasticity clay. Note that the Atterberg limits are only representative of the portion of the soil finer that 0.425mm.

The results from the Particle Size Distribution plots suggest the samples are highly variable. For compaction purposes, approximately half the results classify as Class 1, granular fill with regards to Series 600 (Highways Agency, 2004) with the remainder as Class 2, cohesive fill.

The undrained shear strength against depth in the weathered sandstone within the top 2.5m range from 18kN/m^2 to 56kN/m^2 (very soft to firm).

The SPT N values in the weathered sandstones range from 15 to 125. There is no clear trend of increasing SPT values with depth.

Compaction tests carried out on samples of weathered sandstone show optimum moisture contents ranging from 12% to 23% and the maximum dry density ranging from 1.94Mg/m^3 to 1.65 Mg/m^3 respectively.

Laboratory CBRs results of 2-3% were recorded at less than 1m depth and results of 11-12% at 1.5-2.5m depth were recorded.

Unweathered Sandstone

The uniaxial (unconfined) compressive strength (UCS) tests resulted in a range from 14.4 to 129.8 MPa (moderately strong to strong) with an average of 60.1 MPa (strong).

The results of axial point load tests carried out on core samples of Sandstone show a slight increase with depth although there is considerable scatter. The axial Is_{50} results range from 0.03 to 9.06MPa with an average value of 2.7MPa. A summary of UCS estimated from point load indices, using a factor of 23, is shown below:

Equivalent UCS (MPa)		
Ave	Min	Max
61	0.68	203.

The Fracture spacings of the Sandstone were recorded during logging. The Rock Quality Designation (RQD) values are consistent with a typical value for Fracture Spacing ranging from 20mm to 250mm (very close to medium spaced) and locally greater than 600mm (widely spaced). The division between competent and non-competent rock head for excavation and foundation purposes is made in terms of Fracture Spacing and intact rock strength, and is shown in Table 3.

Table 9: Definition of competent Rock

Rock strength	Fracture Spacing			
	<Very Close (<20-60mm)	Close (60-200mm)	Medium (200-600mm)	>wide (>600mm)
Very weak (<1.25 MPa)	Non-competent	Non-competent	Non-competent	Non-competent
Weak (1.25-5.0 MPa)	Non-competent	Non-competent	Competent	Competent
Moderately weak (5.0-12.5 MP)	Non-competent	Competent	Competent	Competent
>moderately strong (>12.5MPa)	Non-competent	Competent	Competent	Competent

Where the sandstone is slightly weathered the fractures are typically medium to widely spaced, with slight iron staining. The sub-vertical discontinuities, which dip at 70° to 90°, are typically planar, rough and open with occasional iron staining.

The results obtained from a plot of Is50 vs. discontinuity spacing indicate that blasting, non-explosive rock breaking or hydraulic breaking are unlikely to be required as a general excavation methods, although they may be required locally if particularly massive or strong rock is encountered.

6.2.7 Siltstone

Weathered Siltstone

A plot of natural moisture content against depth in the weathered siltstone results in a range from 9% to 36% with an average of 15% but did not show a clear change with depth.

A plot of Plasticity Index against depth for the weathered siltstone shows results between 6 and 27 but do not show a strong relationship with depth. The Casagrande chart for the weathered siltstone indicates the weathered siltstone deposits to be generally low plasticity clays. These plots show no trend with depth.

The undrained shear strength against depth for the weathered siltstone ranges from 33kN/m^2 to 91kN/m^2 to a depth of 2.2m with one result of 151kN/m^2 at 9mbgl. The results show an increase in strength with depth.

The SPT results against depth below ground level range from 16 to 139 but show no apparent increase with depth.

The particle size distribution results on samples of the weathered siltstone suggest the deposits are cohesive in terms of BS5930:1999. For reusability in accordance with Series 600 (Highways Agency, 2004) the material plots almost entirely as Class 2 (cohesive).

Unweathered Siltstone

The UCS testing resulted in a range from 4.1MPa (weak) to 86.8MPa (strong) with an average value of 40.6MPa (moderately strong).

The results of axial point load tests carried out on core samples of Siltstone show a slight increase with depth although there is considerable scatter. The axial Is_{50} results range from 0.01 to 6.8 MPa with an average value of 1.45 MPa. A summary of UCS estimated from point load indices, using a factor of 28, is shown below:

Equivalent UCS (MPa)		
Ave	Min	Max
40	2.8	190

The Fracture spacings of Siltstone were recorded during logging. The Rock Quality Designation (RQD) values are consistent with a typical value for Fracture Spacing ranging from 20mm to 250mm (very close to medium spaced) and locally greater than 400mm (widely spaced).

Most of the Discontinuity Spacing results for the Siltstone fall in to the hard digging, easy or difficult ripping fields. The results indicate that blasting or hydraulic breaking are unlikely to be required as a general excavation methods, although they may be required locally if particularly massive or strong rock is encountered.

6.2.8 Mudstone

Weathered Mudstone

A plot of natural moisture content against depth in the weathered mudstones shows a range from 7% to 38% but did not show a relationship with depth.

A plot of Plasticity Index against depth for the Mudstone results show a range of 6 to 23 with a slight increase with depth. The Casagrande Plot for the weathered mudstone indicates the majority of results to be low to intermediate plasticity clay. The results do not show any obvious relationship with depth.

The undrained shear strength data for samples of the weathered mudstone range from 23kN/m^2 to 219kN/m^2 (soft to very stiff).

The SPT N results against depth below ground level range from 34 to 136.

Compaction tests carried out on samples of the weathered mudstone suggest that optimum moisture content range is 16% to 22% and the maximum dry density range is 1.83Mg/m^3 to 1.66 Mg/m^3.

Laboratory California Bearing Ratio (CBR) tests carried out on the weathered mudstone resulted in values of 0.8% and 5%.

Unweathered Mudstone

The uniaxial (unconfined) compressive strength (UCS) tests resulted in a range from 13.1 MPa (moderately strong) to 74.3 MPa (strong) with an average value of 30.6MPa (moderately strong).

The results of axial point load tests carried out on core samples of Mudstone show a slight increase with depth although there is considerable scatter. The axial Is_{50} results range from 0.02 MPa (very weak) to 7.2 MPa (moderately weak) with an average value of 1.49 MPa (weak). Summary of UCS estimated from point load indices, using a factor of 20.5, is shown below:

Equivalent UCS (MPa)		
Ave	Min	Max
30.	0.41	147.

The Fracture spacing of Mudstone were recorded during logging. The Rock Quality Designation (RQD) values are consistent with a typical value for Fracture Spacing ranging from 20mm to 250mm (very close to medium spaced) and locally greater than 500mm (widely spaced).

A number of the boreholes in the vicinity of the proposed Cut-and- Cover Tunnel in Mottram encountered very closely spaced fractures, described as planar, smooth, highly polished and locally slickensided with some clay infill, related to movement in the fault zone within the Mudstone.

The sub-vertical fractures in this area are typically planar, rough, open and frequently polished.

The discontinuities at shallow angles are typically closely to medium spaced, although very closely spaced fractures are present at some locations. The fracture surfaces are typically planar, rough and open with some clay infill and iron staining. In the vicinity of the Mottram fault the fracture surfaces are locally smooth.

The steeply dipping joints are typically widely spaced, planar, rough and open with iron-staining and occasional clay infill.

Bedding planes have an average dip of 27°.

Most of the results from the Discontinuity Spacing for the mudstone fall in to the hard digging or easy ripping fields, with some falling into the difficult ripping field. The results indicate that blasting or hydraulic breaking are unlikely to be required as a general excavation methods, although they may be required locally if particularly massive or strong rock is encountered.

6.2.9 Kinderscout Grit

Weathered Kinderscout Grit

The plot of natural moisture content with depth below ground level shows a range of results from 6% to 25% and a slight decrease of moisture content with depth.

A plot of Plasticity Index against depth for the weathered Kinderscout Grit resulted in values between 7 and 35 but did not appear to show a relationship with depth. The Casagrande chart for samples of weathered Kinderscout Grit indicate low plasticity clay and one of high plasticity clay.

The particle size distribution results on samples of the weathered Kinderscout Grit show cohesive properties where the Kinderscout Grit has weathered to a clay. In terms of the classification and compaction requirements in accordance with Series 600 (Highways Agency, 2004), approximately half the samples tested classify as Class 1 and the other half as Class 2. Further testing during the works will be required to confirm this pattern.

The SPT results against depth below ground level are show a range from 13 to 120.

The Compaction tests carried out samples of the weathered Kinderscout Grit show an optimum moisture content range from 14% to 24% and a maximum dry density range from 1.88Mg/m^3 to 1.58 Mg/m^3.

The CBR tests carried our resulted in values of 2.2-3%. These low results probably reflect the clayey nature of weathered Kinderscout Grit.

Unweathered Kinderscout Grit

The results the UCS tests carried out on samples of the Kinderscout Grit range from 38.6MPa (moderately strong) to 84.2MPa (strong) with an average value of 61.3MPa (strong).

The results of axial point load tests carried out on core samples of Kinderscout Grit show a slight increase with depth although there is considerable scatter. The axial Is_{50} results range from 0.27 MPa to 5.9 MPa with an average value of 2.59 MPa (weak). Summary of UCS estimated from point load indices, using a factor of 23.7, is shown below:

Equivalent UCS (MPa)		
Ave	Min	Max
61.	6.4	139.

The Fracture spacings of the Kinderscout Grit were recorded during loggingThe Rock Quality Designation (RQD) values are consistent with a typical value for Fracture Spacing ranging from 20mm to 250mm (very close to medium spaced) and locally greater than 600mm (widely spaced).

Much of the Kinderscout Grit outcropping near the surface beneath the eastern sections of the route has very closely or closely spaced sub-horizontal fractures.

The sub-vertical fractures (70° to 90°) were typically more widely spaced to moderately widely spaced.

The discontinuity survey done by Mott McDonald, 2005, in local quarries indicates more massive rock than the borehole data. The mean discontinuity spacing based on 12 scanlines is 1.04m, compared to 0.20m for the borehole data, with a range of 0.4m to 3.8m. This difference in Fracture Spacing probably represents a real difference in ground conditions i.e. it is not simply a function of sample disturbance during core drilling, as the quarries would have been opened in locations where suitable material was available close to the surface on steeply sloping ground. A similar decrease in Fracture Spacing and improvement in rock quality is seen in the deeper sections of Boreholes BH121-1, BH132, BH134 and BH104.

The bedding plane orientation shows an average dip of 15°.

The sub-horizontal fracture surfaces in the Kinderscout Grit are typically described as planar, rough and open with iron staining. Locally the discontinuity surfaces are smooth and contained clay infill.

The sub-vertical fractures are often described as planar, rough and open.

Most of the results from the Discontinuity Spacing analysis for the Kinderscout Grit fall in to the ‘easy’ or ‘difficult’ ripping fields, with some falling into the ‘hard digging’ field. The results indicate that blasting or hydraulic breaking are unlikely to be required as a general excavation methods, although they may be required locally if particularly massive or strong rock is encountered. A visual inspection of the quarries indicates the rock to be blocky with numerous voids between them. There is no sign of previous blasting. It is understood that when the quarries were in operation, the rock was pulled out in blocks.

6.2.10 Local Coal Measures

No geotechnical information other than the borehole log descriptions is available on these possible LCM rocks, and the only significance of this alternative interpretation of the geology lies in the possible presence of old coal workings at depth. However, as concluded in the Hyder, 2006 report section 5.5.4, the risk of coal workings being present beneath the route is considered to be low.

6.3 A628 (T) Climbing Lanes

6.3.1 Construction

Both proposed locations of the climbing lanes will be constructed by cutting into the adjacent ground on the northern side and/or extending over the southern side to provide a wide single carriageway cross section (WS2) as described in TD27/05. The A628 widening scheme involves the following works:

- Earthworks consisting of an embankment on the westbound carriageway and/or a cutting on the eastbound carriageway.

- Temporary and permanent rock bolts that would be drilled into cut slopes along the westbound carriageway to provide short term stability for construction and long-term stability for cutting options. Alternatively, retaining structures may be used.
- Permanent rock bolts or ground anchors will be installed to stabilize existing slopes and then extended to support new retaining structure for the embankment extension option. Alternatively, retaining structures may be used.

6.3.1.1 Westbound Embankment

Rock bolts or ground anchors would be installed through the west bound embankment, providing stability for the road widening. The rock bolt rods could either be the full length to tie into the facing, or couplers could be added later to extend the rods. A facing or retaining wall would then be constructed and tied into the rock bolts. Suitable fill material would then be used to extend the embankment outwards.

This option is less easy to construct, especially the retaining wall. A platform would also be needed at the base of the retaining wall for maintenance checks. However, this impact would have the least visual impact on the Pennine route for road users although the impact would be similar for other persons in the vicinity

6.3.1.2 Eastbound Cutting

Steel reinforcing elements would be drilled and grouted into the existing cutting providing temporary stability for the next stage. The element would be terminated at the proposed cut line leaving the shallow rock unreinforced. The rock would be cut back to provide the required width, where a concrete face could be installed, if required. Permanent rock bolts could be installed, if needed through the concrete facing, providing long term stability. A catch fence would be installed at the top of the concrete facing to reduce the risk of animals, rock and any other debris falling on to the road.

This option is the easier of the two to construct, but has a big impact, due the increased height of the cut face, on the visual appearance of the Pennine route for road users.

6.3.2 Material Properties

The following sections are extracts from the GIR produced by WSP in December 2010, available online at HA GDMS No: 24320 (Ref.03). The GIR relates to areas between marker posts 8/8 and 8/9. This area is located between Location 1 and Location 2 of the A628 (T).

6.3.2.1 Colluvium

Colluvium was encountered from ground level to depths varying between 1.3m (TP1) and 1.5m (TP3). This material was observed to be predominantly granular in nature and was characterised as gravelly clayey sand and clayey sandy gravel with occasional cobbles of siltstone in TP2 and TP3.

In TP1, the Colluvium was cohesive in nature and was described as gravelly very sandy clay with occasional cobbles of shale.

Suggested material properties, presented in the WSP report (Ref.03) for the Weathered Kinderscout Grit and Colluvium are summarised in Table 10 below. Both materials have been summarised in one table under the name of Colluvium, despite one being transported and the other being residual

Table 10: Material Properties for Colluvium

Location	Moisture Content (%)	Bulk Unit Weight (kN/m3)	Peak Effective Angle of Shearing Resistance (Ø'p)	Drained Cohesion (c') (kN/m2)
TP1	13 to 19*	18.9	31*	7
TP2 & TP3	13 to 18*	13-18*	37-44*	3-4*

***(*)** Values from shear box test*

The peak and residual parameters quoted in Table 6.1 of the WSP report (Ref.03) are considered likely to be an overestimation of the shear strength governing slope failure. As a result, constant volume parameters are considered more appropriate to represent the shear strength of the materials. The constant volume parameters have been calculated from the plots of shear stress versus horizontal displacement presented in Appendix C (found in Ref.03). These are summarised as Figures 5 and 6 (found in Ref.03) and, based on this assessment, proposed parameters are summarised in Table 11.

Table 11: Design Parameters for Colluvium

Location	Soil Type	Parameter	Design Value	Justification
TP1	Clay	Constant Volume Effective Angle of Shearing Resistance (Ø'cv)	24^{o}	Figure 5 (Found in Ref.03)
		Effective Cohesion (c')	14 kN/m^2 (use 0 kN/m^2)	Assumed value for conservative design
TP2 & TP3	Sand or Gravel	Constant Volume Effective Angle of Shearing Resistance (Ø'cv)	37^{o}	Figure 6 (Found in Ref.03)

Location	Soil Type	Parameter	Design Value	Justification
		Effective Cohesion (c')	4 kN/m^2 (use 0 kN/m^2)	Granular material

6.3.2.2 Kinderscout Grit

Kinderscout Grit bedrock was encountered beneath the weathered Kinderscout Grit / colluvium to a maximum depth of 1.6m bgl in TP03 and was recovered as a very weak brown stained orange angular tabular gravel of siltstone.

No testing was undertaken on this material. Suggested material properties for the Kinderscout Grit are summarised in Table 12.These should be revised when ground information becomes available.

Table 12: Material Properties for Kinderscout Grit

Bulk Unit Weight (kN/m3)	Unconfined Compressive Strength (UCS) (MPa)	Cohesion (kN/m2)	Peak Effective Angle of Shearing Resistance (Ø'p)
22	1.25 – 5.00	125 - 500	35

Please refer to Original GIR pg.9 (Ref.03) for value references.

6.3.2.3 Groundwater/Chemistry

Groundwater was not encountered in any of the exploratory holes.

6.4 A61 Dualling (no longer part of the scheme)

The proposed widening will stay within the existing embankment of the A61. However the design may require gantries, and three known existing structures (two retaining walls and a bridge) may be affected by the road widening.

6.4.1 Material Properties

The following sections are extracts from the GIR produced by WSP in November 2014, available online at HA GDMS No: 28134 (Ref.04). The GIR relates to the Westwood Roundabout (A61/A616 roundabout), at the southern end of the alignment. The values presented should be reviewed in conjunction with any further ground investigation related to the scheme.

6.4.1.1 Cohesive Made Ground

Parameter	No. of Tests	Range	Characteristic Value	Source of Value
Undrained Shear Strength (kPa)	64 SPTs	25 - 374	75	SPT testing
Effective Angle of Friction ø (°)	3 triaxials 68 PIs	23– 31 24 – 30	28	Triaxial and PI testing
Young's Modulus (MPa)	64 SPTs	4 – 66	20	SPT testing
Coefficient of Compressibility (m^2/MN)	64 SPTs	0.03 – 0.36	0.20	SPT testing
Maximum Dry Density (Mg/m^3)	4	1.47 – 1.89	1.75	Laboratory testing
CBR Value (%)	4 lab tests 8 Mexe cone	3 – 27.6 0 – 13.5	2.5	In accordance with published data
pH	27	4.9 – 8.3	Up to sulphate class DS-2 AC-3z	-
Water Soluble Sulphate (mg/l)	27	4.5 – 1500		

Table 6-2 in GIR (Ref.04)

6.4.1.2 Granular Made Ground

Parameter	No. of Tests	Range	Characteristic Value	Source of Value
Young's Modulus (MPa)	10 SPTs	13 – 74	40	SPT testing
Effective Angle of Friction ø (º)	10 SPTs	30 – 40	31	SPT testing
Maximum Dry Density (Mg/m³)	3	1.50 – 1.98	1.70	Laboratory testing
CBR Value (%)	1	1.1 – 1.2	N/A	-
pH	3	7.6 – 9.0	Sulphate class DS-1 and ACEC class AC-1	-
Water Soluble Sulphate (mg/l)	3	25 – 160		

Table 6-3 in GIR (Ref.04)

6.4.1.3 Residual Soil

Parameter	No. of Tests	Range	Characteristic Value	Source of Value
Undrained Shear Strength (kPa)	6 SPTs	250 (220 – 367)	200	SPT testing
Effective Angle of Friction ø (o)	7 PIs	27 (23– 30)	27	PI testing and published parameters
Young's Modulus (MPa)	6 SPTs	60 (40 – 66)	50	SPT testing
Coefficient of Compressibility (m2/MN)	6 SPTs	0.04 (0.04 – 0.06)	0.04	SPT testing

Table 6-5 in GIR (Ref.04)

6.4.1.4 Lower Coal Measures

Parameter	No. of Tests	Range	Characteristic Value	Source of Value
Young's Modulus (MPa)	6 SPTs	147+	50	SPT testing
UCS (MPa)	16 point load (axial)	0.3 – 98.	3	Point load testing
	13 point load (diametral)	0.8 – 37.		
	5 point load (irregular)	5.3 – 18.		

Table 6-6 in GIR (Ref.04)

6.4.1.5 Groundwater

Given the variations in groundwater strikes across the site, and the ground conditions encountered, it is considered that no correlation can be drawn between exploratory holes. Minimal long term groundwater monitoring has been conducted following the ground investigation.

The groundwater monitoring conducted indicates that the installations were generally dry, or contained less than a 0.40m deep column of water. This indicates that the groundwater encountered is unlikely to be connected and no regional groundwater table is considered to have been encountered. Shallow groundwater, although limited, has been recorded and as such should be considered within the geotechnical design.

6.4.2 Mining

The site is underlain by a number of mining shafts. Two are located near Church Lane, whilst the rest are located towards the south, around the A61/A616 roundabout.

The mine entries identified near the A61/A616 roundabout are outside the area of the proposed works. The two located near Church Lane will require further investigation. It is possible that these mine shafts have been remediated for the construction of the A61. However, as no record is available it would not be advisable to proceed with the proposed development until a further investigation has been carried out.

Prior to the mobilisation of a ground investigation, a more detailed Coal Authority assessment should be carried out. This would identify the remediation, if any, of the mine shafts. If a further assessment does not resolve the state of the mine shafts, a targeted ground investigation will be required to identify the condition of the mine shafts. If shallow mine workings are encountered, there will be a need for treatment such as grouting to remove the risks of ground surface subsidence.

7 References

01) The Highways Agency, HD 22/08, Volume 4, Section 1, Part 2, Design Manual for Roads and Bridges, Managing Geotechnical Risk, August 2008

02) A57/A628 Mottram Tintwistle Bypass and A628/A616 Route Restraint Measures, Geotechnical Report, Hyder Consulting, 0298-NH50845-NHR-02-F, March 2006

03) A628 East Bound, Salters Brook Cutting Slope Defect, Ground Investigation Report, (HA GDMS No.24320), WSP, December 2010

04) A61 Westwood Roundabout Improvements, Ground Investigation Report, (HA GDMS No.28134), WSP, November 2014 2010

05) British Geological Survey, 1:50,000 Sheet 86 Glossop, Bedrock and Superficial, 2012

06) British Geological Survey, 1:50,000 Sheet 87 Barnsley, Bedrock and Superficial, 2008

07) British Geological Survey, Online Geo-Index, http://www.bgs.ac.uk/geoindex/

08) Landmark Ltd, Envirocheck Report numbers 91252758, 91272068, 91273428, 91988362, 91988447 (Trans Pennine GIS Data), August 2016

09) Environment Agency. (2016). What's in my backyard? Last accessed 31/08/2016. (http://maps.environmentagency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e)

10) Environment Agency. (2016) Flood Map for Planning (Rivers and Sea)

(http://maps.environmentagency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=floodmap)

11) Coal Authority "Interactive Map" (http://mapapps2.bgs.ac.uk/coalauthority/home.html)

12) BGS "Mining Plans Portal" website (http://www.bgs.ac.uk/nocomico/)

13) Google Earth Pro, Last accessed 31/08/206. Version 7.1.5.1557

14) A628 Long Side Preventive Works, Scheme ID: 4510 & 4551, Value Management Report ,Version 1, Aone+, February 2015

15) Zetica UXO Risk Map (http://www.zetica.com/uxb_downloads.htm)

16) Highways England, HA GDMS, Geotechnical Data Management System v5.12.0 (http://www.hagdms.com/)

DRAWINGS

HE551473-ARC-GEN-ZZZ-DR-D-2001.

HE551473-ARC-HGN-ZZZ-DR-D-2025

HE551473-ARC-HGN-ZZZ-DR-D-2026

HE551473-ARC-HGN-ZZZ-DR-D-2027

HE551473-ARC-HGN-ZZZ-DR-D-2028

HE551473-ARC-HGN-ZZZ-DR-D-2029

HE551473-ARC-HGN-ZZZ-DR-D-2030

HE551473-ARC-HGN-ZZZ-DR-D-2031

HE551473-ARC-HGN-ZZZ-DR-D-2032

HE551473-ARC-HGN-ZZZ-DR-D-2033

HE551473-ARC-HML-A61-DR-D-2001

HE551473-ARC-HML-A61-DR-D-2002

HE551473-ARC-HML-A61-DR-D-2003

HE551473-ARC-HML-A61-DR-D-2004

HE551473-ARC-HML-A61-DR-D-2005

HE551473-ARC-HML-A61-DR-D-2006

NH50845-1405-01

Rev	Date	Description	Drawn	Check	Approv
0.1	04JUL16	INFORMATION PURPOSES	NC	CBM	NW

NOTES:

KEY:

Extents of safety and technology measures

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Client

highways england

HIGHWAYS ENGLAND

Client

Highways England
Piccadilly Gate
Store Street
[redacted]

Site

A57/A628 Trans-Pennine

Suitability Description:

PRELIMINARY DESIGN

NOT FOR CONSTRUCTION

		Date	Signed
Designed	C. BURGHAM-MALIN	04JUL16	
Drawn	N. CLEMENTS	04JUL16	
Checked	C. BURGHAM-MALIN	04JUL16	
Approved	N. WESTWOOD	04JUL16	
Scale:	1:50000 @ A1	Datum:	AOD
Original Size:	A1	Grid:	OS
Suitability Code:	Sx	Project Number:	UA008848

PROJECT:

A57/A628
TRANS-PENNINE
UPGRADE PROGRAMME

TITLE:

LOCATION PLAN

ARCADIS Design & Consultancy for natural and built assets

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London
SW1P 1JA

Coordinating office:
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Birchwood,
[redacted]

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Drawing Number: HE551473-ARC-GEN-ZZZ-DR-D-2001

Revision: 0.1

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Print Date: 2016-07-08 09:51:49

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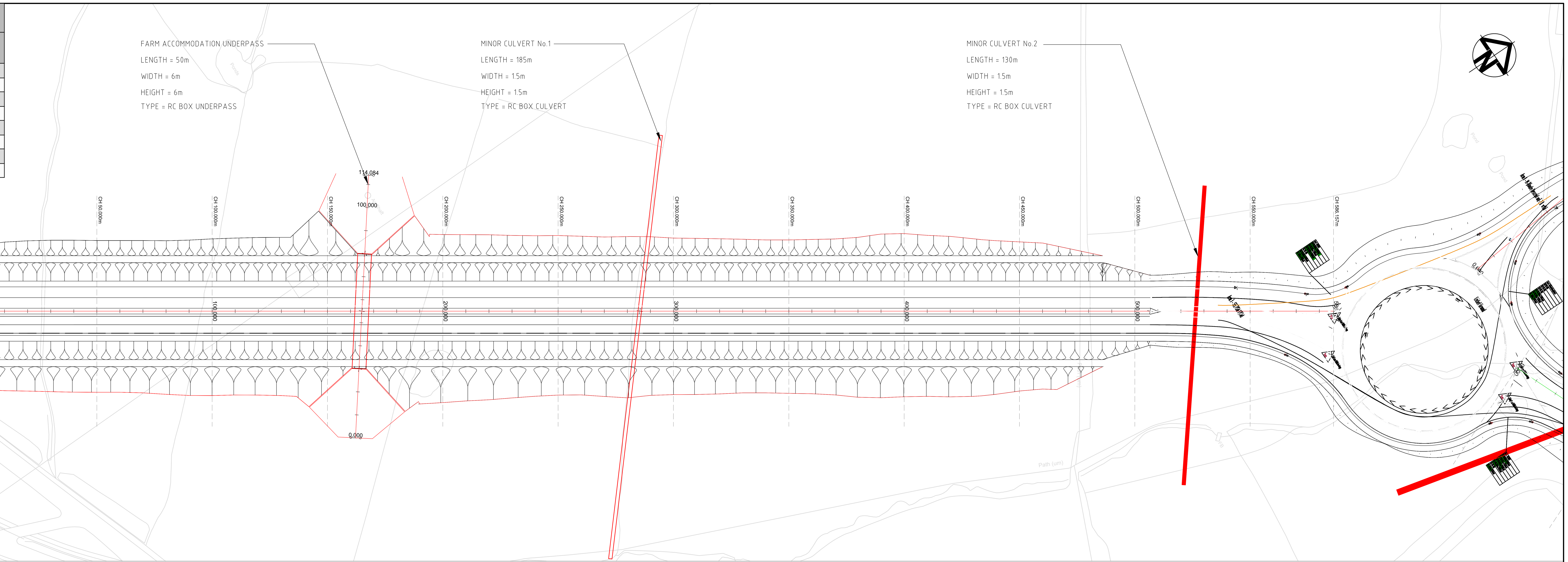
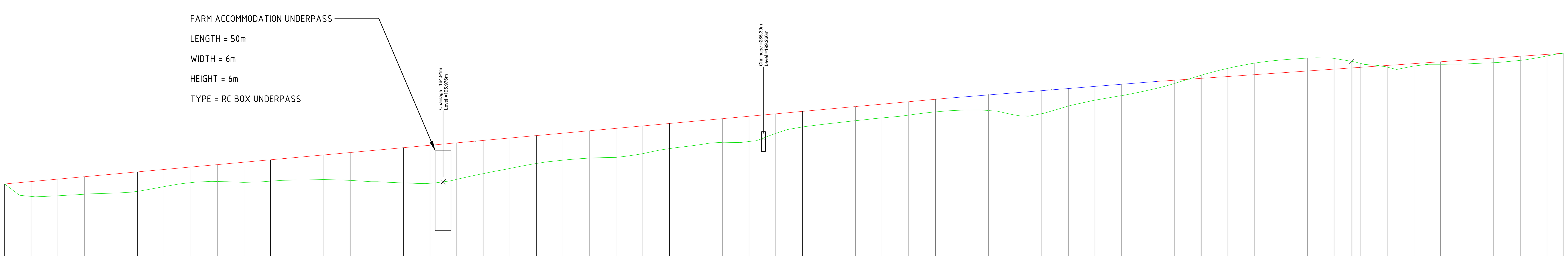
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following significant residual risks (Reference shall also be made to the design hazard log).

Construction	(Enter 'None' if applicable)
Maintenance/Cleaning	(Enter 'None' if applicable)
Use	(Enter 'None' if applicable)
Decommissioning/Demolition	(Enter 'None' if applicable)





Datum: 190.00 mAOD

Chainage	Existing Levels	Proposed Levels	Level Difference
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20.000	194.934	196.179	1.244
30.000	195.048	196.360	1.313
40.000	195.123	196.542	1.419
50.000	195.268	196.724	1.456
60.000	195.621	196.906	1.285
70.000	195.916	197.088	1.172
80.000	196.004	197.270	1.267
90.000	195.941	197.452	1.511
100.000	196.029	197.634	1.605
110.000	196.115	197.816	1.701
120.000	196.147	197.998	1.851
130.000	196.083	198.180	2.097
140.000	195.985	198.362	2.377
150.000	195.897	198.544	2.646
160.000	195.870	198.726	2.855
170.000	196.162	198.908	2.746
180.000	196.595	199.090	2.495
190.000	196.985	199.272	2.287
200.000	197.357	199.454	2.096
210.000	197.607	199.635	2.028
220.000	197.761	199.817	2.056
230.000	[illegible]	[illegible]	[illegible]
240.000	[illegible]	[illegible]	[illegible]
250.000	[illegible]	[illegible]	[illegible]
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380.000	[illegible]	[illegible]	[illegible]
390.000	201.102	202.875	1.773
400.000	201.670	203.034	1.365
410.000	202.113	203.188	1.075
420.000	202.457	203.337	0.880
430.000	202.857	203.480	0.623
440.000	203.371	203.618	0.248
450.000	203.987	203.757	-0.230
460.000	204.503	203.895	-0.607
470.000	204.899	204.034	-0.865
480.000	205.134	204.172	-0.962
490.000	205.278	204.310	-0.968
500.000	205.252	204.449	-0.803
510.000	204.875	204.587	-0.288
520.000	204.593	204.726	0.133
530.000	204.679	204.864	0.185
540.000	204.807	205.002	0.195
550.000	204.842	205.141	0.299
560.000	204.930	205.279	0.349
570.000	205.102	205.417	0.316
580.000	205.438	205.556	0.117
586.157	205.641	205.641	0.000

Horizontal Geometry

Vertical Geometry: G =1.819% L =354.038; R =18200.000 K =182.000 L =79.291; G =1.384% L =152.829

Superelevation

SECTION 1 LONGITUDINAL SECTION
SCALE: H 1:500,V 1:100. DATUM: 190.000

Rev	Date	Description	Drawn	Check	Approv
0.1	02AUG16	INFORMATION PURPOSES	NC	CBM	NW

NOTES:

Client

highways england

HIGHWAYS ENGLAND

Client

Highways England
Piccadilly Gate
Store Street
Manchester, M1 2WD

[redacted]

Site

A57/A628 Trans-Pennine

Suitability Description:
PRELIMINARY DESIGN
NOT FOR CONSTRUCTION

Designed	C. BURGHAM-MALIN	Date 02AUG16	Signed
Drawn	N. CLEMENTS	Date 02AUG16	Signed
Checked	C. BURGHAM-MALIN	Date 02AUG16	Signed
Approved	N. WESTWOOD	Date 02AUG16	Signed
Scale:	1:1000 @ A1	Datum:	AOD
Original Size:	A1	Grid:	OS
Suitability Code:	S0	Project Number:	UA008848

PROJECT:

A57/A628
TRANS-PENNINE
UPGRADE PROGRAMME

TITLE:

OPTION 0 - SECTION 1
PLAN & PROFILE

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Revision: 0.1

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