A1 Birtley to Coal House

Scheme Number: TR010031

Applicant's Responses to ExA's Second Written Questions - Appendix 2.0E - Structure Options Report 11 - PCF Stage 3 - Allerdene Viaduct

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Applicant's Response to ExA's Second Written Questions - Appendix 2.0E - Structure Options Report 11 - PCF Stage 3 - Allerdene Viaduct

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PCF Stage 3 – Allerdene Viaduct

Structure Option Report No.11

March 2019

A1 BIRTLEY TO COAL HOUSE SCHEME

PCF STAGE 3 (PRELIMINARY DESIGN)

ALLERDENE VIADUCT
STRUCTURE OPTION REPORT NO.11

Highways England

Date: March 2019

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APPENDICES

EXECUTIVE SUMMARY

WSP has been appointed as the design consultant by Highways England for Project Control Framework (PCF) Stage 3 (Preliminary Design) of the A1 Birtley to Coal House scheme.

Previous works established that the existing Allerdene bridge should be replaced with a new off-line structure. Preliminary analysis demonstrated that a single span (over the East Coast Main Line) 62m steel composite integral bridge would provide a robust cost-effective bridge solution with significant long-term maintenance benefits.

However, further analysis based on the ground investigation has identified potential risks associated with the single span bridge option due to the earthwork embankment settlement on the approach to the bridge requiring considerable ground improvement works. Therefore, an alternative viaduct option has been developed that best mitigates the major risk associated with ALL the following:

- Reduce the impact of the approach earthwork embankment settlement during both construction and in service as much as reasonably practicable
- Reduce the impact of the new bridge construction over the railway, potential movement of the ECML due to heave
- Simplify/Eliminate the proposed NGN protection works
- Simplify/Eliminate the work to accommodate the existing Allerdene culvert

Works to date indicates that a 6No. span steel composite viaduct (290m long) would provide a robust solution to mitigate the above.

It is anticipated the preferred option (single span bridge and extended embankments vs viaduct with limiting embankments) to be taken forward will be heavily influenced by the following:

- The HE Project Team confirmation on which parameters are of greater importance and therefore should be weighted accordingly.
- The delivery partners experience and knowledge of ground improvement works (rigid inclusions) and their confidence on whether they can manage the settlement risk to within acceptable limits during construction.
- Confirmation from the HE OD team on the limits of residual settlement considered acceptable after construction.
- The delivery partners experience and knowledge of treating (grouting) or mitigating the risk from deep historical mine workings beneath the piers/abutments.

The main compromises would be regarding the long-term maintenance liabilities associated with the bigger viaduct structure, and the management of the settlement and mining risk.

To retain flexibility for the detailed design stage, a multi span viaduct should be considered as an alternative solution to the single span integral bridge and extended embankment solution. Based on the studies to date, it is recommended the following should be undertaken to further validate the findings of this report.

- Formal AIP submission for the Steel Composite Viaduct Option to NWR – This is to ensure NWR provide written agreement in principle to the development of the viaduct proposal should this be the preferred option.
- Supplementary ground investigation at each proposed pier location.

1. INTRODUCTION

1.1 DOCUMENT PURPOSE

WSP has been appointed as the design consultant by Highways England for Project Control Framework (PCF) Stage 3 (Preliminary Design) of the A1 Birtley to Coal House scheme.

This Structure Option Report has been prepared to assess the constraints/challenges associated with the replacement of the existing Allerdene Railway Bridge with a new off line multi span viaduct structure.

1.2 DOCUMENT SCOPE AND VERSIONS

This is the P02 issue of the Allerdene Viaduct Structure Option Report, issued during PCF Stage 3 (Preliminary Design) of the A1 Birtley to Coal House scheme.

2. PROJECT BACKGROUND

2.1 DESCRIPTION OF THE PROJECT

WSP has been commissioned by Highways England to develop the preliminary design for the A1 Birtley to Coal House scheme.

The scheme forms part of the Newcastle Gateshead Western Bypass (NGWB) which is located on the A1 between J65 (Birtley) and J80 (Seaton Burn). It is a part of Highways England's strategic road network serving the metropolitan area of Tyne and Wear.

This project is located between J65 (Birtley) and J67 (Coal House) on the NGWB and is approximately 6.5km in length. The existing carriageways comprise:

- Southbound: Two lanes between Coal House and Eighton Lodge with an additional climbing lane between Smithy Lane and Eighton Lodge and three lanes between Eighton Lodge and Birtley; and
- Northbound: Two lanes with a lane gain/lane drop between Birtley and Eighton Lodge and two lanes between Eighton Lodge and Coal House.

The A1 NGWB is one of the most congested highway links in the North-East Region with more than 110,000 vehicles using the route every day on the busiest section. As a result of this travel demand on the route, there are a number of issues relating to: journey time delays; journey time reliability; route resilience; safety; environmental impacts and development pressures.

Improvements to the A1 NGWB have long been acknowledged as a requirement for economic growth in the region within both local and national policy documents and reflected in the consensus of opinion amongst regional stakeholders that something needs to be done to address the issues to facilitate the economic growth of the region. The route has been identified as a 'hot-spot' requiring Government investment to deliver infrastructure improvements.

Traffic in the region is forecast to grow in the future, largely due to a number of proposed development sites to be delivered through the Newcastle Approved Plan. This additional traffic demand will further exacerbate the issues on the A1 NGWB with traffic modelling work indicating the likely extent of the impacts.

In an attempt to fully understand and address the issues, a number of studies have been undertaken in recent years and these include:

- TAMMS Multi Modal Study (2002);
- Access to Tyne and Wear DaSTS study (2010);
- North East DaSTS Strategic Connectivity Study Report (2010);
- Newcastle City Deal (2012);
- HA Pilot Based Strategy Report (2013);
- A1 Newcastle and Gateshead Western Bypass – Exploration of Dual 3-Lane Provisions Initial Infrastructure Report (2013);
- DRAFT Route-based strategy: Evidence Report London to Scotland East (February 2014);

- The Gateshead and Newcastle Council Core Strategy & Urban Core AAP Draft Infrastructure Delivery Plan has also been used, as well as the Appraisal Specification Report (ASR) for this feasibility study; and
- A1 Newcastle/Gateshead Western Bypass Feasibility Study (2014).

The Feasibility Study undertaken in 2014 followed Steps 1 to 10 of the Transport Appraisal Process (TAP) from the Transport Appraisal Guidance (TAG). Stage 1 of the Feasibility Study (Steps 1 to 4 of the TAP) included a comprehensive review of all of the previous studies outlined above to determine the existing issues on the route and prioritise the sections which most urgently needed attention.

Following the prioritisation of sections, Stage 2 (Steps 5 to 9 of the TAP) looked at developing interventions to address the issues highlighted in Stage 1. Interventions were processed through the Early Appraisal Sifting Tool (EAST) and the best performing interventions were put forward through the Options Appraisal Process and scheme cost estimates were produced by the Highways England Commercial Team.

At Stage 3 of the process (Step 10), a Strategic Outline Business Case (SOBC) was produced for the options which performed well at the Options Assessment Stage.

Stages 1 & 2 of the Feasibility Study identified the following sections of the route which should be given priority:

- J65 – J67 A1 Birtley to Coal House (including Allerdene Railway Bridge);
- J71 – J73 A1 Metrocentre to Derwenthaugh; and
- J74 – J79 A1 Scotswood to North Brunton.

At Stage 3, SOBC’s were produced for the following schemes:

- J65 – J67 A1 Birtley to Coal House (including Allerdene Railway Bridge); and
- J74 – J79 A1 Scotswood to North Brunton.

Both schemes were announced in the Autumn Statement in December 2014 as schemes that should be taken forward into the Roads Investment Strategy (RIS).

The completion of the Feasibility Study concluded PCF Stage 0 (Strategy, Shaping and Prioritisation) for both schemes.

The A1 Birtley to Coal House scheme concluded PCF Stage 1 (Option Identification) in April 2016 and two options were considered at PCF Stage 2 (Option Selection). PCF Stage 2 (Option Selection) concluded in July 2017 that “Option 1a with the offline replacement of Allerdene Bridge should be the recommended route” [1].

2.2 PREFERRED ROUTE

Between J65 (Birtley) and J66 (Eighton Lodge), the carriageway is to be widened asymmetrically to the southbound side of the carriageway, resulting in 3 lanes plus lane gain/drop northbound. Between J66 (Eighton Lodge) and J67 (Coal House) the carriageway is to be widened mostly symmetrically.

The existing speed limits of 50mph southbound from J67 (Coal House) to Smithy Lane Overbridge, 70mph southbound from Smithy Lane to J65 (Birtley) and 50mph throughout the northbound carriageway will be retained. Demolition and reconstruction of North Dene footbridge will be required to accommodate the widening. At J66 (Eighton Lodge) there are 3 underbridges that will also require widening.

Allerdene Bridge will be replaced approximately 40m south of its current location, continuing to use the existing structure to maintain two lanes of traffic both northbound and southbound while the new bridge is constructed. Kingsway Viaduct will also be widened but no changes will be made to Lamesley Roundabout at J67 (Coal House).

2.3 PRELIMINARY DESIGN

Following the development of the PCF Stage 2 (Option Selection) traffic model there was a requirement to amend the design to include 4 lanes southbound through J66 (Eighton Lodge). This design change is documented in detail in technical note *BTN05: TD 22/06 Mainline Lane Configuration - Final Assessment* (dated 8th May 2017) [2]. The current design requires asymmetrical widening whereby the southbound carriageway, is now;

- North of J67 (Coal House) – 3 lanes;
- Through J67 (Coal House) – 3 lanes;
- Between J67 (Coal House) and J66 (Eighton Lodge) – 4 Lanes;
- Between J66 (Eighton Lodge) and J65 (Birtley) – 4 lanes; and
- South of J65 (Birtley) – 3 lanes.

The scheme went to public consultation in February 2018, subsequently the design has been updated further to accommodate this feedback. This design will go through the process of obtaining a Development Consent Order (DCO) with a planned start of work in late 2020.

Refer to Appendix B for schematic plans of the scheme extents/proposed works.

2.4 REPORT OBJECTIVES

This Structure Option Report has been prepared to assess the constraints/challenges associated with the replacement of the existing Allerdene Railway Bridge with a new off line multi span viaduct structure.

Upon completion and sign off, this report shall provide Highways England and the detailed design Delivery Partner with supporting information to establish the best option (single span rail bridge with large embankments vs multispan viaduct with smaller embankments) in terms of buildability, programme, cost and other key factors.

3. ALLERDENE BRIDGE AND THE EXTENDED EMBANKMENT OPTION

3.1 GENERAL

Previous works established that the existing Allerdene bridge be replaced with a new offline structure. Preliminary analysis demonstrated that a single span 62m steel composite integral bridge over the East Coast Main Line would provide a robust cost-effective bridge solution with significant long-term maintenance benefits.

Full details of the single span integral bridge proposal are documented in *Structure Option Report 3 Allerdene Railway Underbridge* (dated March 2018) [3].

Prior to the Ground Investigation, it was anticipated that the approaches leading up to the single span structure would comprise earthwork embankments although it was noted that several ground related risks would need to be reviewed in more detail upon receipt of the Ground Investigation data. Further details regarding the Ground Investigation is discussed in Section 5 of this report.

Following the Ground Investigation, preliminary analysis of the approach embankments between CH11200 to CH11500 showed that ground settlement of 600-1000mm magnitude could occur if no ground improvement works were implemented.

Assessments of the potential ground improvement options (including band drains, piled slab, light weight fill, etc.) identified rigid inclusion (e.g. controlled modulus columns-CMCs, settlement reducing piles, or other similar system) as the preferred option. Further information relating to rigid inclusions is tabulated below, focussing on one option - CMCs.

Rigid inclusions (i.e. CMCs)	
What are they	Vertical columns of grout formed using a displacement auger, effectively densifying the ground around the column. The columns themselves and the ground between them act together as a stiffer stratum than the natural ground, sharing the imposed load.
How they work	The columns increase the stiffness of the ground and transfer load from the embankment deeper down. Both of these effects reduce settlements. If the inclusions can reach a competent stratum (i.e. bedrock), settlements are reduced further.
How they are installed	Using a modified continuous flight auger (CFA) piling rig. The auger is screwed in to soils to the designed depth, which increases the density of the surrounding soil, and as such increases its stiffness and or bearing capacity. When the auger is extracted, cement grout is injected through the auger head, creating a column. The grout is pressurised to allow grout to extend out horizontally further improving the surrounding soils. Very little spoil is created at the top as the auger displaces rather than extracts the soil in the columns. A geogrid-reinforced granular load transfer platform is installed over the inclusions to help transfer the embankment load into the columns rather than the ground between. Nominal reinforcement (one centralised 25-40mm bar) may be required within the columns at the edge of a block due to lateral loading.

Table 3.1 Overview of Rigid Inclusions (i.e. CMCs)

Refer to Appendix C for the general arrangement drawings of the single span integral bridge and the extended embankment option (including ground improvements).

The use of rigid inclusions is the preferred ground improvement option on the basis of cost and smallest impact on programme.

Other infrastructure exposed to the settlement risk include:

- Potential ground movement of the railway – There is a risk of settlement or heave near the railway if an embankment solution is adopted, as the rigid inclusions act to reduce rather than stop ground movement occurring. This has the potential to impact the adjacent Network Rail (NWR) infrastructure (rail track), although the relatively rigid proposed bridge abutment between the embankment and the railway will further reduce such ground movements. This risk needs to be carefully considered via detailed analysis and engagement with specialist contractors. Options would include using a cut off shear wall between the zone of rigid inclusions and the railway or more likely modifying the spacing of the rigid inclusions towards the railway.
- Potential settlement to the replacement Allerdene Culvert – Refer to *Structure Option Report 2 Allerdene Culvert* (dated Feb 2019) [4] for full details. The risk of settlement would impact the culvert replacement works as mitigation measures to control settlement would be needed.
- Potential settlement of the newly diverted NGN gas main – Part of the works to construct the new offline A1 alignment around Allerdene bridge is the diversion of the NGN gas main. The new earthwork embankments would impose significant loads on the gas main leading to potential settlement and rupture. Similar to the above, the need to prevent settlement would impact the gas diversion works as consideration would need to be given to support the earthwork above the gas main. Again, these may include a piled slab with appropriate transition zones each side, or modifying the spacing of the rigid inclusions around the gas main and construction of a concrete slab above. A rigid inclusion option such as this would require a pre-determined allowance for settlement to be built in to the slab design (i.e. a void or compressible fill between the gas main and the slab to accommodate the settlement) and early engagement with specialist contractors and NGN.

The coal mining-related risks are less significant for the embankment and rigid inclusion solution as the rigid inclusions are not relying on the underlying bedrock in the same way as a piled foundation. As such, the extent and potential requirement for grouting of shallow mine workings beneath the embankment is less for the embankment solution.

The settlement risks and the mitigation required to protect adjacent infrastructure raised the introduction of an alternative multi span/viaduct as an option.

Details of the viaduct proposal are discussed in Section 4 of this report.

4. ALLERDENE VIADUCT OPTION

4.1 GENERAL

Having identified potential settlement risks associated with the single span bridge and the extensive earthwork embankment (including ground improvements) option, an alternative option has been developed that best mitigates the risk associated with ALL the following:

- Reduce the impact of the approach earthwork embankment settlement during both construction and in service as much as reasonably practicable
- Reduce the impact of the new bridge construction over the railway and potential ground movement beneath the ECML
- Simplify/Eliminate the proposed NGN protection works
- Simplify/Eliminate the work to accommodate the existing Allerdene culvert

A structural solution in the form of a multi span bridge, otherwise known as a viaduct could provide the most robust solution to mitigate all the above to within acceptable limits.

Options in-between the single span and the multispan viaduct (known as a hybrid option) comprising a 3-span bridge structure (main span over the railway) with embankments, was also initially considered. The current view is the 3-span structure, whilst mitigating some of the risk of settlement around the structure footprint and NWR interface, would still pose the following challenges:

- Increase approach embankments areas that are susceptible to residual settlement when considering rigid inclusions as the preferred form of ground improvement
- NGN services would need still need to be protected

The greater length of viaduct would limit the approaches to the tie ins at both ends of the structure therefore the footprint of the embankment is significantly reduced, limiting the risks associated with settlement of the approach embankments. It should be noted that the approach embankments will still require ground improvement beneath (as detailed in Section 3), but the plan area/extent is significantly reduced as well as being moved further away from the railway.

Irrespective of the structural form, the proposed viaduct would be founded on piled foundations, likely keyed into the underlying bedrock. This solution would limit settlements to within manageable tolerances and significantly reduce the risk of ground movement beneath the rail track. By ensuring the clearance of the viaduct span over the railway (vertical and lateral) is no worse than the limits agreed for the single span structure minimises objection from NWR. Recent meetings with NWR have verbally confirmed their agreement in principle to a viaduct structure. However, an AIP would need to be submitted to acquire written formal endorsement of this alternative proposal.

The NGN diversion and Allerdene culvert could be readily accommodated under one of the new viaduct spans, therefore complex works associated with the protection of the NGN mains are avoided. The existing Allerdene culvert (dilapidated in its current state) could then be removed in its entirety and readily replaced with an open burn that has maintenance and environmental benefits.

4.2 ALIGNMENT REQUIREMENT OVER THE VIADUCT

Along the section of the proposed viaduct, the A1 alignment starts online to the east of the existing Kingsway Viaduct. It then turns offline to the south and starts to climb to provide increased clearance to the ECML. The alignment straightens and levels for the crossing of the railway before turning to the south and climbing again to connect into the existing.

The above introduces many challenges which act to constrain the horizontal and vertical alignment over the proposed new viaduct, these include:

- The alignment is limited horizontally and vertically by the requirement to follow existing across Kingsway Viaduct to retain the existing bridge.
- The alignment is limited horizontally and vertically to allow the adjacent J67 (Coal House) slips to connect into the existing Kingsway Roundabout without an increase in their length which would require additional width on the existing Kingsway viaduct
- The alignment is limited horizontally by the requirement to turn sufficiently offline to provide adequate clearance to the existing Allerdene Bridge so that the existing A1 can remain open while the proposed Allerdene Bridge is constructed
- The alignment is limited vertically by the requirement to climb sufficiently to provide clearance to the OLE masts for the ECML (this clearance is an increase compared with the existing); and
- The alignment is limited horizontally and vertically by the requirement to connect into existing prior to the existing Smithy Lane Overbridge to provide adequate horizontal and vertical clearance to retain the existing structure.

The traffic model has been used to develop both the cross section and slip layouts used in this section. The flows and expected weaving have been assessed to determine the proposed lane configuration of 4 lanes for both carriageways. The flows along the mainline and slips have been used to determine the slip layouts. To provide adequate capacity, a lane gain with ghost island merge is proposed for the J67 (Coal House) southbound merge and a lane drop at parallel diverge is proposed for the J67 (Coal House) northbound merge. These slips would extend onto the viaduct and require width beyond the 4-lane cross section.

4.3 DESIGN ASSUMPTIONS AND CONSTRAINT FOR THE VIADUCT OPTION

Details of the key design constraints (some of which have already been discussed) considered for the viaduct option are tabulated below. This is based on discussion with key stakeholders and previous experience.

FACTORS	STAKE HOLDER INTEREST	DESCRIPTION
Settlement mitigation	HE Project Team	Minimise the impact of settlement as much as reasonably practical on the following: · Approach embankment during both construction and in service · NWR infrastructure · NGN protection works · Allerdene culvert works
Coal mining-related risks	HE Project Team	Minimise the impact of historical coal mining beneath the proposed viaduct piers/abutments.
Disruption to A1 traffic	HE Project Team	Minimise disruption to the traffic on the existing A1 Highway alignment and Network Rail Infrastructure as much as reasonably practical

FACTORS	STAKE HOLDER INTEREST	DESCRIPTION
Structural Form	HE Project Team/HE SES	Provision of functional/cost effective structure design is required. Iconic aesthetically enhanced land mark structure is not required due to the scheme budget constraints
Loading	HE SES/Abnormal Load Team	Viaduct to be designed to sustain the SOV350 abnormal load. This would assist in future proofing the A1 for the routing of heavier European abnormal loads.
Headroom	NWR/HE SES	As per the single span bridge option. The headroom of the span over NWR ECML shall be 6.7m (relative to the track) The headroom for all the other spans shall be at least 5.3m clearance as per TD27/05
Environmental	EA	Structure to span the existing Allerdene Culvert to allow for this to be converted to an open burn.
NGN Requirements	NGN	Structure to span the new NGN gas diversion to avoid the need for a protective piled slab over the main
NWR clearance/working constraints	NWR/HE SES/HE Project team	Lateral clearance – To avoid the design of structures (intermediate supports) for the onerous rail impact loading, a minimum lateral clearance to the nearest running line of 4.5m would be maintained. Existing overhead line equipment - Assumed this would need to be maintained during the works (except during possession working). OLE shall be supported on free standing masts, fixing to the new bridge soffit is prohibited for the permanent works Works on or near the line (Red Zone Working) - Would only be permitted during pre-arranged NWR possession and isolation works, where the running lines are blocked for train movement. Type of possession works anticipated include: (1) Rules of the Route Possession (ROR): These are considered to be the least disruptive type of possession and are available during weekends between 23:00 Saturday night until 06:30 Sunday morning. These require a 12-18 week booking period. (2) Disruptive Possession: These are a complete weekend closure of the train line to enable continuous access and working over a weekend period. For the ECML this type of possession is generally available over the Christmas period (25th/26th December) and requires up to a 104 week booking period. Green zone working (Working adjacent to live rails): Work adjacent to live rails would be permitted on the assumption that a rigid fence is put up between the site of work and nearest open line. The distance between the running line and fence is expected to be a minimum of 3m.
Alignment Constraints	Design team	Refer to Section 4.2 for full details.

Table 4.3 Assumption and Constraints Considered During the Development of the Viaduct Option

4.4 VIADUCT STRUCTURAL FORM

Reinforced and prestressed composite construction was not favoured, mainly due to restrictions in maximum span length which would require a greater number of supports. This not only increases the cost of the foundation works but also the risk of piled foundations clashing with shallow mine workings therefore increasing the programmed works associated with grouting activities (Section 5 provide further details of ground conditions).

The shorter length of the maximum achievable spans in concrete construction would also prevent the ECML being cleared with a single span bridge deck. This would result in failure to comply with NWR's initial geometric clearance requirements whilst also introducing buildability complexities associated with intermediate supports between railway tracks.

Post Tensioned Segmental bridge construction was also eventually ruled against due to the following reasons:

- Segmental bridge construction is complex and unfamiliar in the UK. In comparison steel beam and composite reinforced concrete deck is a fairly standard solution for a road over rail bridge. With a proven track record for safety over the railway.
- Segmental construction over the ECML would be a high-risk operation which at the least may require temporary supports on NWR land during construction (there is restricted working are to complete this). In addition, the width of the deck (40m) is such that stitching would be required both longitudinally and transversely again complicating construction.
- Segmental construction also requires continuous risky work over the railway, which may require special permission or proof of its safety. In comparison Network Rail is content with working off a Paraslim system while trains are running as it is a proven system.
- The weight of the superstructure would be greater in comparison to a steel composite alternative thereby impacting the sub structure and foundation design increasing construction cost.
- Long term, UK whether conditions are such that chloride ingress and the risk associated with this would be high. This would make the make the post tension ducts vulnerable to ingress details of which are difficult to measure without complex PTSI.

Multi girder steel composite was preferred to ladder deck construction as the width of the deck (A1NB and SB deck are each up to 20m wide) is more than the max width (up to 12m) at which ladder decks are generally considered to provide economically favourable solutions.

The preliminary design showed a 6No. span viaduct configuration up to 290m long would provide the optimum solution.

The main rail bridge span would be circa 62m to clear the ECML with sufficient lateral clearance to potentially aid buildability of sub structure/foundation elements outside of possessions .

All the other spans would be circa 45m allowing for the NGN main and the new Allerdene burn to be spanned with sufficient lateral clearance for construction of intermediate supports. Liaison with the support Contractor also highlighted the proposed span configuration allows for the provision of manageable girder lengths when considering fabrication/transportation and installation.

The north and south bound A1 carriageway would be carried by two structurally independent decks. This is to avoid/minimise articulation complexities associated with the construction of discrete spans that would be almost as wide (circa 40m) is they are long (typical deck span 45m).

The main girders would comprise fabricated weathering steel plate sections (to minimise long term maintenance painting liabilities) that support a reinforced concrete deck. The girders could be profiled to enhance aesthetics whilst also providing savings in material cost and weight, benefiting lifting activities.

The intermediate piers would comprise reinforced concrete construction and take the form of either a leaf pier or portal structure to suit Highways England's aesthetic requirements. The end supports would comprise conventional reinforced concrete cantilever wall construction with wingwalls to suit.

To limit settlement (to approximately <25mm) the foundation would comprise reinforced concrete bored piles construction (minimum 900mm dia). The piles would extend into the varying rock head level with an average embedment of 40m below ground. The piled foundations are anticipated to be socketed into rock, which increases the risk of encountering shallow mine workings and associated instability. This risk could be mitigated by localised grouting works at piled foundation supports to the viaduct. However, given the significant depth to the mine workings, grouting works is likely to be complex and therefore costly. Refer to the Coal Mining Risk Assessment for the scheme (HE551462-WSP-VGT-ZZ-RP-VG-00001) for further information.

Mechanical movement joints and bearings would need to be incorporated as part of the viaduct design to control the articulation of the structure. This would introduce maintenance liabilities not required within the single span integral bridge option.

The viaduct would tie into the new A1 earthwork embankments at both ends. The risk of embankment settlement at the tie in points with the existing A1 alignment still exists, but is reduced in extent. This limited risk of settlement would be mitigated via rigid inclusions (of a much-reduced number compared with the embankment required for the single span option).

High level analysis indicates the rigid inclusions would comprise concrete columns circa 300-400mm dia at 1.5m to 2.0m spacing. The embedment depth of the rigid inclusions is anticipated to be 30m or to the base of glasciolacustrine deposits, whichever is shallower. Refer to Section 5 for further geotechnical information.

Refer to Appendix D for General Arrangement drawings of the proposed viaduct option (including limited approach embankments).

4.5 TECHNICAL CHALLENGES

The table below provides details of some of the key technical challenges considered during development of the viaduct option. This was to improve buildability and reduce maintenance liabilities during service.

ELEMENT	CHALLENGE	DESCRIPTION
Articulation	The overall length/width of the structure complicates the design and specification of mechanical movement joints and bearings. This makes these complex moving elements more vulnerable to maintenance issues during service and potential failure.	Whilst mechanical movement joints and bearings are required for the viaduct, their design has been simplified by introducing a movement joint and additional line of bearings to provide 2 discrete 3 span continuous structures. One over the railway (with back spans either side) and one over Allerdene burn (with back spans either side). This would increase the number of joints and bearings required however the design for these in relation to articulation would be less onerous allowing for more simplified proprietary bearing/joints to be installed that are less susceptible to malfunction. Simplified bearings/joints enhance durability and the potential service life of these critical elements.
Access to bearing for maintenance	Bearings will eventually require replacement during the structure service life (every 50 years). Difficult operation to undertake if access is limited	The design includes for the provision of jacking points along the cross-head girders located over the end and intermediate supports. This would aid future bearing replacement operations. Inspection galleries to the end abutments have not been provided as it is assumed the bearing shelves can be readily viewed/access from the front face of the abutment using special access equipment
Gantry provision	Cantilever sign gantry required on the viaduct.	Preliminary design work has identified that the highway upgrade shall require the installation of new advanced direction signage (ADS) along the route. Refer to Structure Option Report 9 ADS Gantries (dated March 2018) [5]. One of the new gantries (SG008) is located at midpoint along the proposed viaduct (pier reference 3). Further review of the highway and the signage design indicates that this is the optimum position to inform drivers and its position cannot be significantly adjusted to avoid the viaduct. Therefore, consideration has been given to locally extending one of the intermediate pier supports (including foundations) to support the truss cantilever gantry. This includes positioning of the gantry behind a VRS with adequate working width. A guard rail has also been provided around the gantry to aid safe access for future inspection/maintenance work.
Central reserve VRS requirement	The NB and SB decks are separated by a gap in excess of 800mm, therefore in accordance with TD19/06 clause 4.34 will need to be infilled by a solid plate or slab. In addition, there is a risk of the maintenance liabilities for 2No. VRS provisions (protect the deck end of the adjacent decks) becoming very onerous	To close the gap between the adjacent decks to satisfy TD19/06 and also minimise the VRS maintenance liabilities, the following has been considered in the preliminary design of the viaduct: A reinforced concrete cover slab shall be installed to cover the gap between the two adjacent decks. A double-sided safety barrier with adequate setback/working width shall be installed on top of the cover slab to prevent errant vehicles colliding and entering traffic traveling in the opposite direction This proposal avoids the requirement for two VRS system within the central reserve providing initial capital cost savings. It also significantly reduces maintenance liabilities associated with two VRS systems.
Differential settlement	Risk of differential settlement between the rigid piled viaduct structure and the semi rigid approaches comprising structural backfill and standard earthwork behind the abutment.	Initial consideration was given to the provision of run on slabs to span areas of potential settlement of structural backfill behind the abutments. However, upon further liaison with the HE SES their preference to avoid the design/construction of run on slabs was noted for the following reasons; *"Ongoing maintenance problems when they have cracked, tilted or collapsed through loss of support on the approach embankment."* An alternative to run on slabs is the extension to the length of the piled heel to the reinforced concrete cantilever wall. It is considered that structural backfill and compaction in this area would reduce the risk of differential settlement between the relatively flexible construction of the approach pavement and the non-flexible viaduct superstructure.

ELEMENT	CHALLENGE	DESCRIPTION
Lifting of girders	Potential craneage/stability/transportation issues	The following design features have initially been considered for the design of the viaduct girders: · Girder configuration is such that they can be lifted in pairs to improve stability during lifting and installation · Girders shall be cut and spliced on site (points of contra flexure) to simplify transport to site · Girders shall be lifted in pairs with permanent GRP formwork in place. This minimises Network Rail interface risks and the requirement for possession during casting of the in-situ deck slab Feasibility of the above would need to be reviewed at detailed design.
Construction of parapet plinths	Construction complicated due to difficult access and extended cantilever design and construction	· Extended cantilever parapet plinths have been avoided, simplifying design and construction of these elements. · Design of the outer pair of girders shall consider loads associated with fixing the temporary edge protection (Paraslim) in place prior to lifting. This will avoid additional possession works to install temporary working platforms to cast the deck edge/parapet plinth. The weight of the paraslim temporary formwork and girders is expected to be within the capacity of the 500T crane used for the intermediate span girder lift. However the girder lift to the ECML span including paraslim weight, would require further detailed review to ensure it is within the capacity of the intended 1000T crane.

Table 4.5 Technical challenges considered to improvement buildability and minimise maintenance liabilities.

Refer to Appendix E for the outline construction methodology (land spans only) for the viaduct prepared by the support contractor Morgan Sindall. Construction methodology for the ECML span requires further review at detailed design taking account of NWR possession and working constraints.

At this stage it is envisaged that for the lifting of the girders for the ECML span, a braced pair would be in the order of 160T and a 1000t Crane such as a Leibherr LTM 1800 would be required which has a capacity of 160T at 48m radius. The crane would be positioned directly behind the North abutment for lifting.

Refer to Appendix F for the Designers Risk Assessment prepared to date for the design/construction of Allerdene Viaduct.

5. GROUND INVESTIGATION

5.1 OVERVIEW OF EXISTING GROUND CONDITIONS

A Geotechnical Design Report (GDR) is not yet available for the project; this shall be prepared as part of PCF Stage 5 – Detailed Design. The GDR and geotechnical design shall be based on:

- The results from ground investigation (GI) undertaken between November 2017 and June 2018 by Central Alliance (factual report reference HE551462-CAX-VGT-ZZ-VG-00001);
- The Coal Mining Risk Assessment (CMRA) (referenced HE551462-WSP-VGT-ZZ-RP-VG-00001); and,
- The geotechnical parameters defined in the Ground Investigation Report (GIR) (referenced HE551462-WSP-VGT-ZZ-RP-VG-00002).

The preliminary choice of foundation solution has been assessed using historical records and data for the site, presented within the Preliminary Sources Study Report (PSSR) for the wider Birtley to Coal House Scheme (HA544664-WSP-HGT-S01-RP-GE-0600-P-01) and the results from the recent GI. It should be noted that the scope of the recent ground investigation was based on the proposed Allerdene single span bridge and extended embankment option and was undertaken prior to the Allerdene Viaduct option being proposed. If the Allerdene Viaduct Option is progressed through detailed design, additional specific ground investigation will be required at the pier locations to comply with BS EN 1997-2. This has been acknowledged and agreed with the Highways England Project Team and SES Geotechnical Advisor.

Historical ground investigation data from British Geological Survey and Highways Agency Geotechnical Data Management System (HAGDMS) is available within the vicinity of the proposed Allerdene Viaduct, as presented within the PSSR. With reference to the PSSR, the GI factual report and the GIR, the following ground conditions are anticipated beneath the proposed viaduct:

- **Made ground (embankment construction):** up to 10.50 m thick (associated with the existing highway embankment) and primarily consisting of clay, silt, pulverised fuel ash, gravel and occasional boulders.
- **Made ground**: A thin veneer (typical thickness of less than 1.5 m) of generally reworked natural cohesive deposits, locally increasing in thickness to 4 m, outwith the existing embankment footprint. Deeper made ground may relate to a remediated gas storage facility to the south of the proposed viaduct location;
- **Alluvium**: approximately 0.50 to 3.40 m thick and comprising layers of silty clay interbedded with bands of sand and gravel. These deposits generally thicken to the west, towards the River Team;
- **Glaciolacustrine deposits:** between 7.20 and 42.50 m thick, thinning towards the east and the edge of the River Team valley. Primarily comprising compressible laminated silty clays, with localised bands of silt and sand; over,
- **Glacial till deposits:** between 3.0 and 5.20 m thick, recorded as thinner towards the west. Primarily comprising gravelly clay, with localised bands of sand and occasional boulders; over,
- **Glacial sand and gravel:** between 0.30 and 3.90 m thick and primarily consisting of layers of sand and gravel; over,

- **Weathered rock:** ranging between 0.70 and 5.00 m thick and primarily consisting of layers of gravelly clay, sand and gravel of mudstone, sandstone, siltstone and/or coal; over,

- **Pennine Middle Coal Measures bedrock:** Comprising interbedded layers of sandstone, mudstone, siltstone, and coal. Rockhead is anticipated to vary significantly across the proposed viaduct location, being recorded at 50.00 m bgl towards the western extent of the viaduct, and 14.70 m bgl at the eastern extent.

Refer to drawings HE551462-WSP-HGT-ZZ-DR-CE-00064 and HE551462-WSP-HGT-BCH-DR-GE-00105 (Appendix D) for illustration of the ground investigation locations and long section of ground conditions in the vicinity of the proposed Allerdene Viaduct.

A Coal Mining Risk Assessment (CMRA) (referenced: HE551462-WSP-VGT-ZZ-RP-VG-00001) has been prepared for the site, taking account of the proposed viaduct. Pertinent details are presented below.

Four faults affecting the bedrock are recorded (on the geological maps) beneath/close to the proposed structure. For ease of reference these have been denoted as F1 to F4:

- F1: located west of the proposed viaduct and crossing the proposed alignment at approximately CH11120. This is a north east to south west trending fault with an anticipated downthrow estimated at 20 to 23 m to the east.
- F2: located beneath the centre of the proposed viaduct at approximately CH11400. This is a north to south trending fault with an anticipated downthrow estimated at 6 to 8 m to the south east.
- F3: located east of the proposed viaduct and crossing the proposed alignment at approximately CH11620. This is a north to south trending fault with an anticipated downthrow estimated at 2 to 3 m to the west.
- F4: located east of the proposed viaduct and terminating against F3, this fault crosses the proposed alignment at approximately CH11620. This is an east to west trending fault with an unknown downthrow to the north.

Five coal seams (Maudlin, Durham Low Main, Brass Thill, Hutton and Plessey) are recorded at shallow depth beneath rockhead within the vicinity of the proposed viaduct. Coal Authority (CA) abandonment plans show recorded workings in the Durham Low Main and the Hutton coal seams. Unrecorded workings have been encountered within the Maudlin coal seam and suspected within the Hutton coal seam:

- Maudlin: recorded between faults F2 and F3 at depths ranging between 30.3 and 35.5 m below ground level (bgl). Unrecorded workings have been encountered between F3 and F4, recorded at 0.55m thick, although workings of up to 1.5m thick are recorded to the east of F3.
- Durham Low Main: recorded at depths between 37.5 to 38.0 m bgl between faults F1 and F2; and around 46.0 m bgl between faults F2 and F3. Workings up to 3m thick have been recorded. The coal seam is interpreted as subcropping immediately west of F2 and the East Coast Mainline railway. The abandonment plans show that the coal seam has been worked with a thickness of extracted coal of 0.85 m.
- Brass Thill: recorded at depths between 41.5 to 42.0 m bgl between faults F1 and F2 and between 46.5 to 57.0 m bgl between faults F2 and F3. The coal seam is interpreted as subcropping in the area immediately west of F2 and the railway.

- Hutton: recorded between faults F1 and F2 at depths ranging between 51.5 and 53.5 m bgl. No thickness, depth or elevation are provided within the abandonment plans but suspected workings up to 0.90 m thick are recorded at depths between 51.20 and 51.60 m bgl.
- Plessey: north to south trending and inferred to subcrop beneath the site and to the northwest of F1. This has been interpreted as below the zone of influence for the proposed viaduct.

Based on the above, and as detailed within the CMRA, the majority of the proposed viaduct is subject to risk of void migration due to recorded or unrecorded mine working collapse affecting the stability of piled foundations, based on the conservative assumption that these piles will be socketed into the underlying rock. This risk is highest adjacent to the railway and beneath the eastern abutment.

As the current ground investigation was designed to inform the embankment and single span bridge option, specific, targeted GI is required at each viaduct abutment/pier location to accurately locate the above coal seams. Based on the findings of these works, the requirement for drilling and grouting beneath the piers and abutments can be confirmed. At this stage, based on the investigation conducted (including for the NGN gas diversion and culvert extension) it should be assumed that grouting of mine workings is required beneath all abutments/piers.

As detailed within the CMRA, the risks associated with mine workings are significantly higher for the viaduct option than the embankment and single span bridge option as there are more piled foundations for the viaduct. The proposed mitigation measures for the two options therefore vary significantly, as summarised below:

- Embankment and single span bridge:

  Drill and grout workings beneath bridge abutments, or design piled foundations to accommodate the mine workings; and,

  Inspect the formation of the embankments and design the ground improvement and load transfer platform/distribution mat accordingly accounting for the mine workings.

- Viaduct:

  Additional ground investigation at each abutment/pier location; and drilling and grouting of mine workings as required.

During the recent GI, groundwater strikes were recorded within the boreholes in the vicinity of the proposed viaduct. Groundwater monitoring installations have been installed within eleven of these exploratory holes. Records from the groundwater strikes and monitoring in the vicinity of the proposed viaduct indicate the presence of:

- perched water bodies within made ground;
- shallow groundwater within the glaciolacustrine deposits between 0.30 and 8.50 m bgl; and
- groundwater at a greater depth within the glaciolacustrine deposits (around 19.40 mbgl) and the underlying Pennine Middle Coal Measures bedrock (between 22.20 and 24.50 m bgl).
- Groundwater monitoring is ongoing and is anticipated to be completed by May 2019.

5.2 GEOTECHNICAL RISKS

The geotechnical risks for the wider site are presented within the PSSR report. These risks have been reviewed and further assessed in the 'Live' Project Risk Registers. Pertinent geotechnical risks in relation to the proposed viaduct foundations are summarised in Table 5.2.

Risk Cause	Risk Event	Primary Risk Impact	Risk Rating*
Engineering Properties of the Ground	There is a risk that the ground model, and the behaviour of such to the proposed works, is different (worse) from that assumed at this stage.	**Construction** delays and remedial design requirements, and potential cost and programme implications.	**Low**
Groundwater	There is a risk that the groundwater model is different (worse) from that assumed at this stage.		**Low**
Contaminated Soils	There is a risk that the assessment of contaminated soils undertaken at this stage is not accurate.		**Low**
Instability of Existing Earthworks	There is a risk that the existing earthworks at the site are not as stable as assumed at this stage.		**Low**
Excessive ground movement related to compressible superficial deposits	There is a risk that loading the superficial deposits may cause excessive settlement beneath/in the vicinity of the proposed viaduct and approach embankments. This may cause negative skin friction on the viaduct piled foundations, particularly at the abutments. This may also cause movement to the East Coast Mainline railway and NGN gas main. The viaduct option helps to reduce this risk.	**Design** – The viaduct option significantly reduces the impact of this risk as the distance between the approach embankments and the ECML / NGN gas main is increased. Detailed design to take account of proposed loadings and design appropriate ground improvement works to reduce settlements behind the abutments.	**Low/medium**
Instability caused by shallow mine workings	There is a risk that the structure will be adversely impacted by collapse of shallow coal mine workings, which will require remediation	**Design** – targeted, specific GI at each pier/abutment location. Detailed design to take account of the anticipated and recorded	**High**

	(likely grouting) during construction	mine workings (refer to the CMRA for the scheme). **Construction** and **operational** collapse of the running surface / structures.	
Unexploded Ordnance	The detailed USO risk assessment for the scheme notes that the site is a 'Low' risk site.	**Construction** delays and requirement for safe deactivation / disposal.	**Low**
Buried Services	There is a risk that buried services might be encountered during excavation of proposed foundations.	**Construction** delays and potential cost and programme implications.	**Medium**
* current assessed level based on Highways England PID and Risk Matrix (v12, August 2015).			

Table 5.2 Geotechnical risks for the proposed Allerdene Viaduct

5.3 REVIEW OF FOUNDATION REQUIREMENTS

The viaduct foundation designs shall be determined through assessment of the bearing capacity of the founding materials (influenced by the ultimate limit state), settlement analysis of the foundations (influenced by serviceability limit state) and pertinent risks/design considerations.

Initial assessment using preliminary loading estimates indicates that shallow foundations are unlikely to be feasible for the proposed viaduct (bearing capacity requirements too high for the assumed ground) and a deep, piled solution is proposed.

Detailed design of any piled solution is likely to be the responsibility of the specialist Piling Contractor (and reported within a Geotechnical Design Report in line with HA 22/08). However, for the benefit of this report an initial feasibility assessment has been undertaken.

Given the potential for loose / soft made ground and superficial deposits, and the sensitivity of the existing structures/infrastructure to ground movements (existing Allerdene Bridge, East Coast Mainline and the Network Rail infrastructure), it is considered likely that a reinforced concrete bored pile solution will be most suitable for the site. However, the use of other piling techniques may also be appropriate for the scheme and may be proposed by the Contractor.

Preliminary assessment of individual pile capacities for various pile diameters (600 to 900mm diameters considered) and depths indicates that an appropriate pile design may be developed with piles bearing into rockhead (socketed 5 m into bedrock to provide fixity). Piles bearing within rock are anticipated to be subject to minimal (less than 15mm) total settlements.

Given the anticipated shallow coal mine workings beneath the site, it is considered that grouting of these workings is likely to be required during construction. Refer to the CMRA for further details. Additional ground investigation at the proposed pier locations would be required during detailed design.

5.4 GROUND IMPROVEMENT BENEATH APPROACH EMBANKMENTS

The approach embankments to the viaduct are anticipated to be subject to excessive settlements if ground improvement of the underlying compressible superficial deposits is not conducted. Assessments into potential ground improvement options have been undertaken throughout the preliminary geotechnical design of the proposed single span Allerdene Bridge option and indicate the preferred ground improvement option to be rigid inclusions.

Preliminary finite element analysis of such ground improvement has been conducted by a specialist contractor and by WSP as part of the single span Allerdene Bridge preliminary design. This analysis specifically focussed on the rigid inclusion performance and the associated ground movements predicted in close proximity to the ECML and diverted NGN gas main. The results of the analysis indicate minimal ground movement affecting the nearest rail (less than 5 mm vertical and horizontal movement predicted). If such movement does occur it is understood from discussions with Network Rail that this could be readily managed during the construction phase via track tamping.

Given the increased distance between the viaduct approach embankments and the ECML (in comparison with the single span option), it is considered that anticipated deflections of the nearest rail line will be further reduced. Therefore, the outcomes of assessments are also relevant to the proposed viaduct approach embankments and therefore haven’t been revisited.

The settlement analysis has also demonstrated that the risk of settlement (during and post construction) beneath the embankments can be significantly reduced by using rigid inclusion ground improvement.

The preliminary design of the ground improvement is illustrated on drawings in Appendix C (for the single span option) and Appendix D (for the viaduct option).

The detailed design of the ground improvement would need to be developed by/in conjunction with a specialist contractor.

Refer to Appendix G for the Geotechnical Risk Register applicable to both the single span and embankment and the viaduct option.

6. SINGLE SPAN VS VIADUCT OPTION

6.1 GENERAL

Highways England and the design Delivery Partner shall be responsible for the selection and development of the preferred option at PCF Stage 5 (Detailed Design). A comparison of the Allerdene Single span with extensive embankment vs the Allerdene Viaduct (limited embankment) option would need to consider a range of keys parameters such as:

- Initial Capital Cost
- Construction Programme
- Buildability
- Risks
- Impact on NWR
- Impact on A1 Traffic
- WLC/Maintenance
- Environmental/Sustainability

A high level review of the above relative to the two options is provided in section 6.2.

6.2 REVIEW OF THE TWO OPTIONS IN RELATION TO KEY PARAMETERS

Initial Capital Cost – Based on the draft developing cost estimates received from Highways England Commercial team in December 2018. The overall scheme cost with the proposed viaduct option is Circa £15 million higher than the overall scheme cost with the proposed single span and embankment (including rigid inclusions).

Construction Programme – The overall construction programme, assuming no significant risk materialise (settlement as predicted/grouting not delayed) is considered will be comparable for the two options (overall 3 year construction programme).

Buildability - Critical activities applicable to both options are tabulated below including an assessment of when an operation is more critical to a particular option (RED text)

	OPTION 1: ALLERDENE SINGLE SPAN BRIDGE AND EXTENDED EMBANKMENT	OPTION 2: ALLERDENE VIADUCT (LIMITING EMBANKMENT)
Bridge construction – Super/sub structure and foundations (62x40m)	Bridge construction – Super/sub structure and foundations (62x40m)	Bridge construction – Super/sub structure and foundations (290x40m) More onerous due to the size of the structure
Rigid Inclusion installation	Rigid Inclusion installation (approx. 10000No.) Considered more onerous due to the significant number required.	Rigid Inclusion installation limited (approx. 6000No.) Note the density/spacing of rigid inclusion is the similar for both options, however the area to be treated reduces for this option thereby reducing the overall number of rigid inclusions required.
Embankment construction	Embankment construction (Approx. volume imported fill 165000m3 overall for the scheme) Considered more onerous due to the significant number required.	Embankment construction limited (Approx. volume imported fill 40000m3 overall for the scheme)
Allerdene Piled Culvert construction	Piled Culvert construction (Approx. 120m long including open burn section) Considered more onerous due to the complexities associated with the piled culvert construction in comparison to an open burn	Allerdene culvert converted to an open burn
Piled cover slab construction to protect the NGN Gas diversion	Piled cover slab construction to protect the NGN Gas diversion	Protection not required
Grouting of shallow mine workings	Required under piled bridge abutment foundation to the single span structure.	Grouting anticipated at multiple locations to align with the increased number of piled foundation required for the viaduct structure. Considered more onerous due to the increase in area requiring treatment and significant/complex grouting works required.

Table 6.2.3 Critical Construction Activities Associated with the Two Options

Whilst the structure is significantly bigger for the viaduct option. The operations to construct the viaduct are straight forward/repetitive for a competent UK bridge contractor. However, the viaduct option has a greater number of piled foundations (anticipated to be socketed into rock), therefore the coal mining-related risks are increased in comparison to the embankment and rigid inclusion solution. Given the significant depth to the mine workings, grouting works is likely to be complex and therefore costly. Refer to the Coal Mining Risk Assessment for the scheme (HE551462-WSP-VGT-ZZ-RP-VG-00001) for a comparison of the coal mining-related risks of the two options.

Risk – The risk of settlement during construction is more onerous for the single span and extended embankment solution. This has the potential to significantly delay the construction progress and incur substantial costs, particularly given its proximity to the railway. In comparison the main risk associated with the viaduct option is delays and cost relating to the increased area of grouting of shallow mine workings. The risks associated with this is considered to be onerous, given the complexity of the grouting works (at such a depth) and the unknown nature of treating mine workings.

Impact on NWR – Both option provides the vertical and lateral clearances agreed in principal with NWR for the span over the ECML.

The risk of ground movement affecting the track is considered greater for the single span bridge option, as the approach embankments (and therefore anticipated ground movements) are closer to the track. As summarised in section 5, the settlement analysis completed to date indicates the risk associated with track movement is significantly reduced by the use of rigid inclusion ground improvement and should be managed by track tamping during construction.

Impact on the A1 Traffic – Both options promote offline construction of the new bridge/embankments whilst traffic is maintained on the existing alignment.

The settlement analysis completed to date (as discussed in Section 5) indicates the risks associated with embankment settlement are significantly reduced by the use of rigid inclusion ground improvement. Although residual settlement of the embankment is still anticipated, the magnitude is significantly reduced.

One of the perceived advantages of the viaduct option is the smaller footprint of earthwork embankment (limited to the tie ins) that is susceptible to settlement.

WLC/Maintenance – The table below provides details of the critical long-term maintenance operations applicable to the two options. The RED text denotes when a maintenance activity is considered more onerous for a particular option.

	OPTION 1: ALLERDENE SINGLE SPAN BRIDGE AND EXTENDED EMBANKMENT STRUCTURE HAS A 120 YEAR SERVICE LIFE	OPTION 2: ALLERDENE VIADUCT (LIMITING EMBANKMENT) STRUCTURE HAS A 120 YEAR SERVICE LIFE
Resurfacing due to residual settlement of carriageway over extended approach embankments.	Settlement analysis indicates residual settlement after construction are significantly reduced through the use of rigid inclusion ground improvement. The frequency/severity of re-surfacing due to settlement is also reduced . The potential area affected is more significant than the viaduct option. Approx Area Impacted = 20000m2	Limited extent of embankments impacted by settlement resulting in potential resurfacing. Approx area impacted = 7000m2
Mechanical Joint replacement	No mechanical joints. Simple APJs to be replaced during surfacing renewal works – circa every 50 years. Expect to be renewed at least 2 times during the bridge service life	Complex mechanical joints (3No) to be renewed every 50yrs Expect to be renewed at least 2 times during the bridge service life. More complex in comparison to APJ renewal works.
Waterproofing renewal	Applicable to both options. Required every 30-40years align with surfacing and joint renewal works. Expect to be renewed at least 3 times during the bridge service life Surface area to be WP is approx. 60x40m	Applicable to both options. However more onerous due to the extent of the deck surface area to be waterproofed. Required every 30-40 years aligned with surfacing and joint renewal works. Expect to be renewed at least 3 times during the bridge service life Surface area to be WP is approx. 290x40m
Bearing replacement	No bearings – not applicable.	Complex mechanical bearings expect to be renewed every 50 years Expect to be renewed at least 2 times during the bridge service life

	OPTION 1: ALLERDENE SINGLE SPAN BRIDGE AND EXTENDED EMBANKMENT STRUCTURE HAS A 120 YEAR SERVICE LIFE	OPTION 2: ALLERDENE VIADUCT (LIMITING EMBANKMENT) STRUCTURE HAS A 120 YEAR SERVICE LIFE
VRS renewal	Required every 50 years Expect to be renewed at least 2 times during the bridge service life Approx. extent - 2No. VRS up to 60m long (bridge edges). 1No. Safety Barrier renewal (central reserve) up to 60m long It is noted that the VRS will transition into a safety barrier beyond the bridge extent over the embankments (2No. safety barriers approx. 230m long). However the renewal of this is less onerous and more cost effective in comparison to a bridge parapet	VRS renewal on the bridge structure more onerous for the viaduct option due to significant length of the VRS required for the viaduct structure. Renewal required every 50years. Expect to be renewed at least 2 times during the bridge service life. Approx. extent - 2No. VRS up to 290m long (bridge edges). 1No. Safety Barrier renewal (central reserve) up to 290m long.
Embankment landscaping	Landscaping liabilities more onerous due to the scale and extent of approach embankment construction Approx area of embankment to be maintained = 17000m2	Landscaping liabilities limited due to the significantly reduced size of embankments Approx area of embankment to be maintained = 7000m2
Inspection (general and principal)	Frequency of PI (every 6 years) and GI (every 2 years) will be the same for both option. However, the access and inspection requirements are less onerous for this option (single span)	Inspection requirements are more onerous due to the size and complexity of the structure (mechanical bearings/joints)
Allerdene Culvert inspection and maintenance	This option retains Allerdene culvert as a structure to be inspected and maintained over its service life	This option allows for Allerdene culvert to be replaced with an open burn that removes all structural inspection and maintenance liabilities

Table 6.2.4 Comparison of Critical Maintenance Activities

Based on the above It is anticipated the maintenance liabilities associated with the single span option would be less onerous over the 120-year service life of the structure.

The critical areas of concern were the risk to movement of the railway track and extensive settlement of the embankment (during and after construction). The settlement analysis conducted indicates both these risks can be reduced via ground improvement in the form of rigid inclusions.

Sustainability (Social/Economic/Environmental) - On one hand the viaduct option is considered more environmentally onerous due to the processing of large quantities of structural steel and concrete material. On the other hand, the single span option is more onerous when considering the volume of earth fill and concrete for the rigid inclusions to be imported (excessive haulage and C02 emissions) on site.

The viaduct option would provide the opportunity to convert the existing Allerdene culvert into an open burn introducing biodiversity benefits that would otherwise not be realised.

The viaduct option allows for an open structural form to be provided allowing for the land beneath the bridge spans to no longer be sterilised for future development as is the case with the single span and extensive embankment solution.

The assessment of the Single span with extended embankment option and the Viaduct (limiting embankment option has shown the two options to be feasible. The preferred option would require a compromise regarding the long-term maintenance liabilities associated with the bigger viaduct structure, and the management of the settlement and the historical mining risk.

It is anticipated the preferred option to be taken forward will be heavily influenced by the following:

- The HE Project Team confirmation on which parameters are of greater importance and therefore should be weighted accordingly.
- The delivery partners experience and knowledge of ground improvement works (rigid inclusions) and their confidence on whether they can manage the settlement risk to within acceptable limits during construction.
- Confirmation from the HE OD team on the limits of residual settlement considered acceptable after construction.
- The delivery partners experience and knowledge of treating (grouting) or mitigating the risk from deep historical mine workings beneath the piers/abutments.

7. CONCLUSION & RECOMMENDATION

7.1 CONCLUSION

Previous works established the existing Allerdene bridge should be replaced with a new off-line structure. Preliminary analysis demonstrated that a single span (over the East Coast Main Line) 62m steel composite integral bridge would provide a robust cost-effective bridge solution with significant long-term maintenance benefits.

However, further analysis based on the ground investigation had identified potential risks associated with the single span bridge due to the earthwork embankment settlement on the approach to the bridge requiring considerable ground improvement works. Therefore, an alternative option was developed that best mitigates the major risk associated with ALL the following:

- Reduce the impact of the approach earthwork embankment settlement during both construction and in service as much as reasonably practicable
- Reduce the impact of the new bridge construction over the railway, potential movement of the ECML due to heave
- Simplify/Eliminate the proposed NGN protection works
- Simplify/Eliminate the work to accommodate the existing Allerdene Culvert

Works to date indicates that a 6No. span steel composite viaduct (290m long) would provide the most robust solution to mitigate the above.

The structural form (steel composite deck) and span over the railway is no worse than the single span structure that was agreed in principle with NWR. The NGN diversion could be readily accommodated under one of the new bridge spans and complex works associated with the protection of the NGN mains are avoided. The existing Allerdene culvert (dilapidated in its current state) can be removed in its entirety and readily replaced with an open burn that has maintenance and environmental benefits.

The assessment of the Single span with extended embankment option and the Viaduct (limiting embankment) option has shown the two options to be feasible. The preferred option would require a compromise regarding the long-term maintenance liabilities associated with the bigger viaduct structure, the management of the settlement and the historical mining risk.

It is anticipated the preferred option to be taken forward will be heavily influenced by the following:

- The HE Project Team confirmation on which parameters (cost/programme/buildability etc) are of greater importance and therefore should be weighted accordingly.
- The delivery partners experience and knowledge of ground improvement works (rigid inclusions) and their confidence on whether they can manage the settlement risk to within acceptable limits during construction.
- Confirmation from the HE OD team on the limits of residual settlement considered acceptable after construction.
- The delivery partners experience and knowledge of treating (grouting) or mitigating the risk from deep historical mine workings beneath the piers/abutments.

Options in-between the single span and the multispan viaduct (known as a hybrid option) comprising a 3-span bridge structure (main span over the railway) with embankments, has been considered as part of this study. The current view is the 3-span structure, whilst mitigating some of the risk of settlement around the structure footprint and NWR interface, would pose the following challenges:

- Increase approach embankments areas that are susceptible to residual settlement when considering rigid inclusions as the preferred form of ground improvement
- NGN services would need still need to be protected
- Allerdene culvert would need to be replaced with a new culvert structure requiring access for inspection and maintenance

7.2 RECOMMENDATION

To retain flexibility for the detailed design stage, a multi span viaduct should be considered as an alternative solution to the single span integral bridge and extended embankment solution.

Based on the studies to date, it is recommended the following should be undertaken to further validate the findings of this report.

- Formal AIP submission for the Steel Composite Viaduct Option to NWR – This is to ensure NWR provide written agreement in principle to the development of the viaduct proposal should this be the preferred option.
- Supplementary ground investigation at each proposed pier location.

Appendix A

REFERENCES AND GLOSSARY OF TERMS AND ACRONYMS

APPENDIX A-1

REFERENCES

[1] HA551462-WSP-GEN-BCH-RP-D-0000_051 S2 P2.0 Scheme Assessment Report – A1 Birtley to Coal House; WSP; 10th July 2017

[2] BTN05: TD 22/06 Mainline Lane Configuration - Final Assessment; WSP; 8th May 2017

[3] Structure Option Report 3 Allerdene Railway Underbridge (dated March 2018)

[4] Structure Option Report 2 Allerdene Culvert (dated Feb 2019)

[5] Structure Option Report 9 ADS Gantries (dated March 2018)

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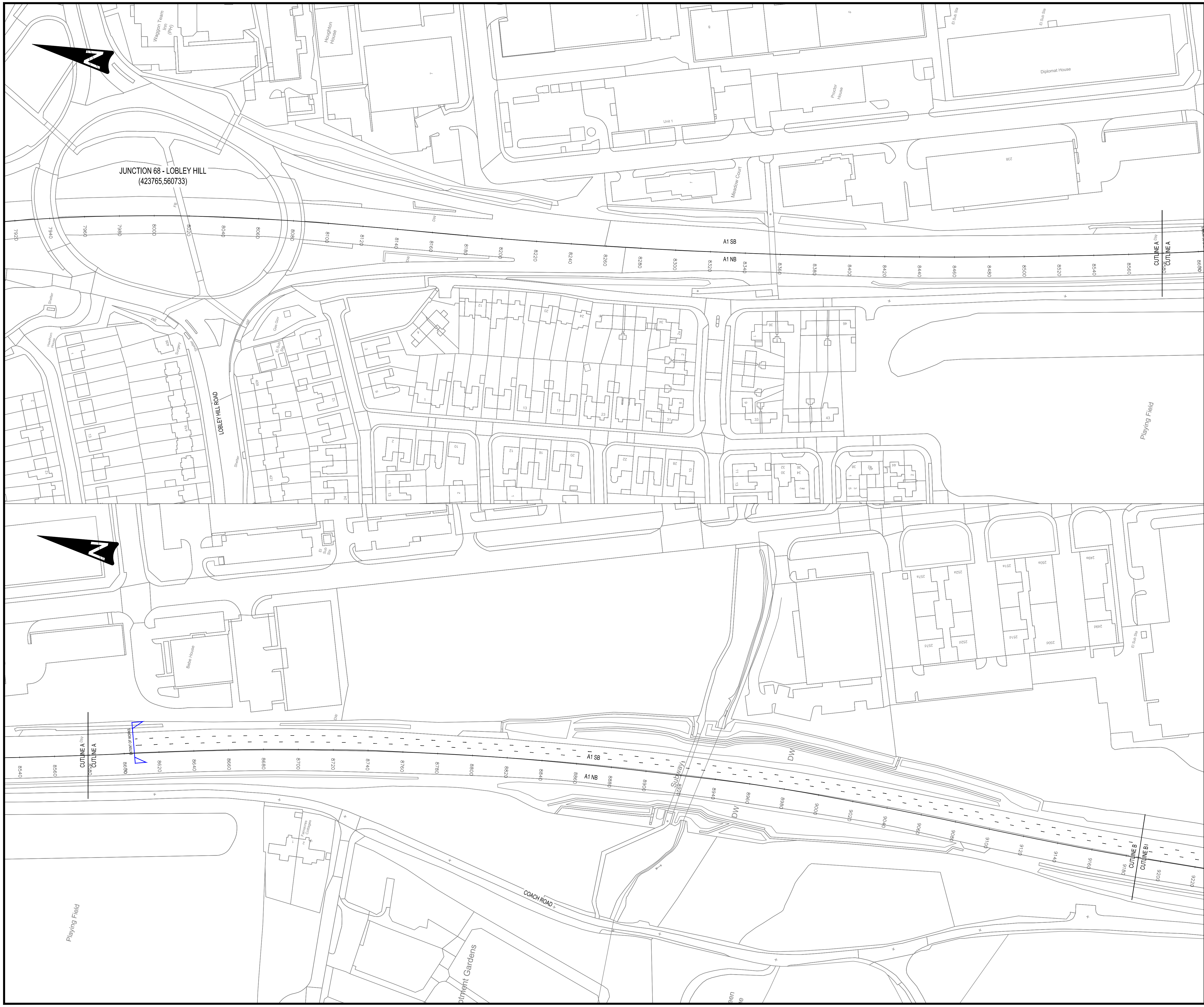
APPENDIX A-2

GLOSSARY OF TERMS AND ACRONYMS

Acronym/Term	Description
DCO	Development Consent Order
NGWB	Newcastle/Gateshead Western Bypass
PCF	Project Control Framework
RIS	Roads Investment Strategy
SOBC	Strategic Outline Business Case
TAG	Transport Appraisal Group
TAP	Transport Appraisal Process
NWR	Network Rail
EAST	Early Appraisal Sifting Tool
NGN	Northern Gas Networks
ADS	Advanced direction signage
CMC	Controlled modulus column
GDR	Geotechnical Design Report
SOR	Structure Option Report
GIR	Ground Investigation Report
PSSR	Preliminary Sources Study Report
HAGDMS	Highways Agency Geotechnical Data Management System
CMRA	Coal Mining Risk Assessment

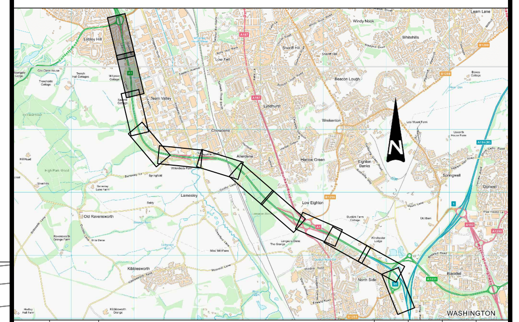
Appendix B

SCHEMATIC SCHEME PLAN



KEY

- EXISTING CARRIAGEWAY TO BE RETAINED WHERE VERTICAL ALIGNMENT PERMITS
- NEW CARRIAGEWAY CONSTRUCTION
- EXISTING HIGHWAY BOUNDARY TO BE RETAINED (WHERE AVAILABLE)
- PROPOSED HIGHWAY BOUNDARY FENCE
- PROPOSED GANTRY LOCATION
- PROPOSED RETAINING WALL
- EXISTING STRUCTURE
- PROPOSED NEW/WIDENED STRUCTURE
- DRAINAGE ATTENUATION POND
- EXISTING FOOTPATH TO BE RETAINED
- PROPOSED FOOTPATH DIVERSION/ UPGRADE
- PROPOSED NETWORK RAIL OLE
- NETWORK RAIL LAND BOUNDARY



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P02	06/09/16	MINOR AMENDMENTS TO EWKS & STRUCTURES, CHAINAGE ADDED	JWL	CP	---	NGR
P03	10/02/17	ISSUED FOR PUBLIC CONSULTATION	JWL	MB	SG	NGR
P04	10/02/17	DESIGN DEVELOPMENT POST PUBLIC CONSULTATION	JWL	MB	SG	NGR
P05	02/08/17	UPDATE FOLLOWING STAGE 2 TRAFFIC MODEL	JWL	MB	SG	NGR
P06	24/01/18	FOR STATUTORY PUBLIC CONSULTATION	AW	MB	SG	NGR
P07	08/06/18	UPDATES FOLLOWING THE ISSUE OF BEP	JS	IA	SG	NGR
P08	26/07/18	AMENDMENTS FOLLOWING UPDATE TO THE TRAFFIC MODEL	JS	MB	SG	NGR

Suitability: Work in Progress
Status: S0

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Client: highways england

Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title:

OFFLINE REPLACEMENT OF ALLERDENE BRIDGE GENERAL ARRANGEMENT SHEET 1 OF 6

Scale	Drawn	Eng. Check	Approved	Authorised
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Original Size: A1	Date: 26/07/18	Date: 26/07/18	Date: 26/07/18	Date: ---

Drawing Number
HE PIN: HE551462 | Originator: WSP | Volume: HGN | Revision: P08
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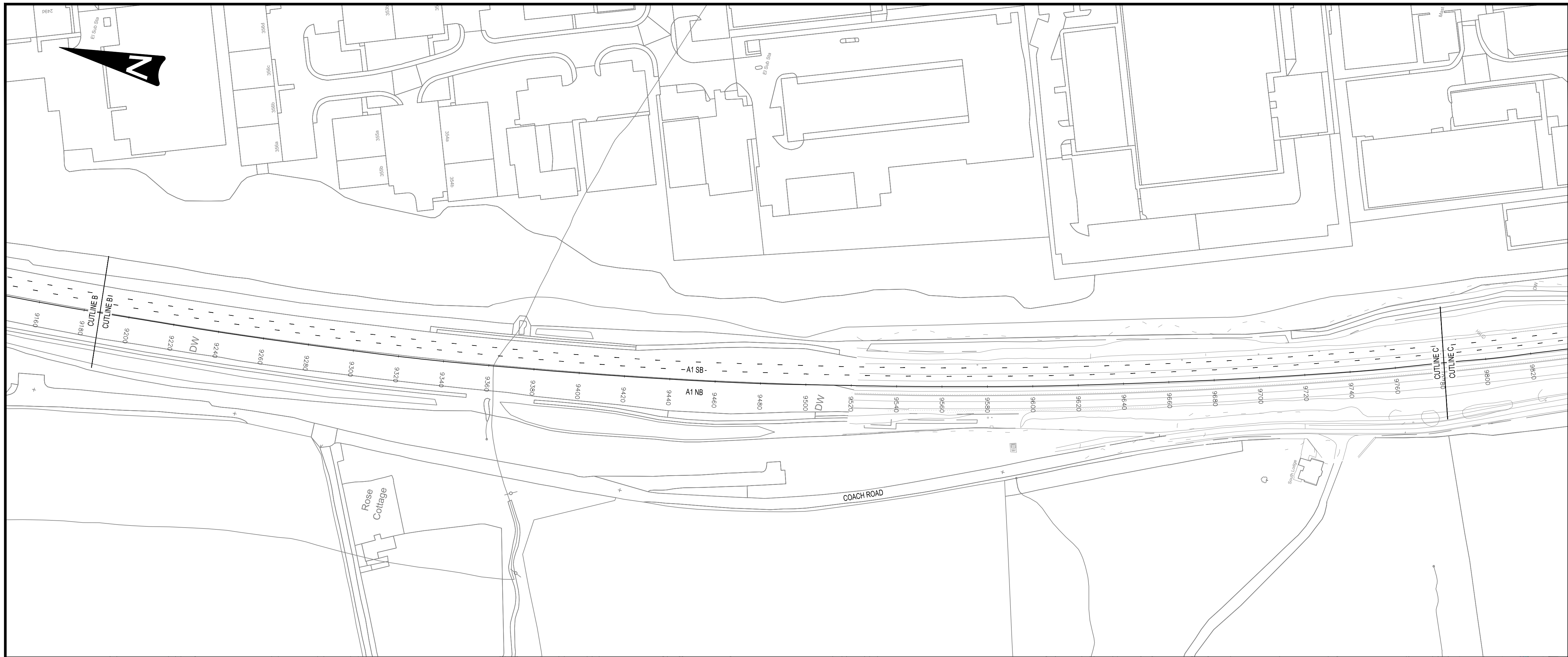

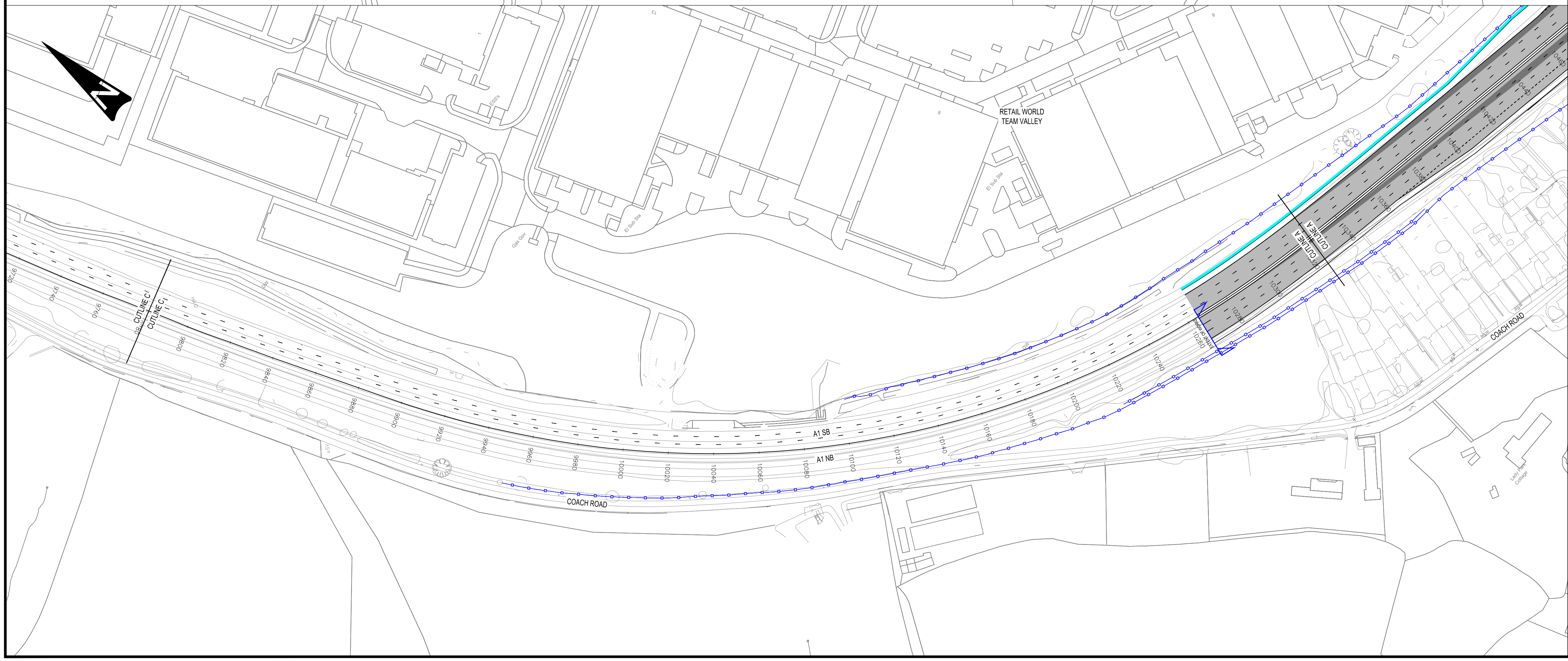

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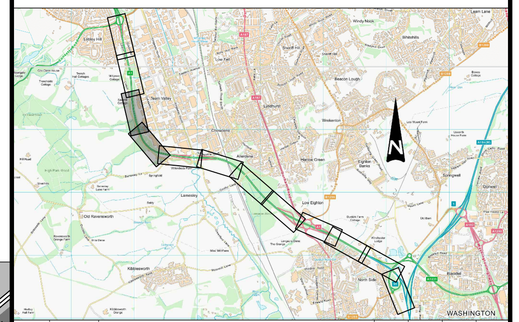
- EXISTING FOOTPATH TO BE RETAINED
- PROPOSED FOOTPATH DIVERSION/ UPGRADE
- PROPOSED NETWORK RAIL OLE
- NETWORK RAIL LAND BOUNDARY



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P02	06/09/16	MINOR AMENDMENTS TO EWKS & STRUCTURES, CHAINAGE ADDED	JWL	CP	---	NGR
P03	10/02/17	ISSUED FOR PUBLIC CONSULTATION	JWL	MB	SG	NGR
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P07	08/06/18	UPDATES FOLLOWING THE ISSUE OF BEP	JS	IA	SG	NGR
P08	26/07/18	AMENDMENTS FOLLOWING UPDATE TO THE TRAFFIC MODEL	JS	MB	SG	NGR

Suitability: Work in Progress
Status: S0

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Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title:

OFFLINE REPLACEMENT OF ALLERDENE BRIDGE GENERAL ARRANGEMENT SHEET 2 OF 6

Scale	Drawn	Eng. Check	Approved	Authorised
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Original Size	Date	Date	Date	Date
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Drawing Number

HE PIN	Originator	Volume	Revision
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Section	Type	ID	Direction	Type	Role	Number	PW Stage Code
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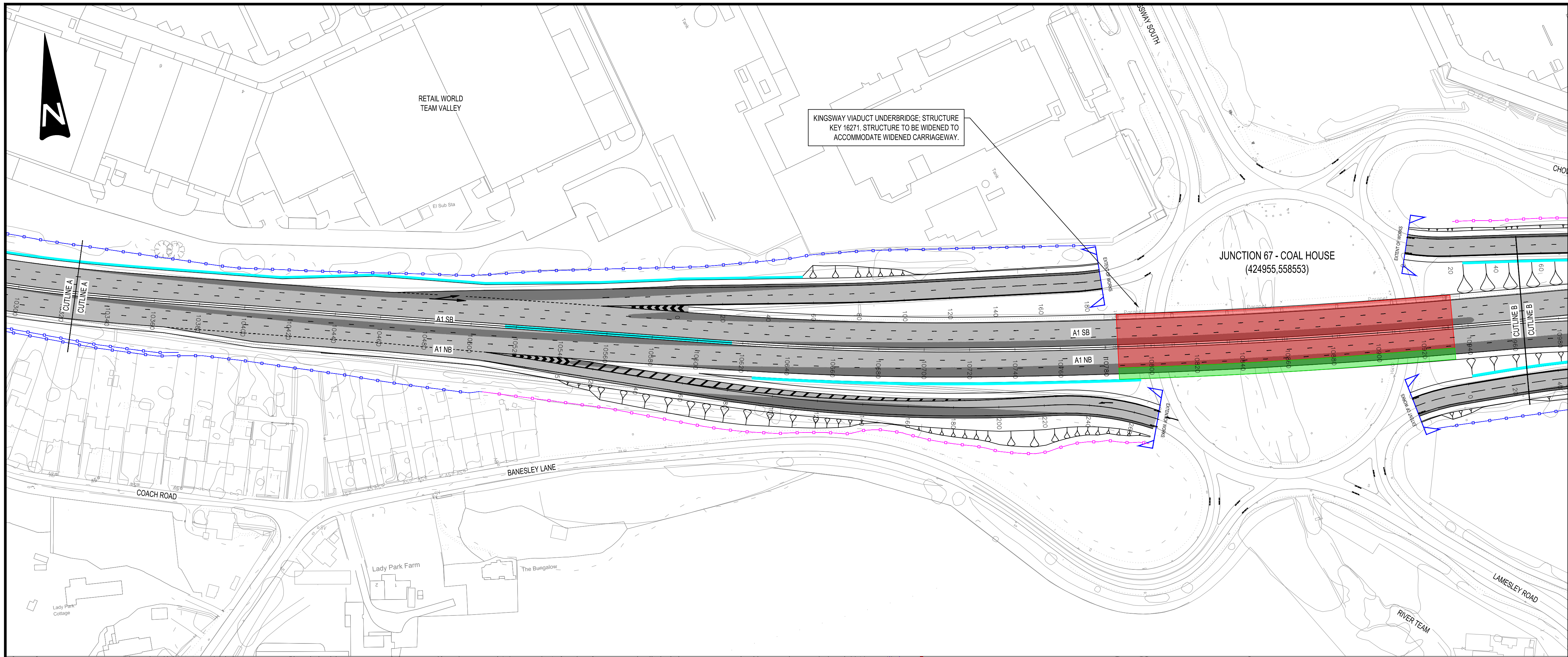
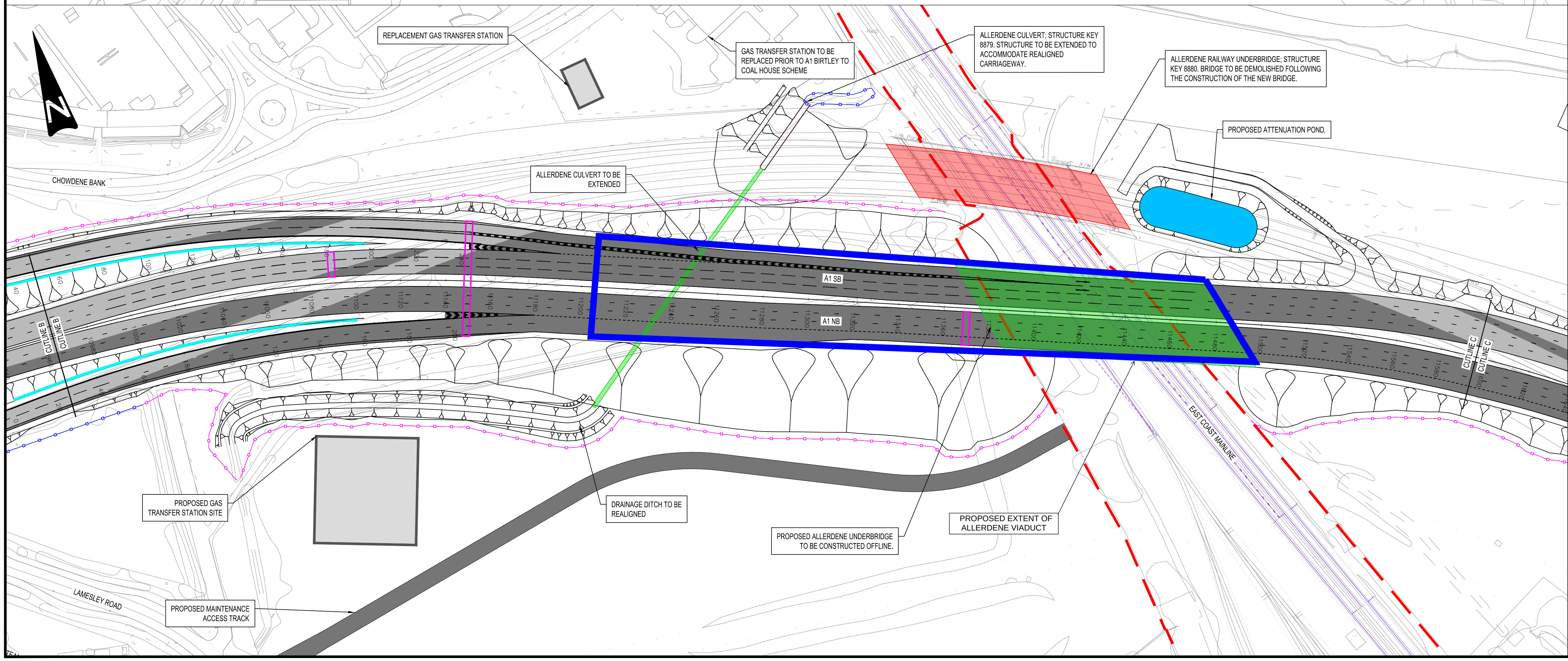
Confidential





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- PROPOSED NETWORK RAIL OLE
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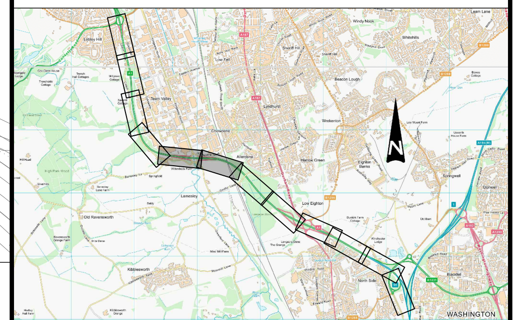

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P07	08/06/18	UPDATES FOLLOWING THE ISSUE OF BEP	JS	IA	SG	NGR
P08	26/07/18	AMENDMENTS FOLLOWING UPDATE TO THE TRAFFIC MODEL	JS	MB	SG	NGR

Suitability: Work in Progress | Status: S0

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Client: highways england

Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title: OFFLINE REPLACEMENT OF ALLERDENE BRIDGE
GENERAL ARRANGEMENT
SHEET 3 OF 6

Scale	Drawn	Eng. Check	Approved	Authorised
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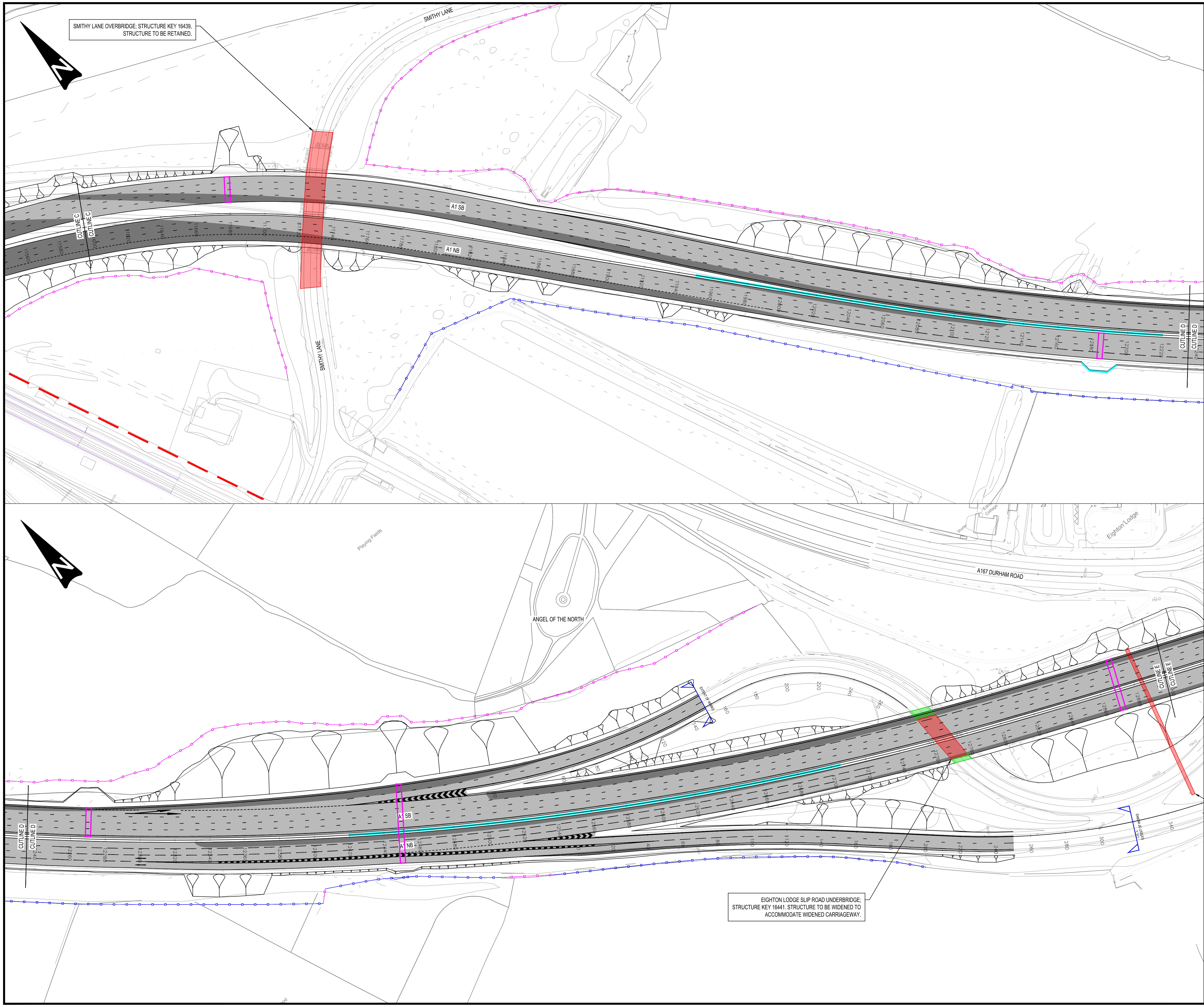

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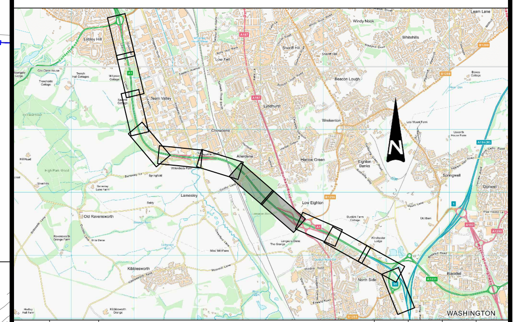
- NETWORK RAIL LAND BOUNDARY



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Suitability: Work in Progress
Status: S0

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Client: highways england

Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title: OFFLINE REPLACEMENT OF ALLERDENE BRIDGE GENERAL ARRANGEMENT SHEET 4 OF 6

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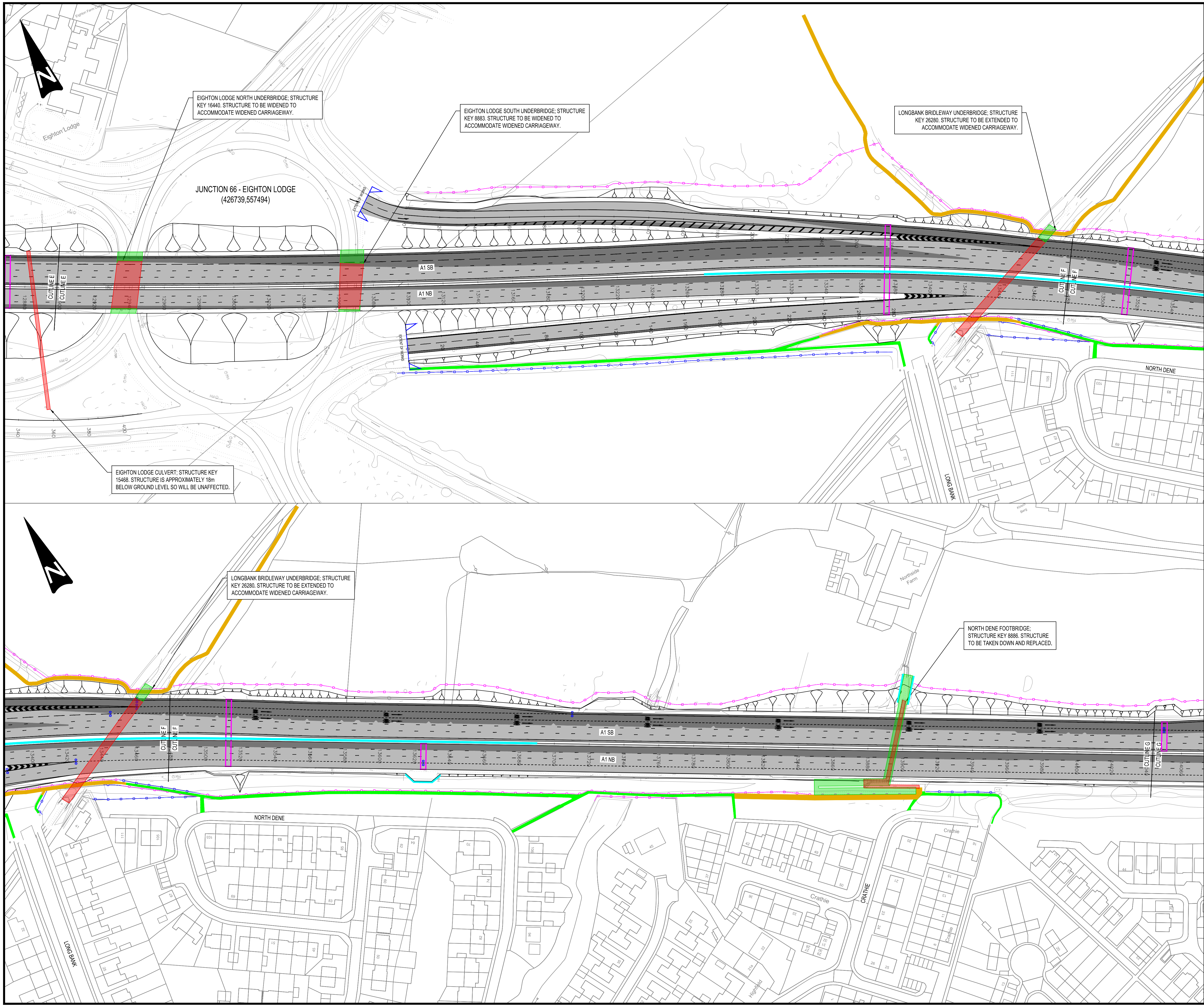

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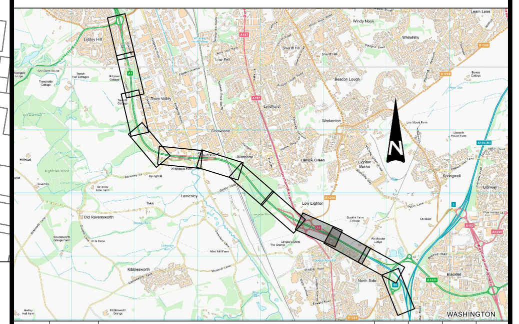

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Suitability: Work in Progress
Status: S0

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Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title: OFFLINE REPLACEMENT OF ALLERDENE BRIDGE GENERAL ARRANGEMENT SHEET 5 OF 6

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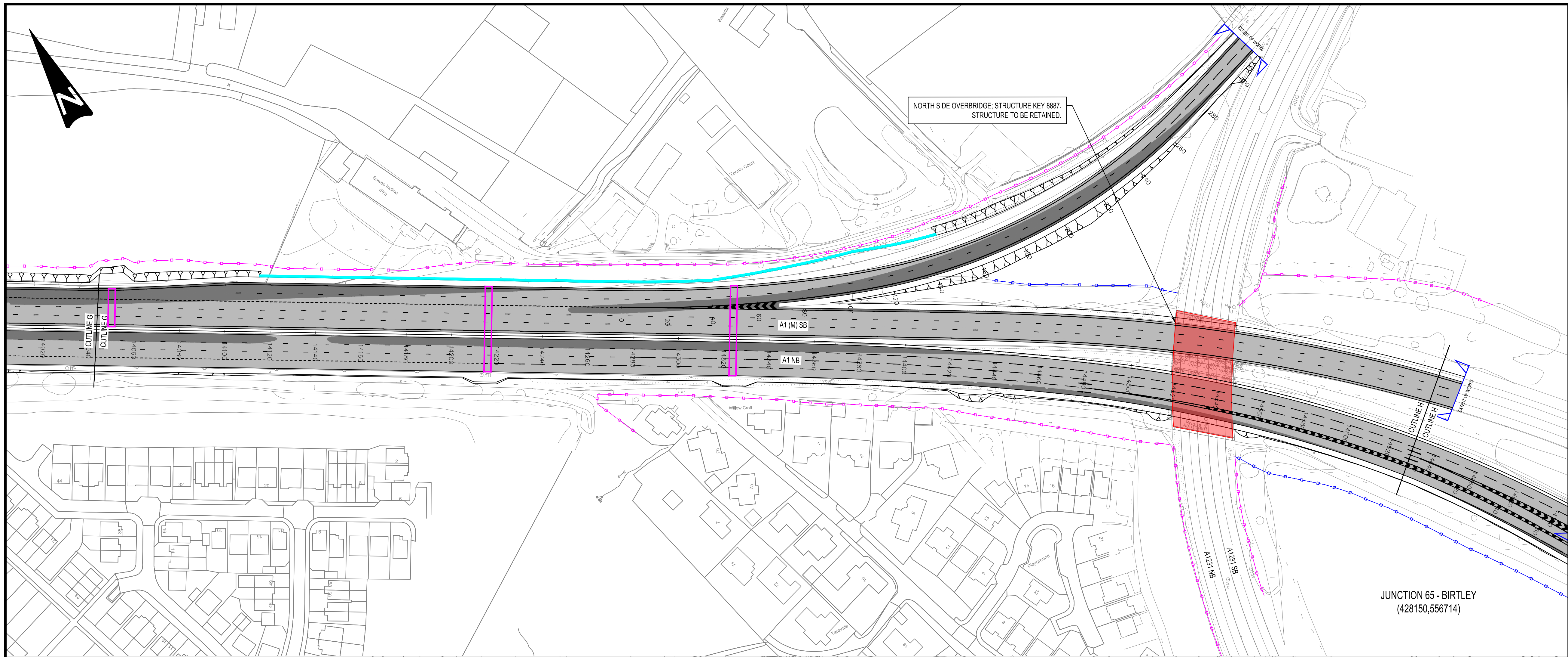

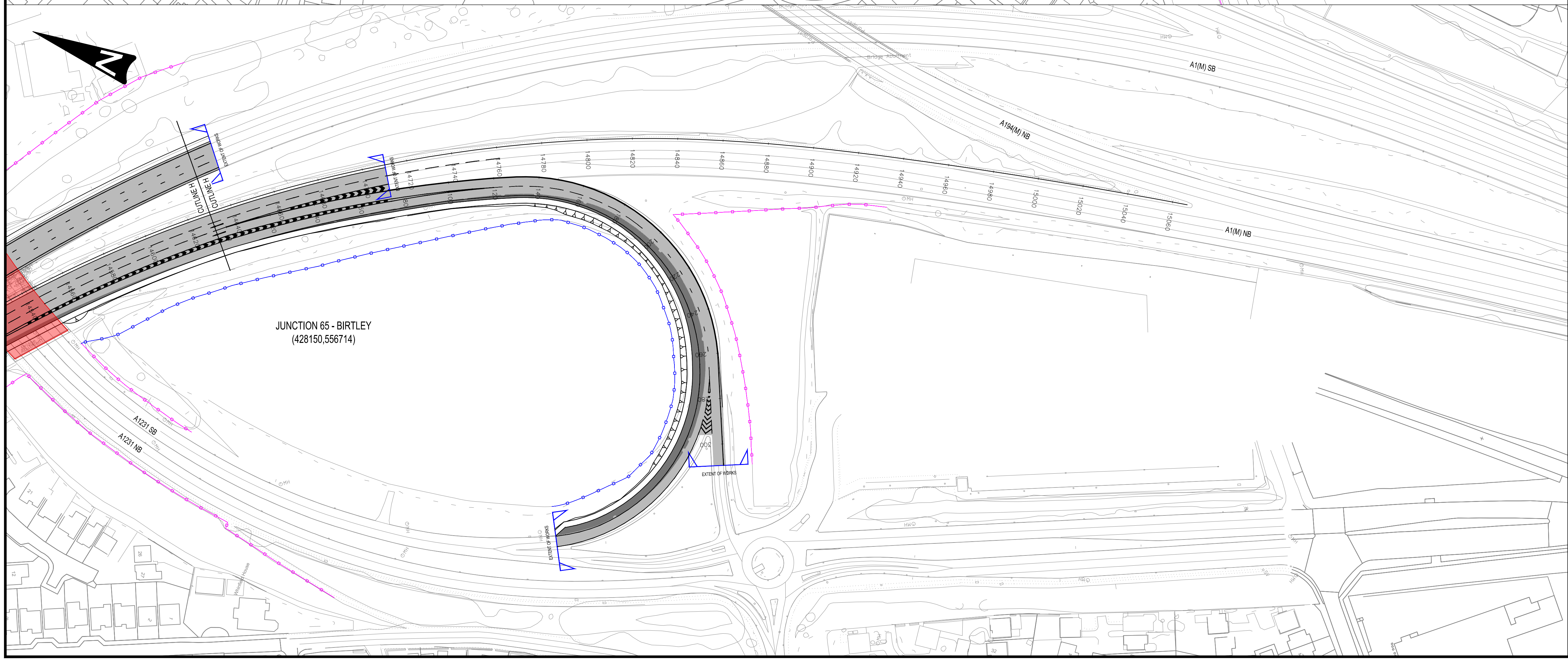

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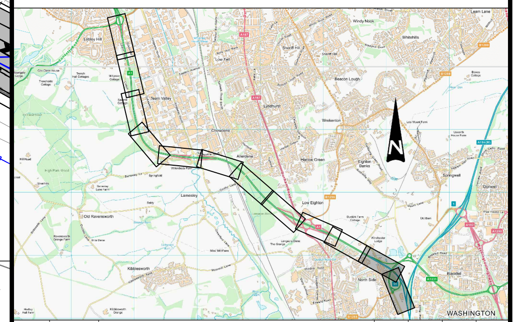

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Suitability: Work in Progress
Status: S0

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Client: highways england

Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title:

OFFLINE REPLACEMENT OF ALLERDENE BRIDGE GENERAL ARRANGEMENT SHEET 6 OF 6

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Drawing Number
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Section: S4 | Type | ID | Direction: X | Type: DR | Role: CH | Number: 01006 | PW Stage Code: 3

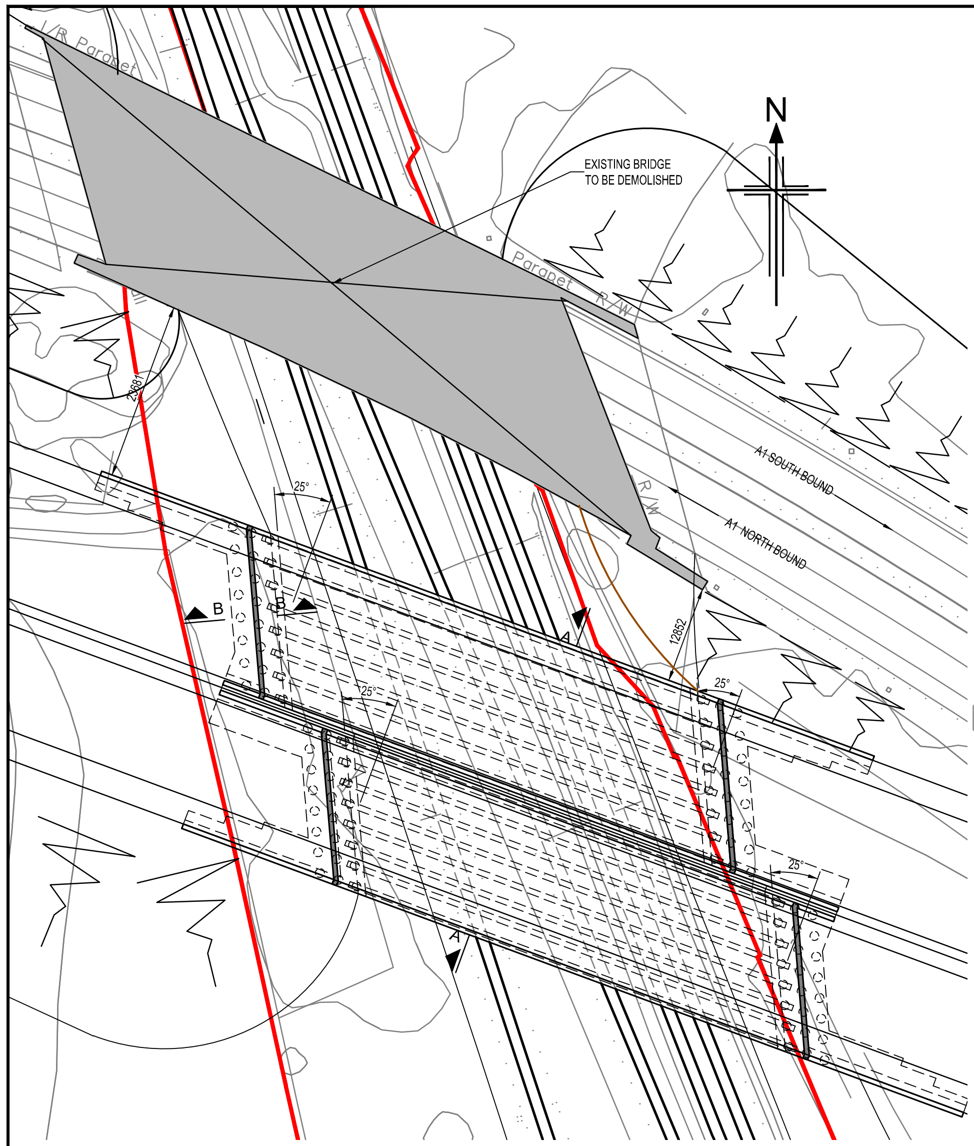
Confidential

Appendix C

SINGLE SPAN AND EXTENDED EMBANKMENT OPTION

APPENDIX C-1

GENERAL ARRANGEMENT



PLAN
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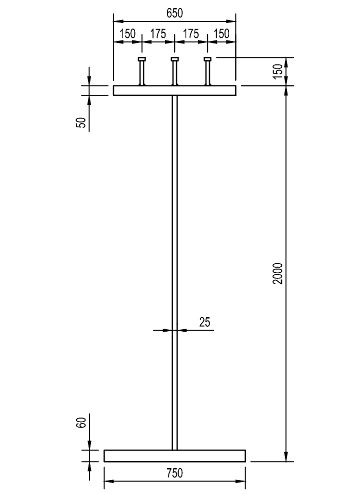
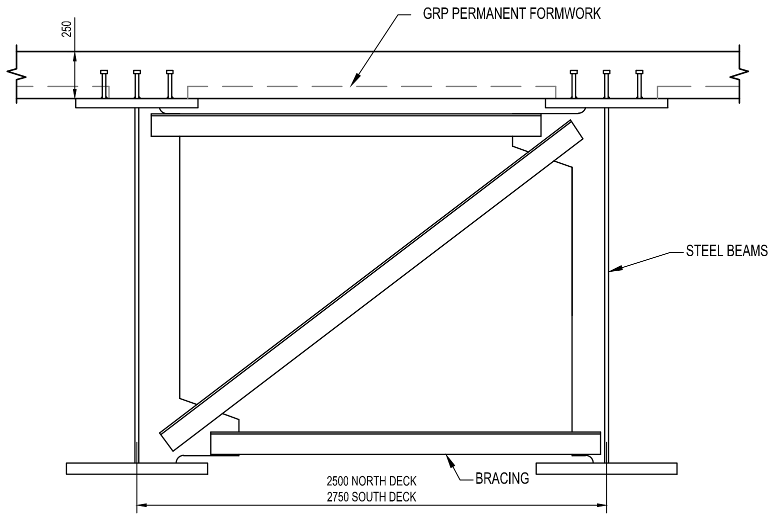
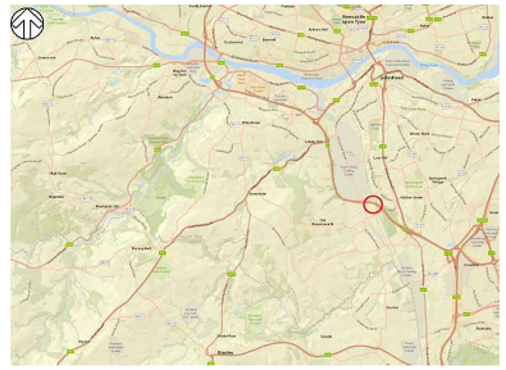


INDICATIVE TYPICAL WEATHERING STEEL GIRDER
SCALE 1:20



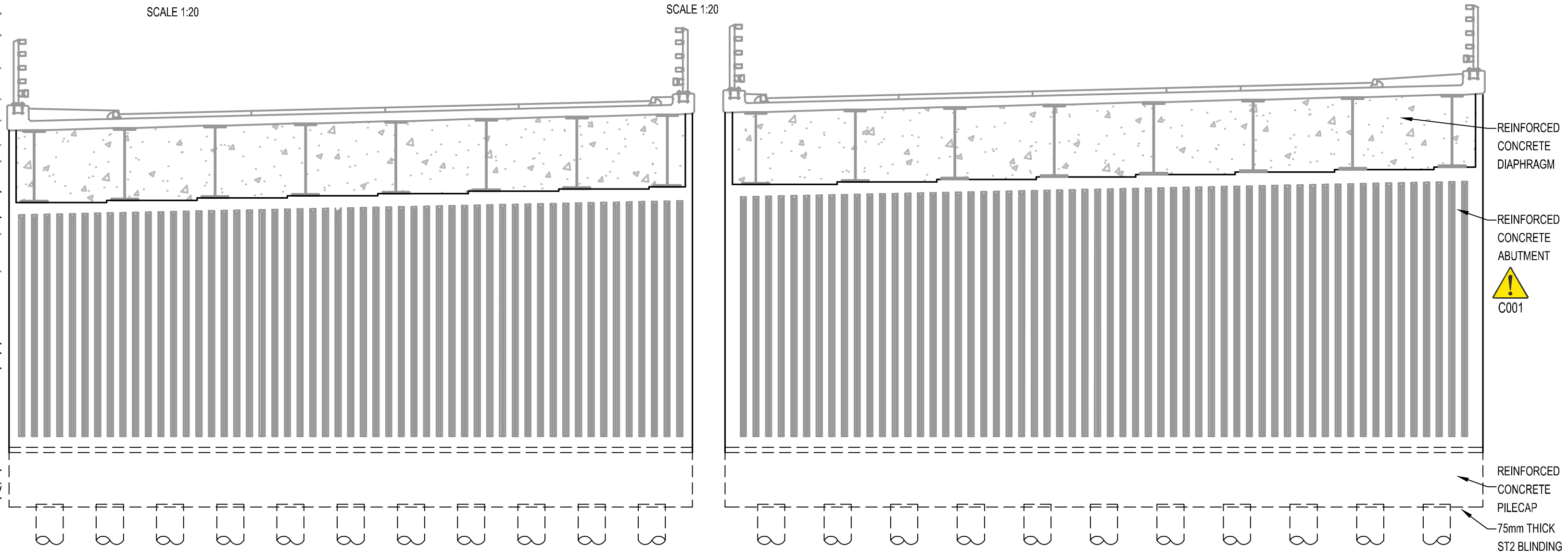
TYPICAL GRP FORMWORK DETAIL ON SOUTH DECK
SCALE 1:20



KEY PLAN
SCALE 1:5000

NOTES

1) ALL DIMENSIONS ARE IN MM UNLESS STATED OTHERWISE
2) ALL LEVELS ARE IN METRES UNLESS STATED OTHERWISE
3) DO NOT SCALE IN CASE OF ANY DOUBTS, OMISSIONS OR ERRORS SEEK CLARIFICATION FROM THE DESIGNER
4) THE BRIDGE SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE RELEVANT DRAWINGS AND SPECIFICATION FOR HIGHWAY WORKS (SHW)
5) THE DESIGN OF ALL OLE WORKS TO BE ACCOMMODATED ARE DETAILED IN THE ALLERDENE RAILWAY BRIDGE OLE GRIP 3 REPORT
6) THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DIVERSION OF ALL SERVICES IMPACTING THE WORKS, DETAIL OF SERVICES ARE SHOWN ON THE SERVICES INFORMATION DRAWINGS AND APPENDIX 1/16 OF THE SHW
7) THE CONTRACTOR IS RESPONSIBLE FOR ALL TEMPORARY WORKS DESIGN AND INSTALLATION TO FACILITATE THE PERMANENT WORKS
8) THE CONTRACTORS ATTENTION IS DRAWN TO THE FOLLOWING NWR CONSTRAINTS TO BE MAINTAINED DURING THE WORKS
   - THE MINIMUM VERTICAL CLEARANCE FROM THE TOP OF THE RAIL TO THE DECK SOFFIT IS 6.7M
   - THE MINIMUM LATERAL CLEARANCE FROM THE RUNNING LINE TO THE PROVISION OF OLE MASTS IS 3.0M
   - THE MINIMUM SAFETY ZONE TO BE MAINTAINED FROM THE OLE MAST AND THE FENCE LINE (BEHIND WHICH THE BRIDGE SHALL BE CONSTRUCTED) IS 3.0M
   - THE MINIMUM LATERAL CLEARANCE BETWEEN THE RUNNING LINE AND THE FACE OF THE BRIDGE ABUTMENTS IN THE PERMANENT CONDITION IS 4.5M
9) THE CONTRACTOR SHALL REFER TO THE PRE CONSTRUCTION H&S INFORMATION FOR DETAILS OF THE H&S RISKS AND HOW THESE HAVE BEEN REDUCED/ELIMINATED DURING THE DESIGN PROCESS. KEY RESIDUAL RISKS THAT HAVE NOT BEEN ELIMINATED ARE RECORDED IN THE H&S TABLE AND HIGHLIGHTED ON THIS DRAWING



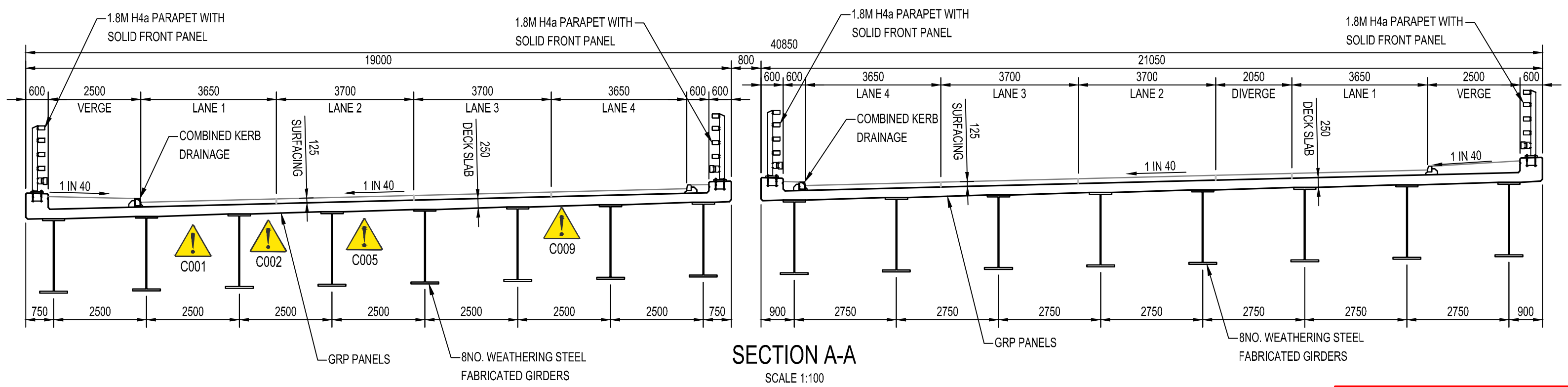
TYPICAL ABUTMENT ELEVATION
SCALE 1:100

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
CONSTRUCTION
REF C001 - WORKING AT HEIGHT
REF C002 - PERSONNEL AND PLANT ENCROACHING THE LIVE RAILWAY
REF C005- HEAVY LIFTING -STEEL GIRDERS
REF C009- INSTABILITY OF GRP DECK PLANKS

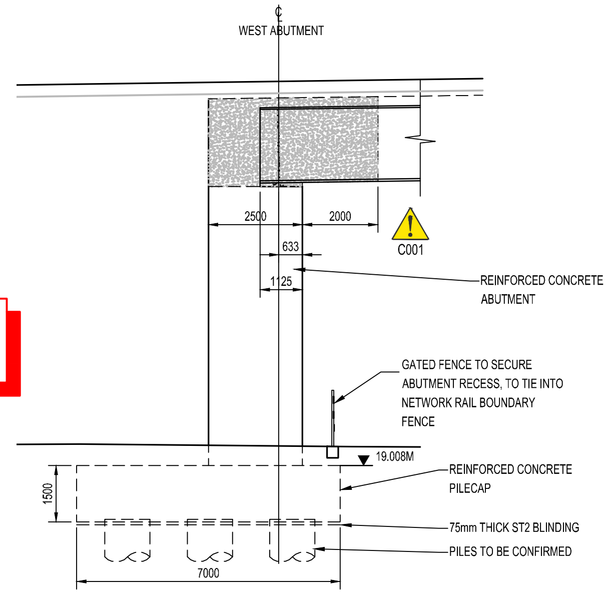
SAFETY, HEALTH AND ENVIRONMENTAL SYMBOL LEGEND

⚠ INDICATES A RESIDUAL RISK AS A WARNING

Rev.	Date	Description	By	Chk'd	App'd
P01.1	14/11/16		---	---	---

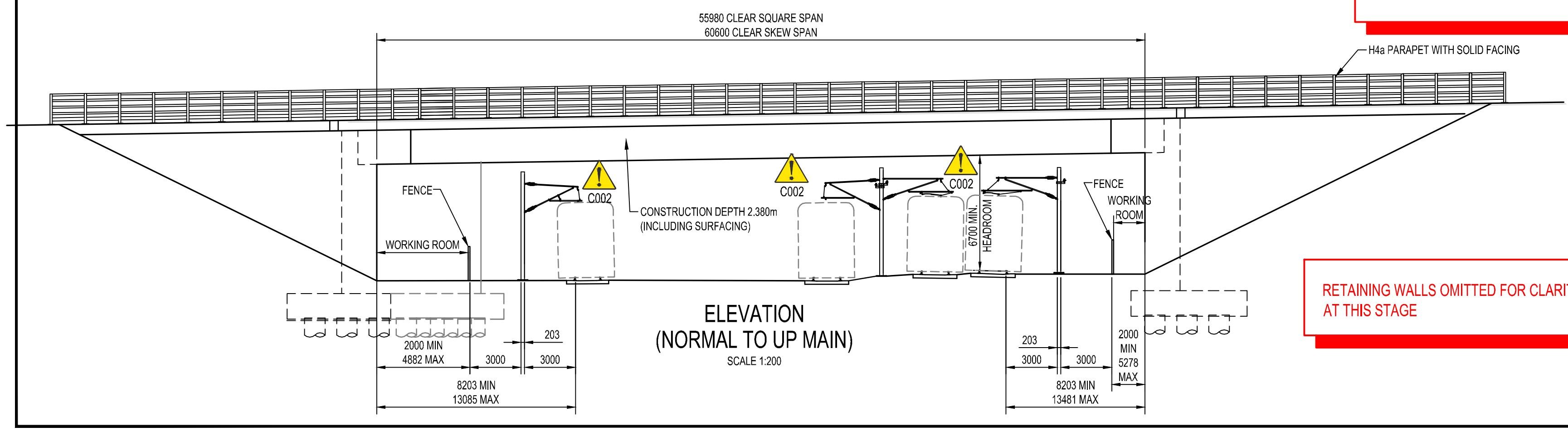


SECTION A-A
SCALE 1:100



SECTION B-B
SCALE 1:100

BRACING OMITTED FOR CLARITY AT THIS STAGE



ELEVATION
(NORMAL TO UP MAIN)
SCALE 1:200

RETAINING WALLS OMITTED FOR CLARITY AT THIS STAGE

WSP
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LS11 0DL
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Client
Working on behalf of
highways england

Project Title
A1 BIRTLEY TO COALHOUSE

Drawing Title
ALLERDENE OFFLINE REPLACEMENT
SINGLE SPAN INTEGRAL BRIDGE
GENERAL ARRANGEMENT

Scale	Drawn	Checked	Approved	Authorised
AS SHOWN	---	---	---	---
Original Size	Date	Date	Date	Date
A1	---	---	---	---

Drawing Status: Initial Status or WIP
Suitability: S0

Drawing Number

Project	Originator	Volume
HE551462	WSP	SBR

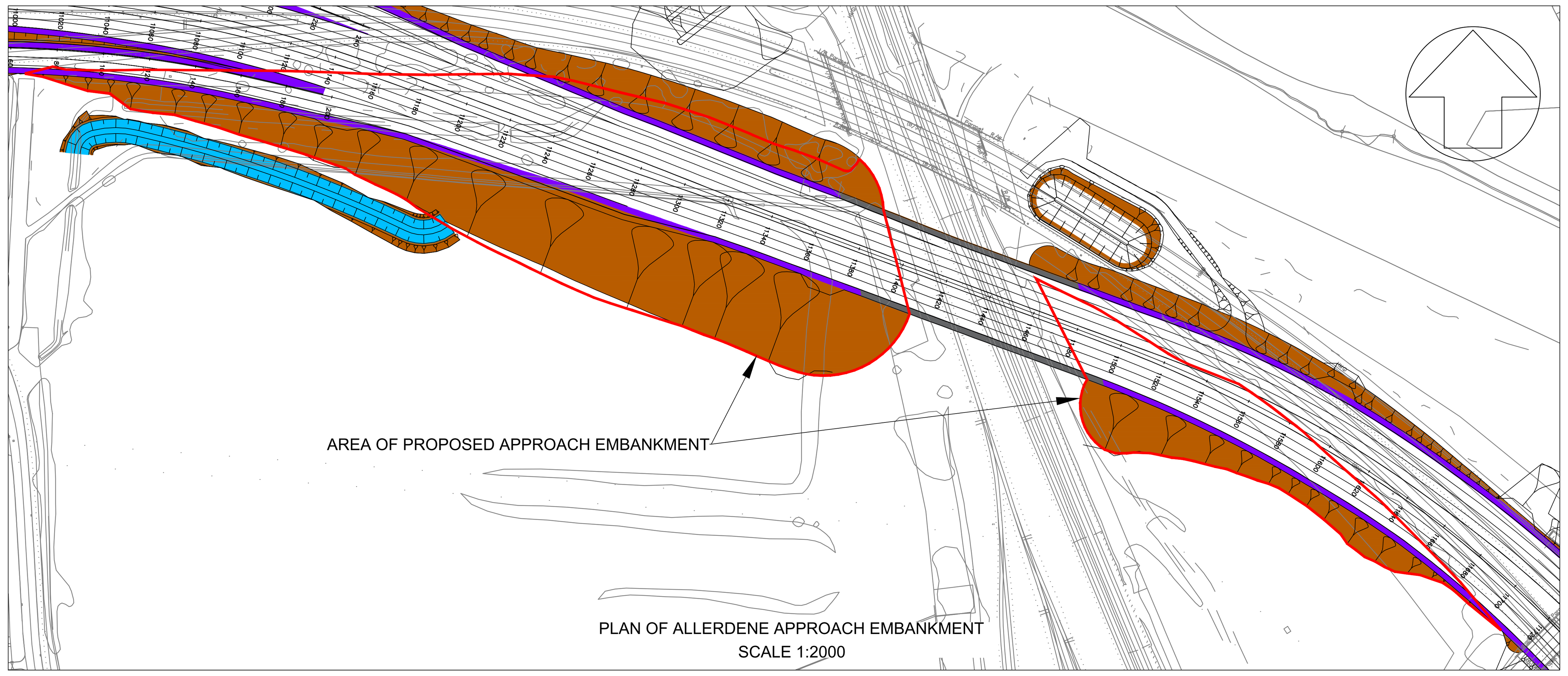
Location	Type	Role	Number
BCH	DR	S	00022

Project Ref. No.
Revision: P01.1

APPENDIX C-2

EMBANKMENT DETAILS

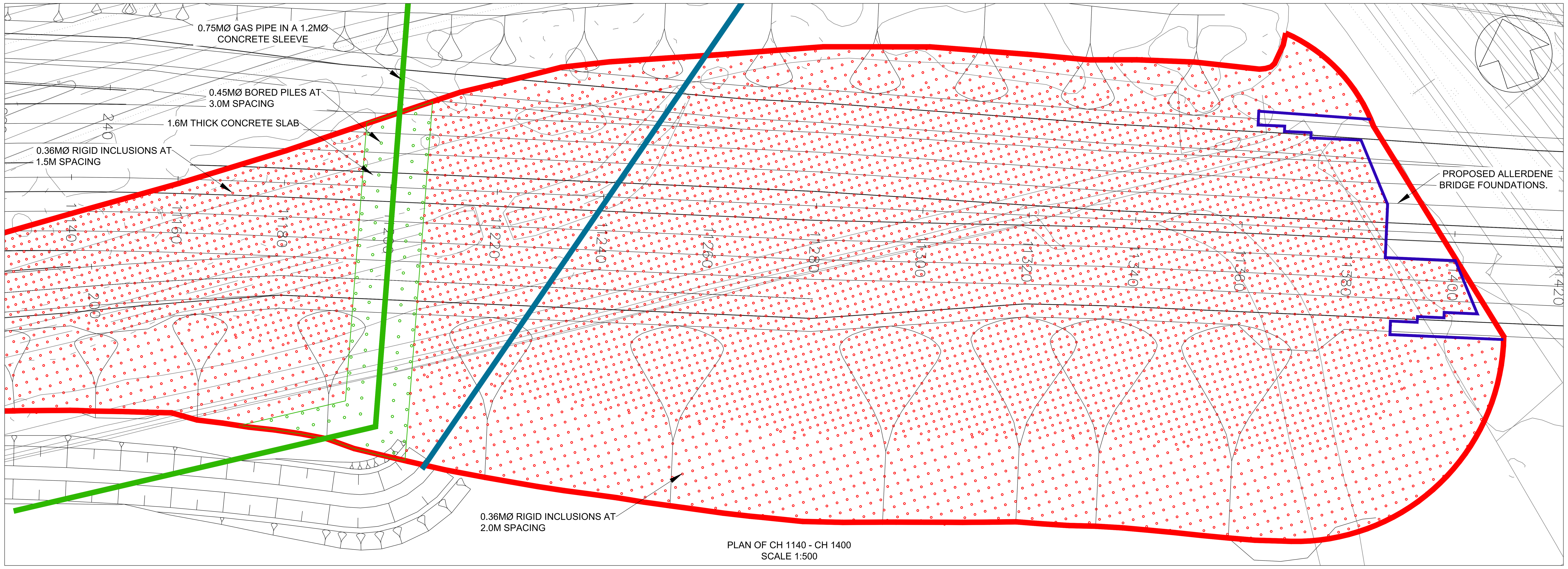
DO NOT SCALE



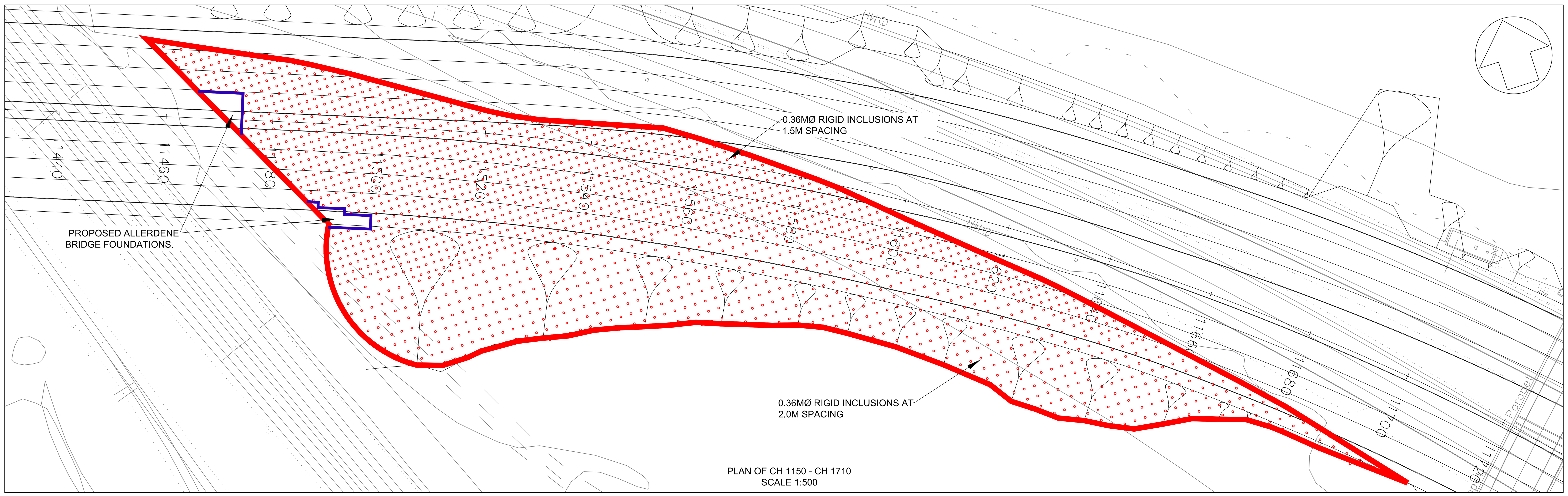
PLAN OF ALLERDENE APPROACH EMBANKMENT
SCALE 1:2000

PLAN OF CH 1000 - CH 1140
SCALE 1:500

APPROXIMATELY 9,975 RIGID INCLUSIONS



PLAN OF CH 1140 - CH 1400
SCALE 1:500



PLAN OF CH 1150 - CH 1710
SCALE 1:500

NOTES:

1. DO NOT SCALE FROM DRAWING.
2. DRAWING FOR INFORMATION ONLY.
3. THIS DRAWING IS TO BE READY IN CONJUNCTION WITH DRAWING HE551462-WSP-HGT-BCH-DR-GE-00107B.
4. POSITION OF RIGID INCLUSIONS ARE INDICATIVE ONLY. FINAL LOCATIONS AND SPACING OF RIGID INCLUSIONS TO BE DETERMINED FOLLOWING DETAILED DESIGN.
5. DESIGN OF ANY TEMPORARY WORKS REQUIRED SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
6. THE INDICATIVE SPACING OF THE RIGID INCLUSIONS ARE BASED ON THE MOST LIKELY GROUND CONDITIONS AND MOST LIKELY MATERIAL PROPERTIES. REFER TO THE : A1 BIRTLEY TO COAL HOUSE: ALLERDENE EMBANKMENT GROUND IMPROVEMENT TECHNICAL MEMO FOR DETAILS OF HOW RIGID INCLUSIONS SPACING VARIES WITH THE WORST AND BEST CASE GROUND CONDITIONS AND MATERIAL PROPERTIES.
7. THE 5 ROWS OF CONTROLLED MODULUS COLUMNS CLOSEST TO THE OUTSIDE OF THE EMBANKMENT FOOTPRINT TO BE REINFORCED WITH 1 X 25-40mm CENTRAL BAR TO CIRCA 20m.
8. CONTROLLED MODULUS COLUMNS TO BE BETWEEN 350-400mm IN DIAMETER.

KEY:

- EXTENT OF BAND DRAINS WITHIN EMBANKMENT
- PROPOSED EARTHWORKS
- BRIDGE FOUNDATION TRANSITION ZONE
- 000.000 SCHEME CHAINAGE
- PROPOSED GAS MAIN
- PROPOSED CULVERT

RIGID INCLUSIONS

X SPACING

Rev.	Date	Description	By	Eng. Chk	Disc. Chk	App'd
			---	---	---	---

Suitability: FOR INFORMATION
Status: S2

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Park Millshaw Park Lane
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LS11 0DL, UK
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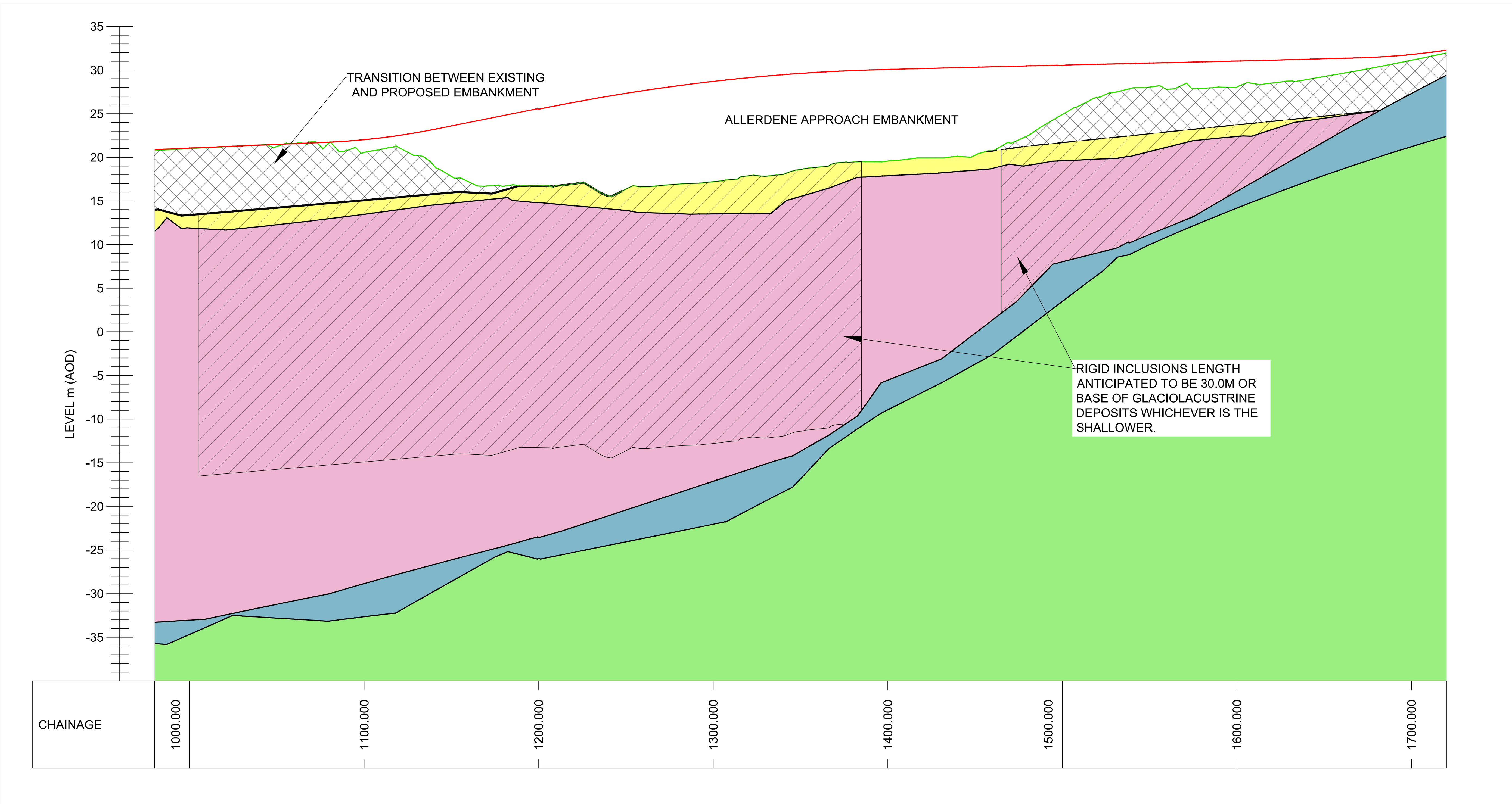
Client: highways england

Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title: ALLERDENE BRIDGE (SINGLE SPAN) INDICATIVE GROUND IMPROVEMENT OPTION - RIGID INCLUSIONS

Scale	Drawn	Eng. Check	Approved	Authorised
As Shown	---	---	---	---
Original Size: A1	Date: ---	Date: ---	Date: ---	Date: ---

Drawing Number
HE PIN: HE551462 | Originator: WSP | Volume: HGT | Revision: -
Section: ZZ | Type: DR | Role: CE | Number: 00107A | PW Stage Code: -



LONG SECTION THROUGH CENTRE OF ALLERDENE APPROACH EMBANKMENT
HORIZONTAL SCALE: 1:2,000
VERTICAL SCALE: 1:400

KEY:

DO NOT SCALE

- MADE GROUND
- ALLUVIUM
- GLACIOLACUSTRINE DEPOSITS
- GLACIAL TILL
- ROCK
- RIGID INCLUSIONS
- PROPOSED GROUND LEVEL
- EXISTING GROUND LEVEL
- STRATA BOUNDARIES
- INDICATIVE STRATA BOUNDARIES

NOTES:

1. DO NOT SCALE FROM DRAWING.
2. DRAWING FOR INFORMATION ONLY
3. POSITION OF RIGID INCLUSIONS ARE INDICATIVE ONLY. FINAL LOCATIONS AND SPACING OF RIGID INCLUSIONS ARE TO BE DETERMINED FOLLOWING DETAILED DESIGN.
4. DESIGN OF ANY TEMPORARY WORKS REQUIRED SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
5. THE INDICATIVE SPACING OF THE RIGID INCLUSIONS ARE BASED ON THE MOST LIKELY GROUND CONDITIONS AND MOST LIKELY MATERIAL PROPERTIES. REFER TO THE : A1 BIRTLEY TO COAL HOUSE: ALLERDENE EMBANKMENT GROUND IMPROVEMENT TECHNICAL MEMO FOR DETAILS OF HOW RIGID INCLUSIONS SPACING VARIES WITH THE WORST AND BEST CASE GROUND CONDITIONS AND MATERIAL PROPERTIES.

REV	DATE	BY	DESCRIPTION	CHK	APP
P01	11/10/2018	BW	INITIAL ISSUE	BT	CP

DRAWING STATUS: S2 - FOR INFORMATION

wsp

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wsp.com

CLIENT: HIGHWAYS ENGLAND

ARCHITECT:

SITE/PROJECT: A1 ROAD IMPROVEMENTS COAL HOUSE JUNCTION (J67) TO BIRTLEY JUNCTION (J65)

TITLE: ALLERDENE BRIDGE (SINGLE SPAN) INDICATIVE GROUND IMPROVEMENT OPTION - RIGID INCLUSIONS

SCALE @ A1:	CHECKED:		APPROVED:
AS SHOWN	BT		CP
PROJECT NO: 70015226	DESIGNED: RJ	DRAWN: BW	DATE: March 19

DRAWING No: HE551462-WSP-HGT-BCH-DR-GE-00107B

REV: P01

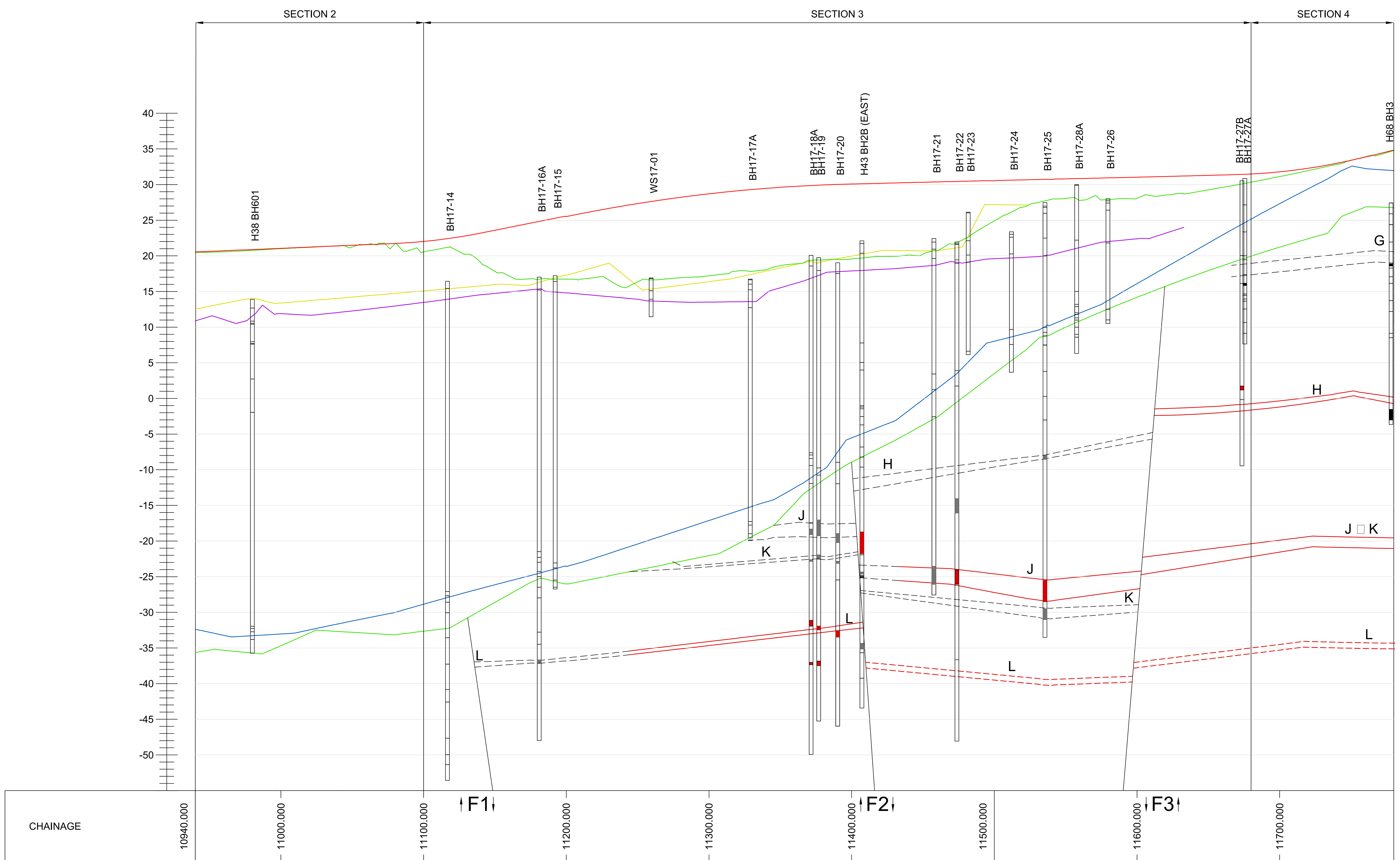
DO NOT SCALE

SEAM REFERENCE	STANDARD N.C.B. SEAM REFERENCE	WORKED SEAM THICKNESS (m)	SEAM THICKNESS (m)
MAIN	G	N/A	0.3□
MAUDLIN	H	1.1 - 1.52	0.5 - 3.1□
DURHAM LOW MAIN	J	0.85	0.13 - 2.5□
BRASS THILL	K	N/A	0.23 - 1.5□
HUTTON	L	UNKNOWN	0.9 - 2.1□□

□ BASED ON RECORDED INTACT THICKNESS IN EXPLORATORY HOLES
□□ BASED ON BGS GEOLOGICAL MAP

NOTES:

1. AREA BETWEEN TOP OF SUPERFICIAL DEPOSITS AND EXISTING GROUND TO BE ASSUMED AS MADE GROUND.
2. MINING RISK CATEGORIES EXPLAINED IN COAL MINING RISK ASSESSMENT REPORT □HE551462-WSP-VGT-ZZ-RP-VG-00001□.



PROPOSED STRUCTURES		ALLERDENE APPROACH EMBANKMENT	ALLERDENE RAILWAY BRIDGE	ALLERDENE APPROACH EMBANKMENT
PERCEIVED COAL MINING RISK	EARTHWORKS	LOW		LOW
	STRUCTURES		HIGH	
	MINE GAS	LOW	HIGH	LOW
MITIGATION	EARTHWORKS	INSPECTION OF FORMATION AND SUITABLE DESIGN OF LOAD TRANSFER PLATFORM AND RIGID INCLUSIONS.		INSPECTION OF FORMATION AND SUITABLE DESIGN OF LOAD TRANSFER PLATFORM AND RIGID INCLUSIONS.
	STRUCTURES		DRILLING AND GROUTING	
	MINE GAS	GAS MONITORING TO BE UNDERTAKEN IN EXCAVATIONS AND CONFINED SPACES		GAS MONITORING TO BE UNDERTAKEN IN EXCAVATIONS AND CONFINED SPACES
		WORKS TO BE UNDERTAKEN IN ACCORDANCE WITH COAL AUTHORITY PERMIT AND HSE GUIDANCE.		

KEY:

- EXISTING GROUND LEVEL
- PROPOSED GROUND LEVEL
- TOP OF ALLUVIUM
- TOP OF GLACIOLACUSTRINE DEPOSITS
- TOP OF GLACIAL TILL
- ROCKHEAD
- INFERRED COAL SEAM BASED ON STRATIGRAPHIC SEQUENCE AND RELATIONSHIP TO COAL AUTHORITY RECORDED WORKINGS AND/OR COAL OR VOIDS RECORDED ON BOREHOLE LOGS
- COAL AUTHORITY RECORDED WORKINGS (ELEVATION SHOWN ON COAL AUTHORITY PLANS OR BOREHOLE RECORDS)
- INFERRED COAL AUTHORITY RECORDED WORKINGS (ELEVATION NOT SHOWN ON COAL AUTHORITY PLANS OR BOREHOLE RECORDS)
- COAL SEAM WITHIN BOREHOLE
- WORKED COAL SEAM WITHIN BOREHOLE

FAULTS:

F1: THROW □20-23m
F2: THROW □6-8m
F3: THROW □2-3m

REV	DATE	BY	DESCRIPTION	CHK	APP
P01	21/09/2018	BW	INITIAL ISSUE	AH	BD

DRAWING STATUS: S2 - FOR INFORMATION

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wsp.com

CLIENT: HIGHWAYS ENGLAND

ARCHITECT:

SITE/PROJECT: A1 ROAD IMPROVEMENTS COAL HOUSE JUNCTION (J67) TO BIRTLEY JUNCTION (J65)

TITLE: GEOLOGICAL LONG SECTION COAL MINING RISK - SECTION 3 OPTION 1 ALLERDENE BRIDGE SINGLE SPAN

SCALE @ A1: AS SHOWN	CHECKED: AH		APPROVED: BD
PROJECT NO: 70015226	DESIGNED: FR	DRAWN: BW	DATE: March 19

DRAWING No: HE551462-WSP-HGT-BCH-DR-GE-00099 — REV: P01

SCALE:
HORIZONTAL 1:2,000
VERTICAL 1:400 (5x EXAGGERATION)

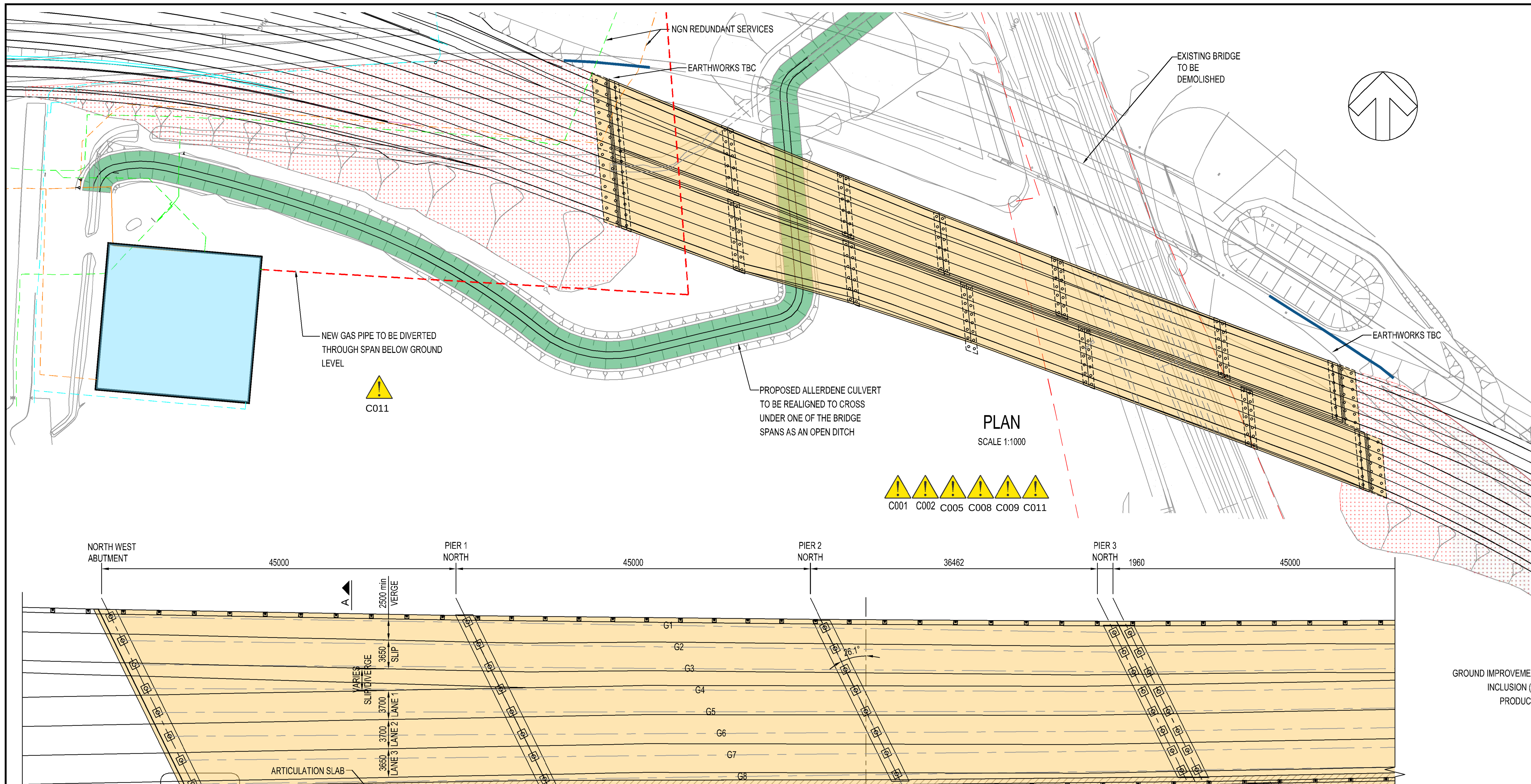
Appendix D

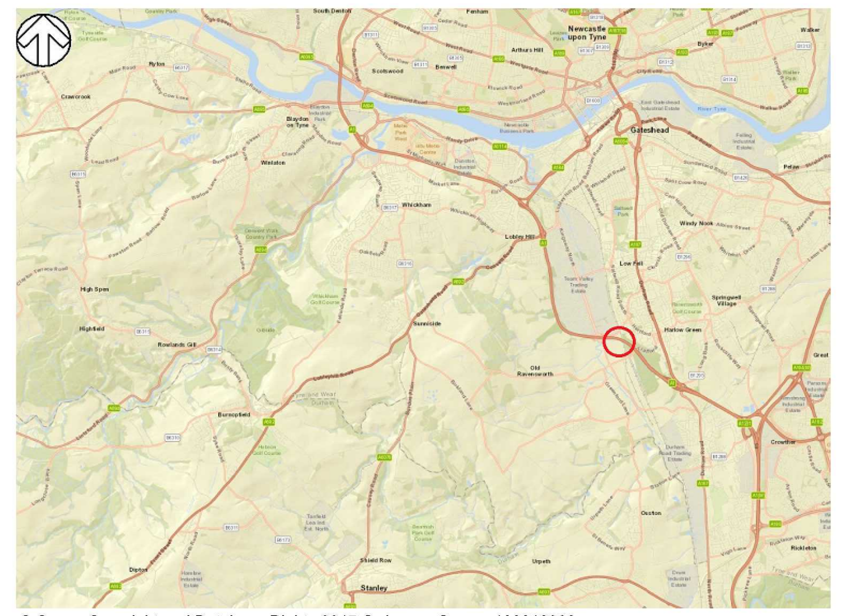
VIADUCT OPTION

APPENDIX D-1

BRIDGE GA

DO NOT SCALE

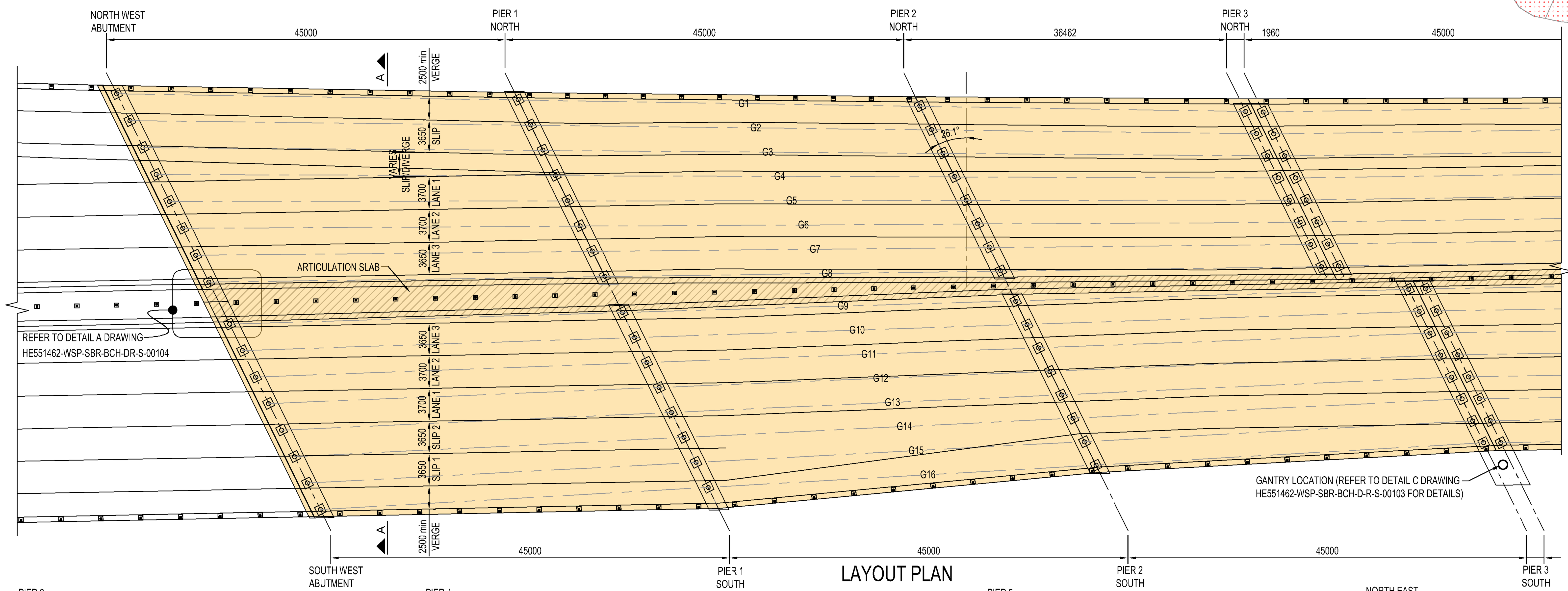




KEY PLAN

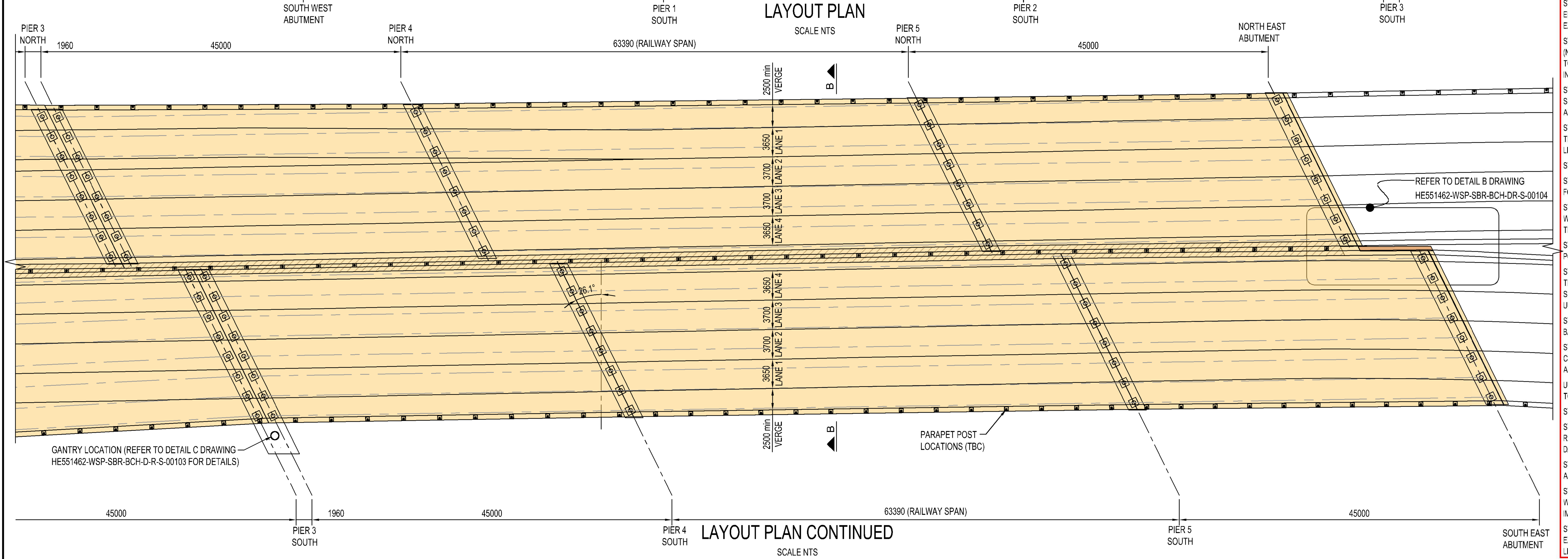
SCALE 1:5000

- VIADUCT
- PROPOSED CULVERT
- 0.36m Ø RIGID INCLUSIONS AT 1.5m SPACING
- NETWORK RAIL BOUNDARY
- PROPOSED TEMPORARY SHEET PILING TO FACILITATE THE VIADUCT CONSTRUCTION IN CLOSE PROXIMITY TO THE EXISTING A1 ALIGNMENT



LAYOUT PLAN

SCALE NTS



LAYOUT PLAN CONTINUED

SCALE NTS

SUGGESTED CONSTRUCTION SEQUENCE (TO BE CONFIRMED BY THE CONTRACTOR)

THE INDICATIVE/SUGGESTED CONSTRUCTION SEQUENCE AS LISTED BELOW HAS BEEN DEVELOPED BASED ON COLLABORATION WITH THE SUPPORT OF THE CONTRACTOR DURING THE PCF STAGE 3 PRELIMINARY DESIGN.

THE FINAL APPOINTED PRINCIPAL CONTRACTOR SHALL BE RESPONSIBLE FOR THE DEVELOPMENT AND IMPLEMENTATION OF THE PROPOSED CONSTRUCTION SEQUENCE.

STAGE 1 - DIVERT UTILITIES (POSSESSION/NON POSSESSION WORKS): ALL SERVICES IMPACTING THE WORKS SHALL BE IDENTIFIED AND DIVERTED TO ACCOMMODATE THE WORKS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DIVERSION OF ALL SERVICES IMPACTING THE WORK.

STAGE 2 - ESTABLISH TRAFFIC CONTRAFLOW OVER EXISTING ALLERDENE ALIGNMENT (NON POSSESSION WORKS)

STAGE 3 - INSTALL TEMPORARY WORK AROUND THE TIE LOCATION OF EXISTING AND NEW ALIGNMENTS (NON POSSESSION WORKS).

STAGE 4 - INSTALL PILES FOR THE BRIDGE ABUTMENT AND ALL PIERS EXCEPT THOSE ADJACENT TO THE RAILWAY (NON POSSESSION WORKS).

STAGE 5 - INSTALL NEW OLE BASES (POSSESSION WORKS): FOUNDATION AND BASES FOR THE NEW OLE MAST SHALL BE INSTALLED IN ACCORDANCE WITH THE OLE DESIGN, DETAILS ARE PROVIDED IN THE WSP OLE FORM A REPORT. THE FOUNDATIONS AND BASES SHALL BE DESIGNED IN ACCORDANCE WITH NWR TAA REQUIREMENTS.

STAGE 6 - INSTALL NEW OLE GANTRY MASTS (POSSESSION WORKS): THESE SHALL COMPRISE PROPRIETARY SYSTEMS THAT HAVE BEEN APPROVED BY NR.

STAGE 7 - CONNECT NEW OLE APPARATUS TO CABLES/REMOVE OLD MASTS (POSSESSION WORKS): THIS SHALL ENSURE OLE PROVISIONS ARE IN PLACE UPON INSTALLATION OF THE NEW BRIDGE AND DEMOLITION OF THE EXISTING.

STAGE 8 - INSTALL ENABLING WORKS FOR CONSTRUCTION OF THE ADJACENT BRIDGE PIERS TO THE TRACKS (NON POSSESSION WORKS): ANTICIPATE ENABLING WORKS IN THE FORM OF SHEET PILES SHALL BE REQUIRED TO FACILITATE THE BRIDGE PIERS CONSTRUCTION. THE DESIGN OF THIS SHALL REQUIRE BOTH HE/NWR TAA INPUT. IT IS ASSUMED THE SHEET PILES SHALL REMAIN INSITU UPON COMPLETION.

STAGE 9 - INSTALL PILES FOR THE BRIDGE PIERS (NON POSSESSION WORKS): ANTICIPATE TRACK MONITORING SHALL BE REQUIRED DURING THIS STAGE TO ENSURE THE MOVEMENT OF THE TRACK REMAINS WITHIN ACCEPTABLE LIMITS.

STAGE 10 - RC ABUTMENT/PIERS/WINGWALL WORKS (NON POSSESSION WORKS): PIERS ADJACENT TO THE TRACKS TO BE CAST IN STAGES TO LIMIT RISK OF FORMWORK FALLING WITHIN 3M OF THE NEAREST OLE LINE/RUNNING RAIL.

STAGE 11 - PART BACKFILL TO ABUTMENT/WINGWALLS (NON POSSESSION WORKS).

STAGE 12 - NORTH AND SOUTH BRIDGE BEAMS IN PAIRS (POSSESSION WORKS): TEMPORARY WORKS IN THE FORM OF A CRANE LIFTING PAD SHALL BE REQUIRED. THE POSITION/SIZE OF THE CRANE TO BE CONFIRMED.

STAGE 13 - INSTALL GRP FORMWORK (POSSESSION WORKS): PERMANENT FORMWORK SHALL PROVIDE A WORKING PLATFORM FROM WHICH WORKS CAN BE UNDERTAKEN OUTSIDE POSSESSION FOR THE CASTING OF THE RC DECK SLAB.

STAGE 14 - CAST RC DECK SLAB: DECK TO BE CAST UP TO THE EDGE CANTILEVERS/PARAPET UP STAND (NON POSSESSION WORKS).

STAGE 15 - CAST PARAPET UPSTAND/CANTILEVER (POSSESSION/NON POSSESSION WORKS): THE CASTING OF THE INNER CANTILEVERS BETWEEN THE TWO ADJACENT DECKS COULD BE UNDERTAKEN OUTSIDE POSSESSION SHOULD SIMILAR TEMPORARY WORKS BE DEPLOYED. WORKS TO INSTALL EDGE PARAPETS WOULD ALSO BE UNDERTAKEN AT THIS STAGE.

STAGE 16 - INSTALL PRECAST COVER SLAB BETWEEN THE TWO ADJACENT DECKS TO SUPPORT DOUBLE SIDED BARRIER (NON POSSESSION WORKS).

STAGE 17 - CARRIAGEWAY WORKS (NON POSSESSION WORKS): INCLUDES WATERPROOFING/SURFACING AND CONSTRUCTION OF VERGES TO THE BRIDGE AND EARTHWORKS AND CARRIAGEWAY WORKS FOR THE APPROACHES TO THE NEW A1 HIGHWAY ALIGNMENT.

UPON COMPLETION, TRAFFIC ON THE EXISTING A1 ALIGNMENT SHALL BE DIVERTED ONTO THE NEW ALIGNMENT TO FACILITATE THE DEMOLITION OF THE EXISTING BRIDGE.

STAGE 18 - REMOVE EXISTING CARRIAGEWAY: FROM THE EXISTING REDUNDANT ALLERDENE BRIDGE DECK.

STAGE 19 - BREAKOUT THE EXISTING CONCRETE DECK OVERSLAB, CENTRAL SPAN (POSSESSION WORKS): REMOVAL OF THE RC DECK TO THE CENTRAL SPAN SHALL REQUIRE CAREFUL CONSIDERATION TO AVOID DAMAGE TO THE RAIL INFRASTRUCTURE.

STAGE 20 - REMOVE CENTRAL SPAN GIRDERS AND CONCRETE BELOW HALF JOINTS (POSSESSION WORKS): ANTICIPATED THAT EXISTING GIRDERS SHALL BE REMOVED IN PAIRS.

STAGE 21 - REMOVE SIDE SPAN, RC SLAB AND BEAMS (NON POSSESSION WORKS): REMAINING DEMOLITION WORKS OF THE EXISTING BRIDGE FROM THIS STAGE ONWARD IS CONSIDERED NON CRITICAL AS IT DOES NOT IMPACT THE RAIL LINE OR THE A1 TRAFFIC.

STAGE 22 - REMOVE EXISTING PIERS (NON POSSESSION WORKS): REMAINING DEMOLITION WORKS OF THE EXISTING BRIDGE FROM THIS STAGE ONWARD IS CONSIDERED NON CRITICAL AS IT DOES NOT IMPACT THE RAIL LINE OR THE A1 TRAFFIC.

GENERAL NOTES

1. THIS DRAWING TO BE READ WITH CONJUNCTION WITH DRAWING NO. HE551462-WSP-SBR-BCH-DR-S-00101 TO HE551462-WSP-SBR-BCH-DR-S-00104.
2. UNLESS INDICATED OTHERWISE DIMENSIONS ON THESE DRAWINGS ARE SHOWN IN MILLIMETRES, LEVELS ARE SHOWN IN METRES ABOVE ORDNANCE DATUM AND CO-ORDINATES ARE SHOWN IN METRES WITH REFERENCE TO THE NATIONAL GRID.
3. DO NOT SCALE IN CASE OF ANY DOUBTS, OMISSIONS OR ERRORS SEEK CLARIFICATION FROM THE DESIGNER
4. STRUCTURAL BRIDGE DETAILS PROVIDED ON THIS DRAWING ARE INDICATIVE ONLY BASED ON LIMITED INFORMATION AVAILABLE TO DATE. THE SIZE OF STRUCTURAL ELEMENTS ARE BASED ON PRELIMINARY CALCULATION AND PREVIOUS SIMILAR TYPE WORKS. ALL INFORMATION IS SUBJECT TO DETAILED DESIGN PRIOR TO FINAL CONFIRMATION.
5. THE FOLLOWING CRITICAL INFORMATION IS REQUIRED TO VERIFY THE FEASIBILITY OF THE PROPOSED OPTION AND DEVELOP THIS FURTHER AT DETAILED DESIGN (IF PREFERRED):
   - SITE INVESTIGATION INFORMATION TO CONFIRM FOUNDATION PARAMETERS
   - LIAISON WITH NWRR - CONFIRM WORKING CONSTRAINT ADJACENT/ OVER RAILWAY.
   - LIAISON WITH HE - CONFIRM STRUCTURAL REQUIREMENTS
   - LIAISON WITH STATUTORY UNDERTAKERS -CONFIRM EXISTING/NEW SERVICES IMPACTED BY THE WORKS
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TEMPORARY WORKS DESIGN AND SHALL TAKE ALL MEASURES NECESSARY TO MAINTAIN THE STABILITY OF THE WORKS DURING ALL TEMPORARY CONSTRUCTION STAGES, INCLUDING EDGE CANTILEVER FORMWORK AND EDGE PROTECTION PRIOR TO ERECTION OF EDGE BEAMS.

SPECIFIC NOTES

1. OPTION COMPRISES CONSTRUCTION OF A COMPOSITE STEEL BEAM AND SLAB CONTINUOUS BRIDGE DECK.
2. THE OPTION HAS BEEN DEVELOPED BASED ON THE FOLLOWING ASSUMPTIONS
   - DESIGN LOADING: LM1/LM2, LM3 AND LM4 LOADING UP TO A MAXIMUM SOV350
   - HIGHWAY CROSS SECTION BASED ON PRELIMINARY ALIGNMENT DESIGN BY WSP HIGHWAYS
   - DESIGN LIFE FOR THE NEW ELEMENTS: 120 YEARS
   - THE EXISTING ALLERDENE BRIDGE LANES CAN BE CLOSE OR CONTRAFLOW SO THAT WORKS WITH TRAFFIC CAN BE ESTABLISHED
   - PROPOSED CLEARANCES FOR THE BRIDGE SPAN OVER NWR INFRASTRUCTURE SHALL BE ACCEPTABLE

KEY MATERIAL AND FINISHES

1. ALL STRUCTURAL STEEL PLATES AND SECTIONS SHALL BE GRADE S355 J2W+N TO BS EN 10025-5, EXCEPT TOP AND BOTTOM FLANGES OF LONGITUDINAL GIRDERS 50MM THICK WHICH SHALL BE GRADE S355 K2W+N TO BS EN 10025-5.
2. STEELWORK SHALL BE FABRICATED AND ERECTED IN ACCORDANCE WITH BS EN 1090-2 AND IN ACCORDANCE WITH APPENDIX SERIES 1800 OF THE SPECIFICATION.
3. CONCRETE GRADES TO THE BRIDGE ELEMENTS SHALL BE AS LISTED BELOW

SUBSTRUCTURE	STRENGTH CLASS
PILES	C32/40
PILE CAPS	C40/50
BEARING PLINTH	C40/50
PIER WALL	C40/50
ABUTMENT WALLS	C40/50
WINGWALLS	C40/50
STRING COURSES	C40/50
BLINDING CONCRETE SHALL BE DESIGNATED CONCRETE	FND2
SUPER STRUCTURE	STRENGTH CLASS
DECK SLAB	C40/50
DIAPHRAGMS	C40/50
STRING COURSES	C40/50
VERGE INFILL	PAV2

4. AT THE ABUTMENT DIAPHRAGMS A SEALANT SHALL BE PROVIDED ALONG THE EDGE OF ANY INTERFACE BETWEEN THE WEATHERING STEEL AND CONCRETE.
5. ABUTMENTS AND WINGWALLS TO BE BACKFILLED WITH SELECTED GRANULAR FILL CLASS 6N OR 6P IN ACCORDANCE WITH SPECIFICATION APPENDICES OF 600 SERIES.

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

C01 – WORKING AT HEIGHT
C02 – PERSONNEL AND PLANT ENCROACHING THE LIVE RAILWAY
C05 – HEAVY LIFTING OF STEEL GIRDERS
C08 – INSTABILITY OF GRP PANELS
C09 – PILED FOUNDATION CONFLICT OPEN MINES
C11 – WORK CLOSE TO LIVE TRAFFIC

SAFETY, HEALTH AND ENVIRONMENTAL SYMBOL LEGEND

INDICATES A RESIDUAL RISK AS A WARNING

Rev.	Date	Description	By	Chk'd	App'd
P02	17/12/18	PIER 3 UPDATED	JW	RM	HM

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http://www.wspgroup.com

Client: Working on behalf of highways england

Project Title: A1 BIRTLEY TO COALHOUSE

Drawing Title: ALLERDENE VIADUCT OUTLINE GENERAL ARRANGEMENT SIX SPAN OPTION (SHEET 1 OF 4)

Scale	Drawn	Checked	Approved	Authorised
AS SHOWN	RA	RM	HM	NR
Original Size: A1	Date: 17/12/18	Date: 17/12/18	Date: 17/12/18	Date: 17/12/18

Drawing Status: For Information | Suitability: S0

Drawing Number: Project HE551462 | Originator WSP | Volume SBR | Location BCH | Type DR | Role S | Number 00102

Project Ref. No.:

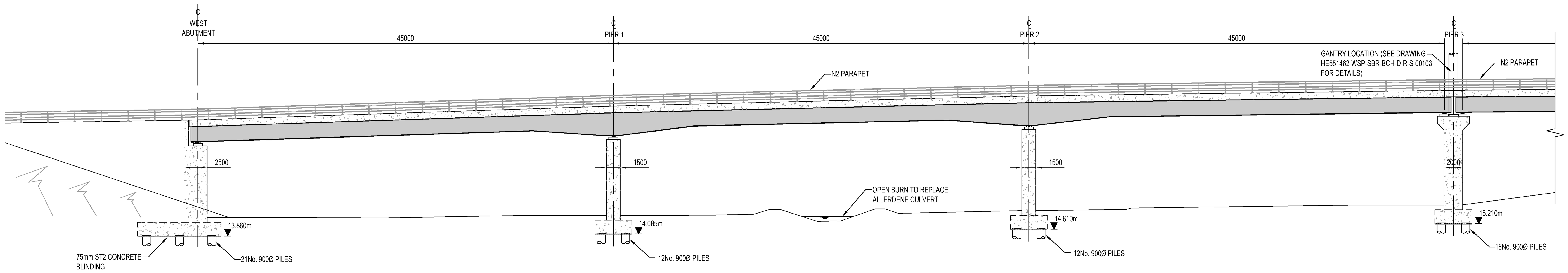
Revision: P02

DO NOT SCALE

Millimetres 0 10 100

NOTES:

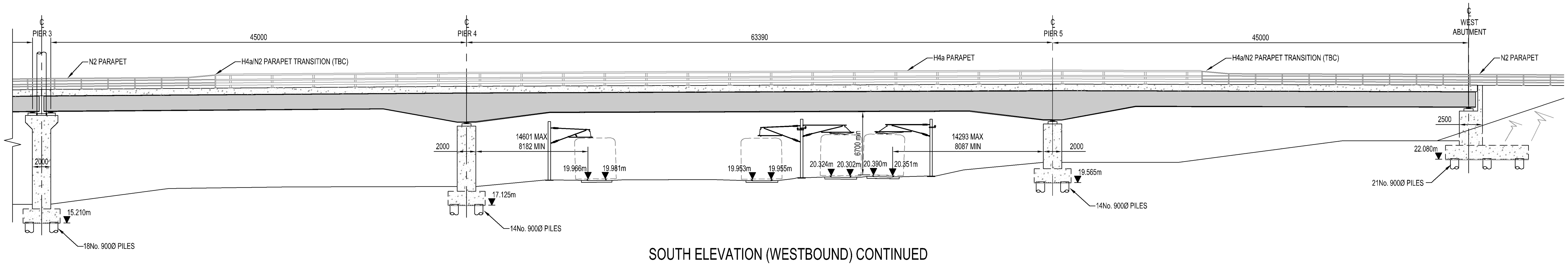
1. REFER TO DRAWING HE551462-WSP-SBR-BCH-DR-S-00101 FOR NOTES



SOUTH ELEVATION (WESTBOUND)

SCALE 1:250

NGN DIVERTED GASS PIPE (TBC)



SOUTH ELEVATION (WESTBOUND) CONTINUED

SCALE 1:250

Rev.	Date	Description	By	Chk'd	App'd
P02	17/12/18	No. OF PILES AT PIER 3 REVISED	JW	RM	HM

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http://www.wspgroup.com

Client: Working on behalf of highways england

Project Title: A1 BIRTLEY TO COALHOUSE

Drawing Title: ALLERDENE VIADUCT OUTLINE GENERAL ARRANGEMENT SIX SPAN OPTION (SHEET 2 OF 4)

Scale	Drawn	Checked	Approved	Authorised
AS SHOWN	RA	RM	HM	NR
Original Size: A1	Date: 17/12/18	Date: 17/12/18	Date: 17/12/18	Date: 17/12/18

Drawing Status: For Information

Suitability: S0

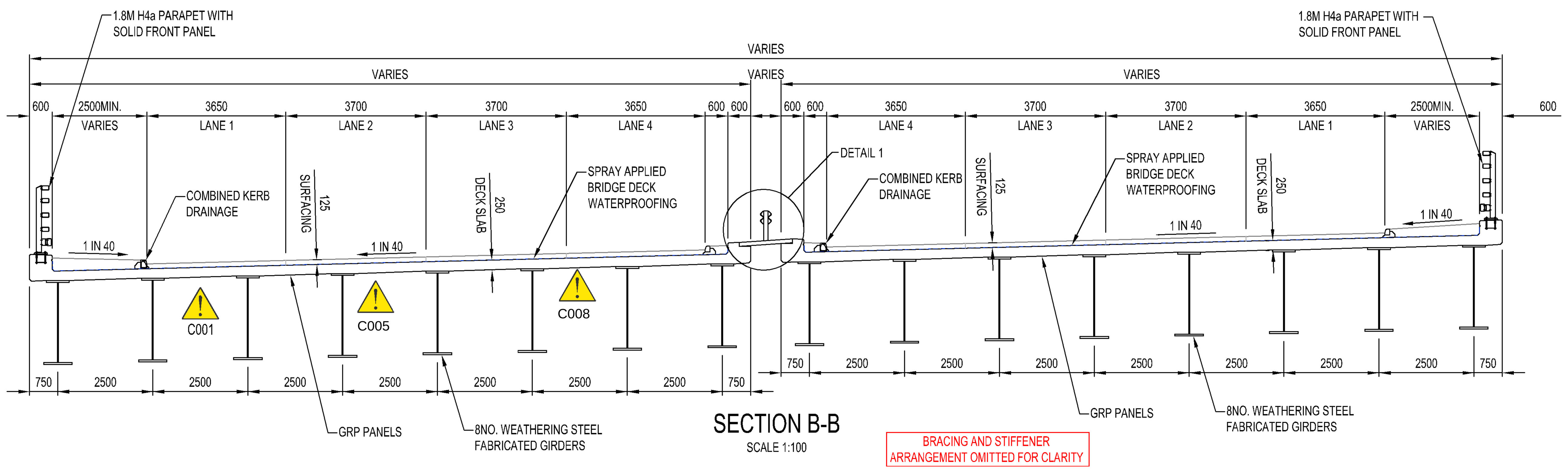
Drawing Number: Project HE551462 | Originator WSP | Volume SBR | Location BCH | Type DR | Role S | Number 00103

Project Ref. No.

Revision: P02

DO NOT SCALE

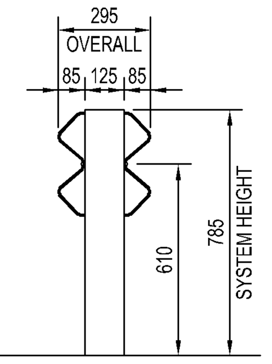
Millimetres 0 10 100



SECTION B-B

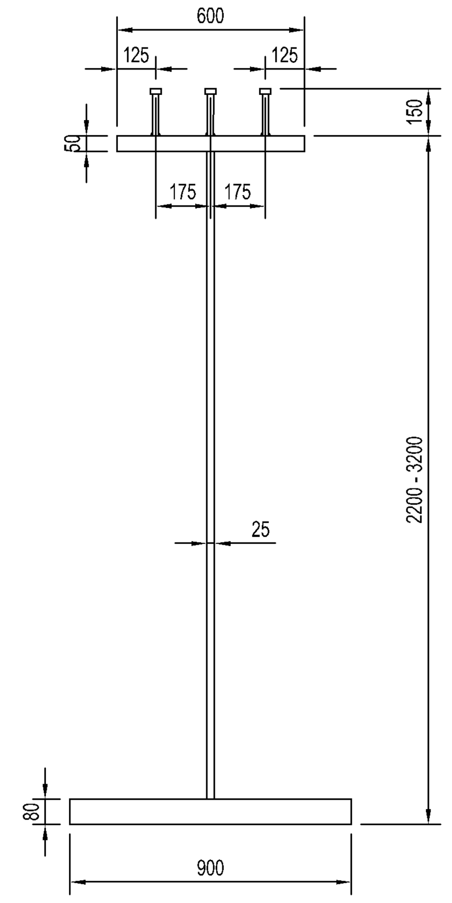
SCALE 1:100

BRACING AND STIFFENER ARRANGEMENT OMITTED FOR CLARITY



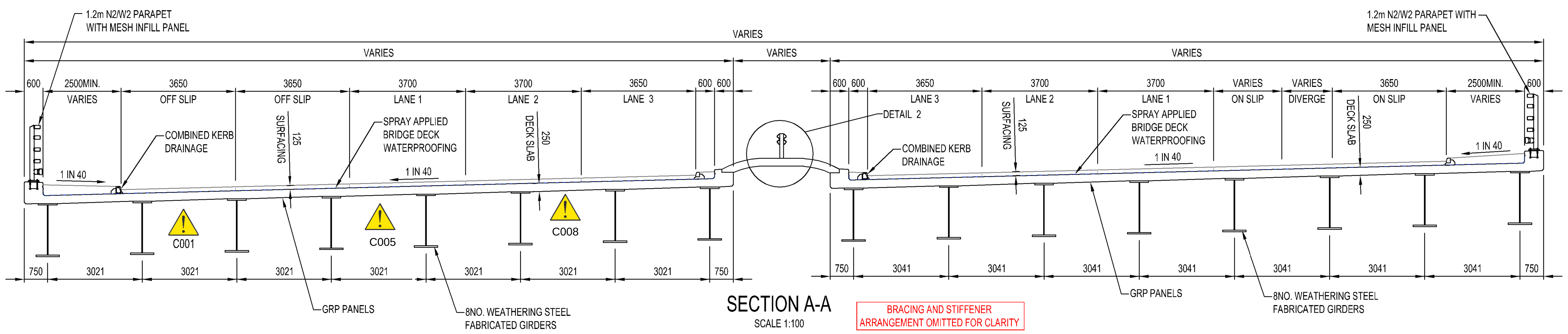
CENTRAL BARRIER DETAIL

SCALE 1:20



INDICATIVE TYPICAL WEATHERING STEEL GIRDER AT SECTION B-B

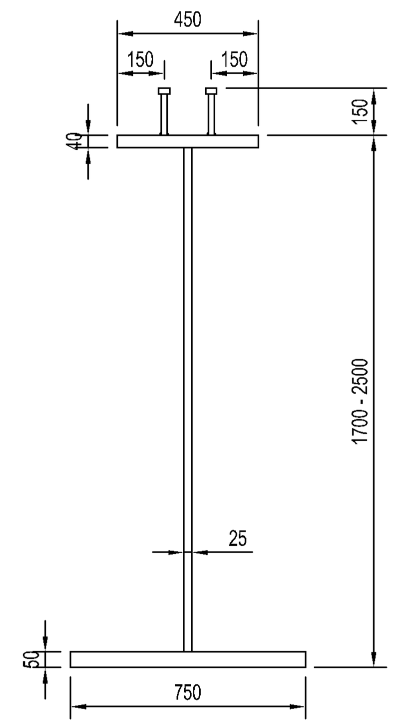
SCALE 1:20



SECTION A-A

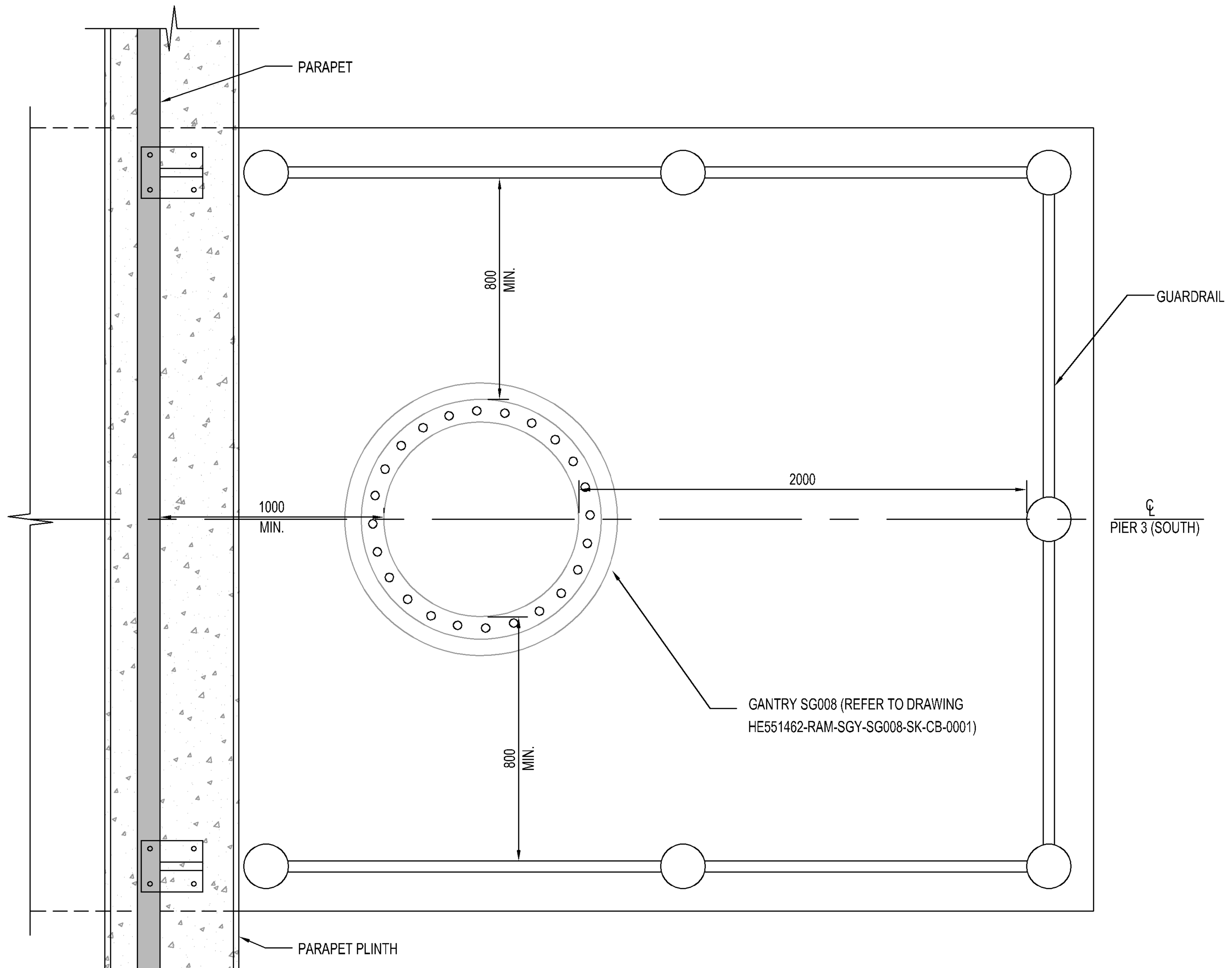
SCALE 1:100

BRACING AND STIFFENER ARRANGEMENT OMITTED FOR CLARITY



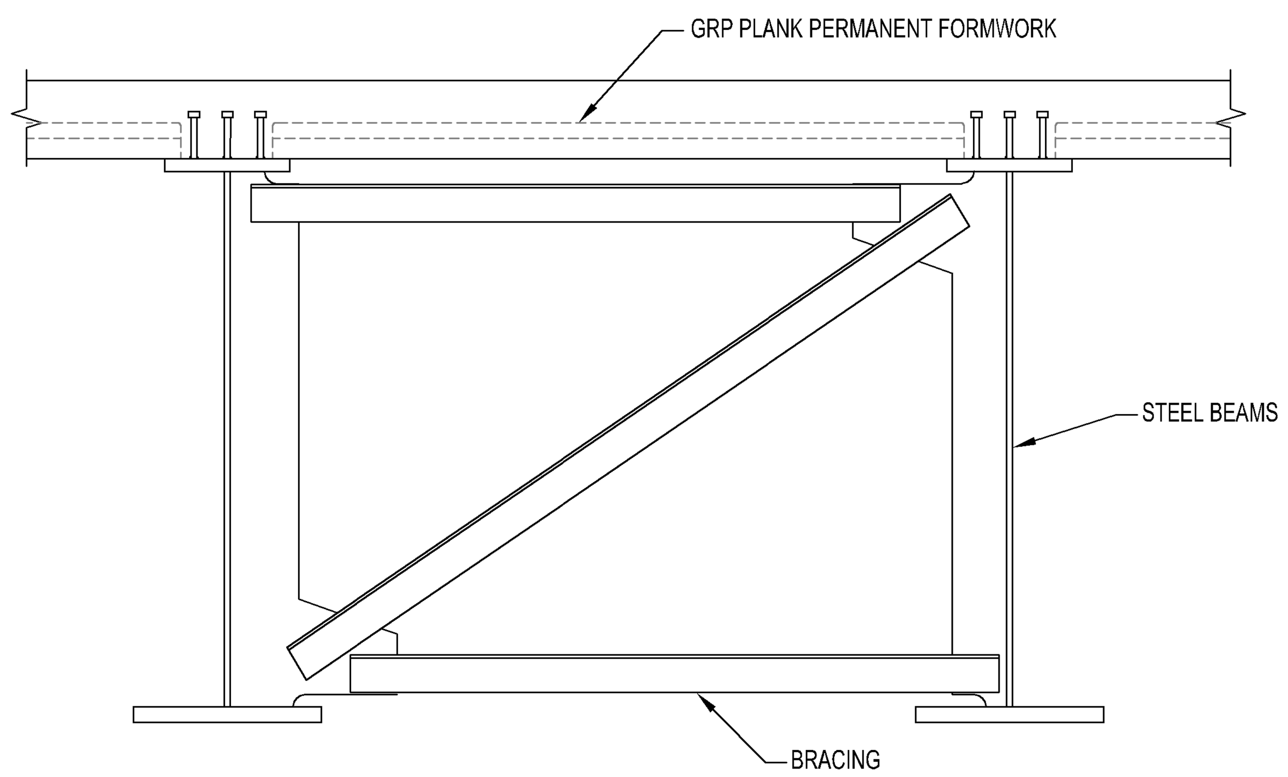
INDICATIVE TYPICAL WEATHERING STEEL GIRDER AT SECTION A-A

SCALE 1:20



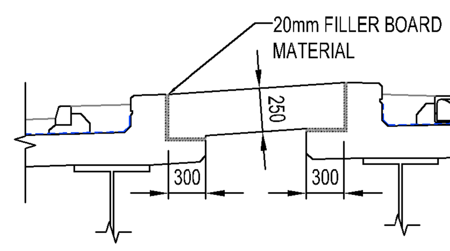
DETAIL C - PLAN ON GANTRY LOCATION

SCALE 1:20



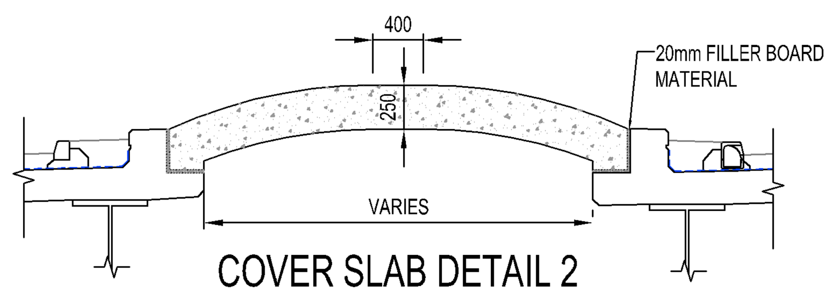
INDICATIVE GRP FORMWORK, MAIN GIRDER & BRACING DETAILS

SCALE 1:20



COVER SLAB DETAIL 1

SCALE 1:50



COVER SLAB DETAIL 2

SCALE 1:50

GENERAL NOTES

1. REFER TO DRAWING HE551462-WSP-SBR-BCH-DR-S-00101 FOR NOTES.

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

CONSTRUCTION

C01 – WORKING AT HEIGHT
C02 – PERSONNEL AND PLANT ENCROACHING THE LIVE RAILWAY
C05 – HEAVY LIFTING OF STEEL GIRDERS
C08 – INSTABILITY OF GRP PANELS
C09 – PILED FOUNDATION CONFLICT OPEN MINES
C11 – WORK CLOSE TO LIVE TRAFFIC

SAFETY, HEALTH AND ENVIRONMENTAL SYMBOL LEGEND

INDICATES A RESIDUAL RISK AS A WARNING

Rev.	Date	Description	By	Chk'd	App'd
P02	17/12/18	DETAIL C UPDATED	JW	RM	HM

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http://www.wspgroup.com

Client: Working on behalf of highways england

Project Title: A1 BIRTLEY TO COALHOUSE

Drawing Title: ALLERDENE VIADUCT OUTLINE GENERAL ARRANGEMENT SIX SPAN OPTION (SHEET 3 OF 4)

Scale	Drawn	Checked	Approved	Authorised
AS SHOWN	JW	RM	HM	HM
Original Size A1	Date 17/12/18	Date 17/12/18	Date 17/12/18	Date 17/12/18

Drawing Status: For Information

Suitability: S0

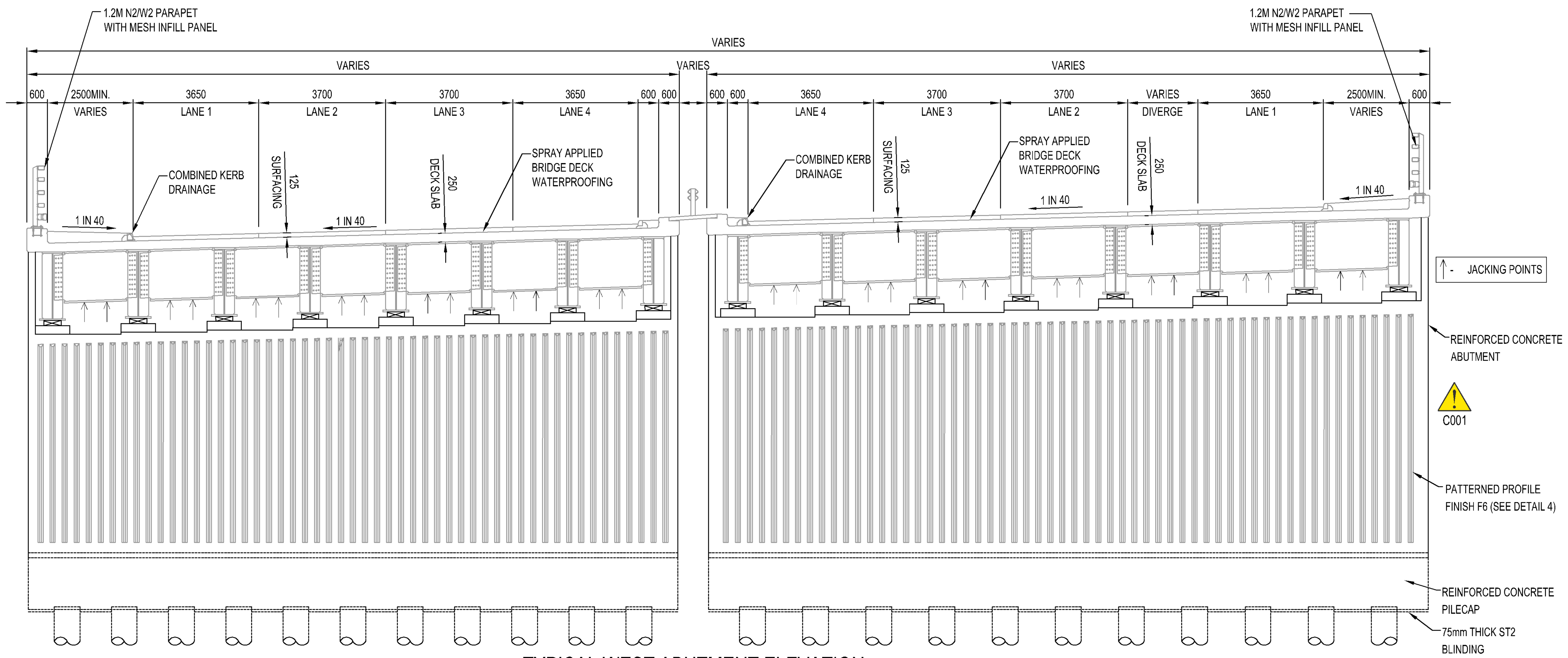
Drawing Number: Project HE551462 | Originator WSP | Volume SBR | Location BCH | Type DR | Role S | Number 00104

Project Ref. No.

Revision: P02

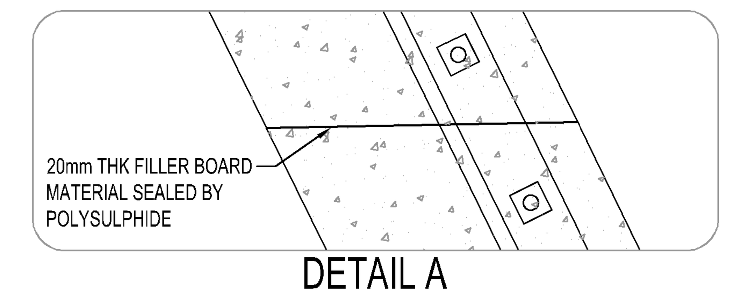
DO NOT SCALE

Millimetres 0 10 100



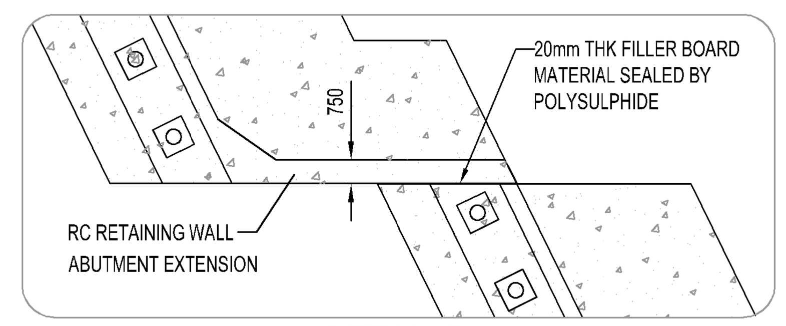
TYPICAL WEST ABUTMENT ELEVATION

SCALE 1:100



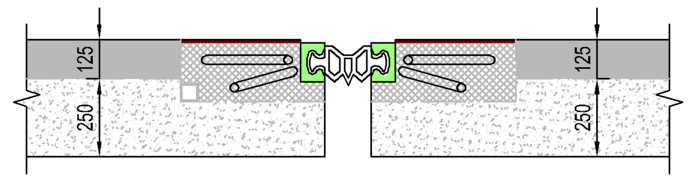
DETAIL A

SCALE 1:200



DETAIL B

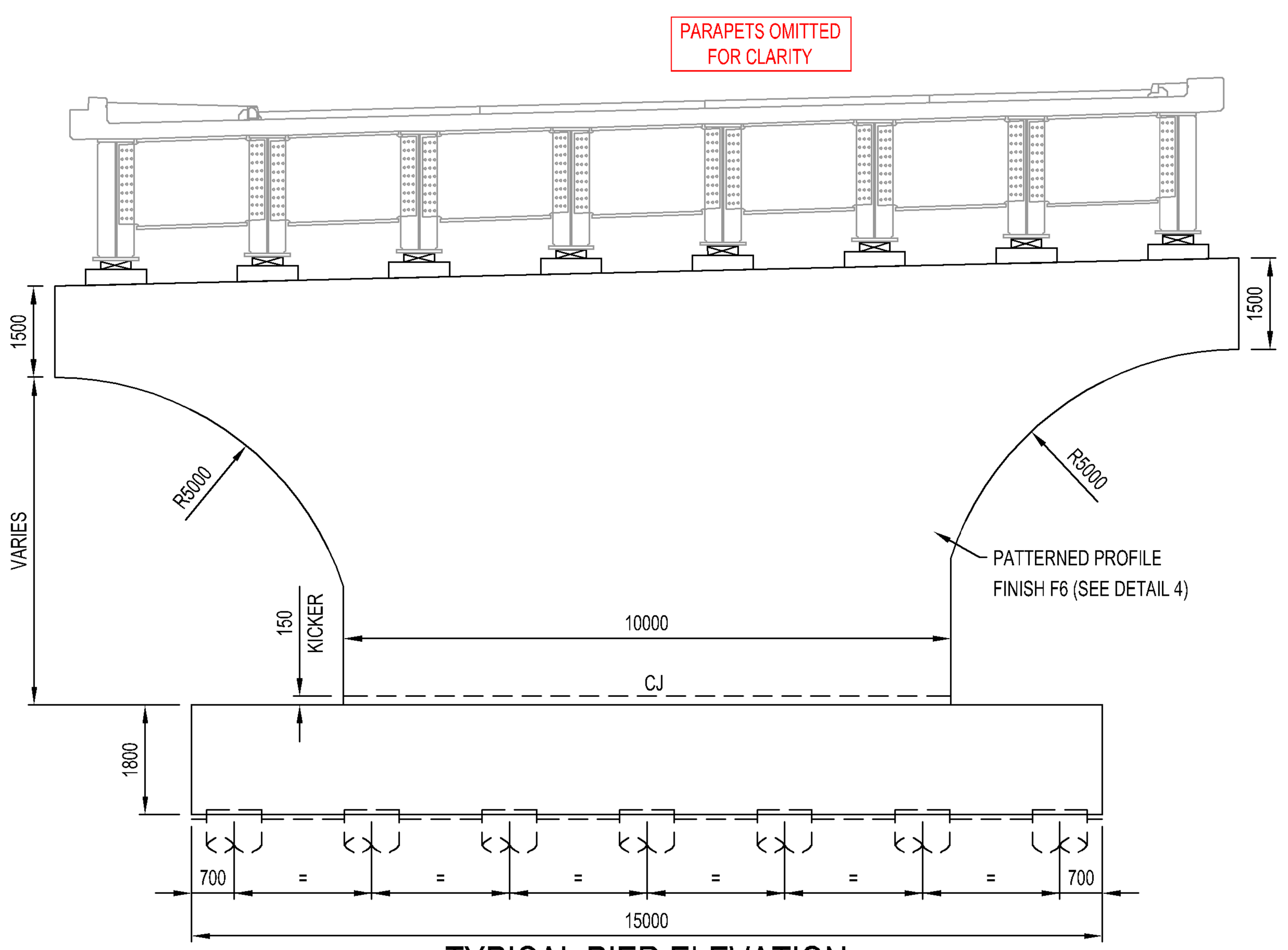
SCALE 1:200



EXPANSION JOINT - DETAIL 3

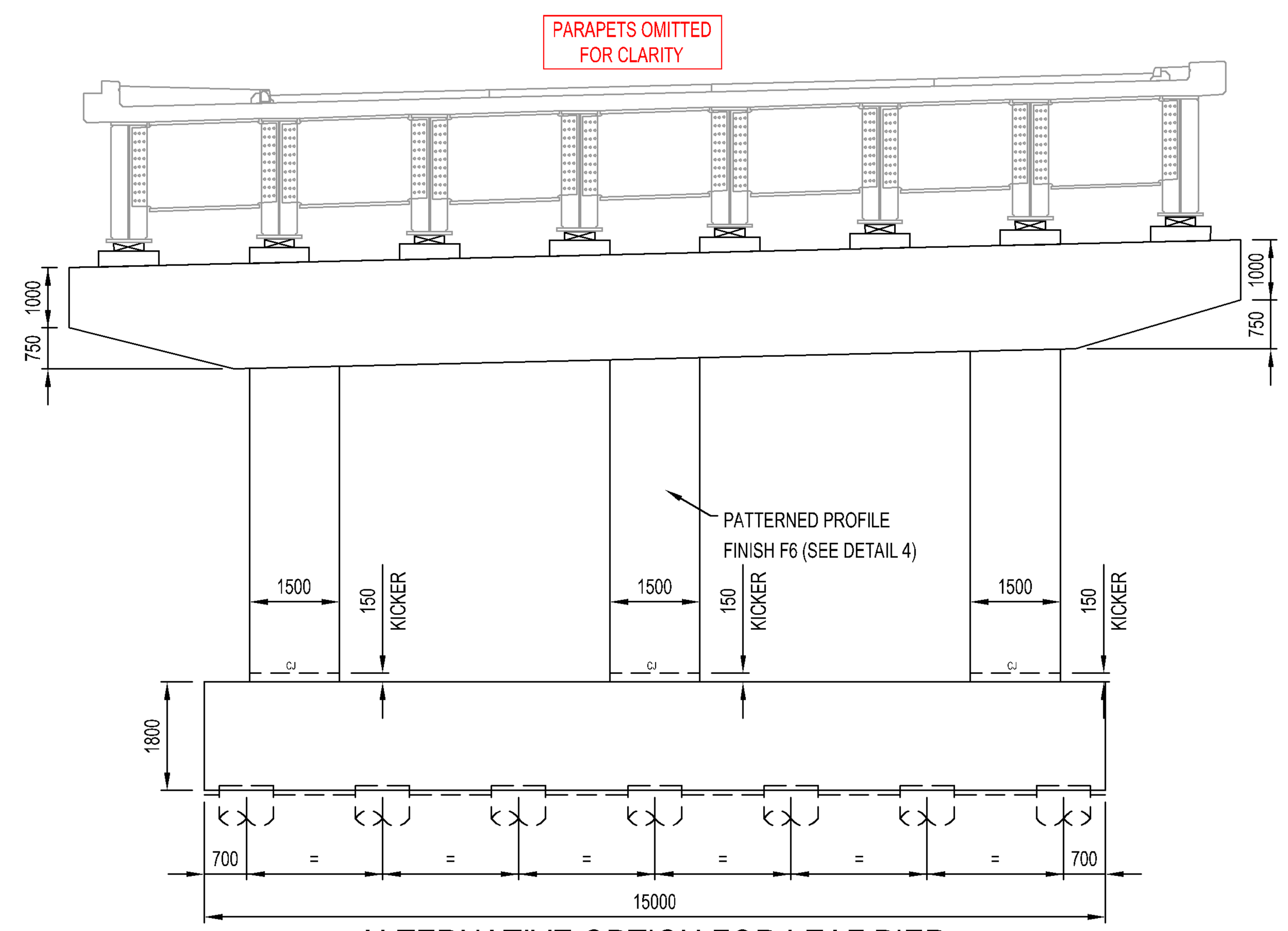
(HIGHWAYS AGENCY TYPE 6 ELASTOMERIC IN METAL RUNNERS)

SCALE 1:20



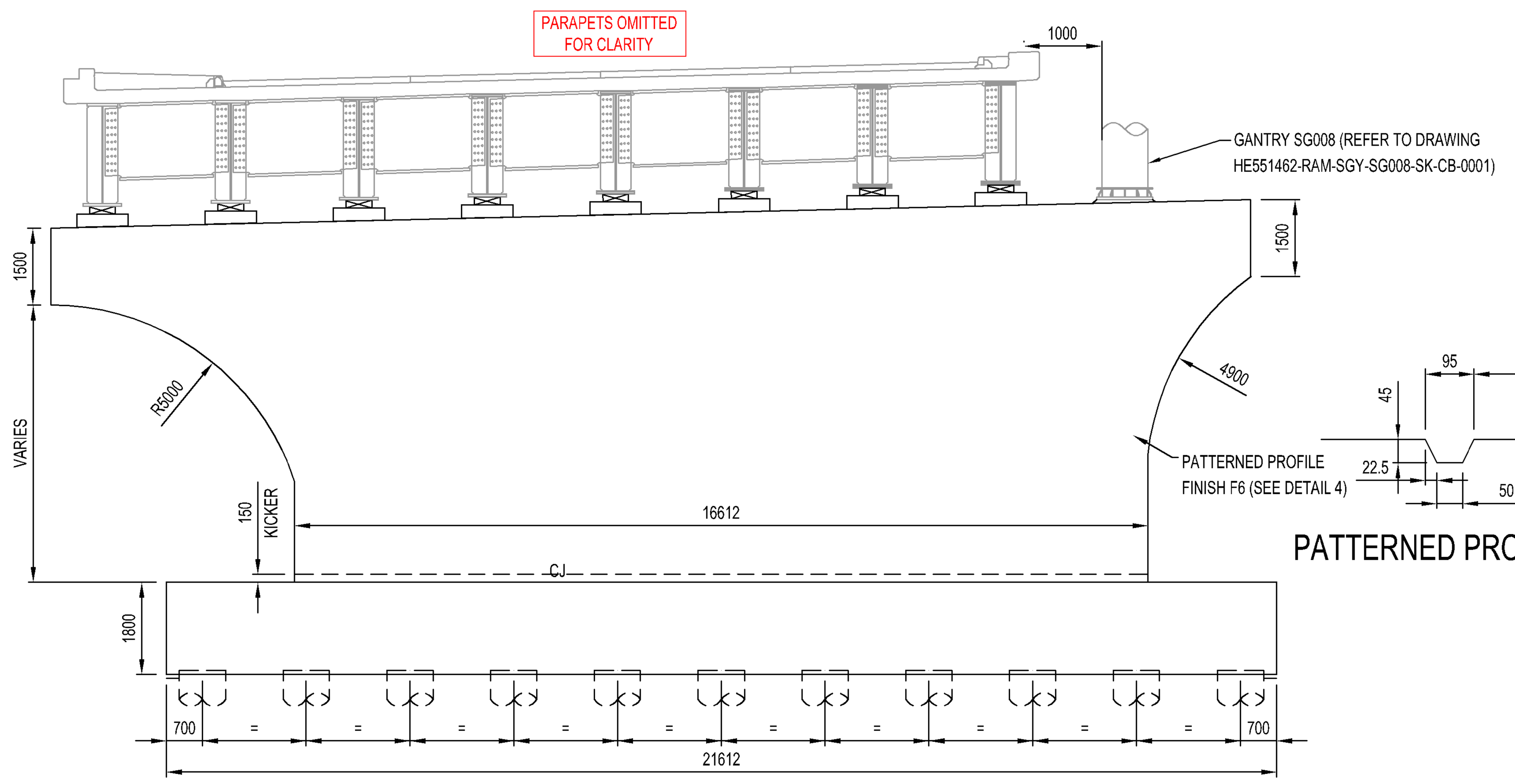
TYPICAL PIER ELEVATION

SCALE 1:100



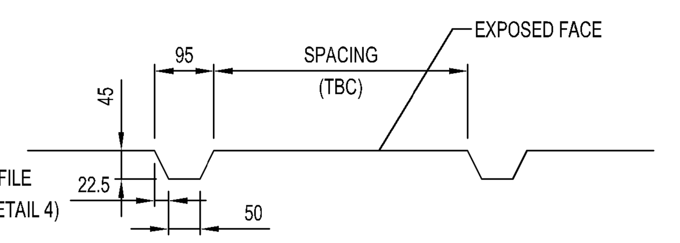
ALTERNATIVE OPTION FOR LEAF PIER

SCALE 1:100



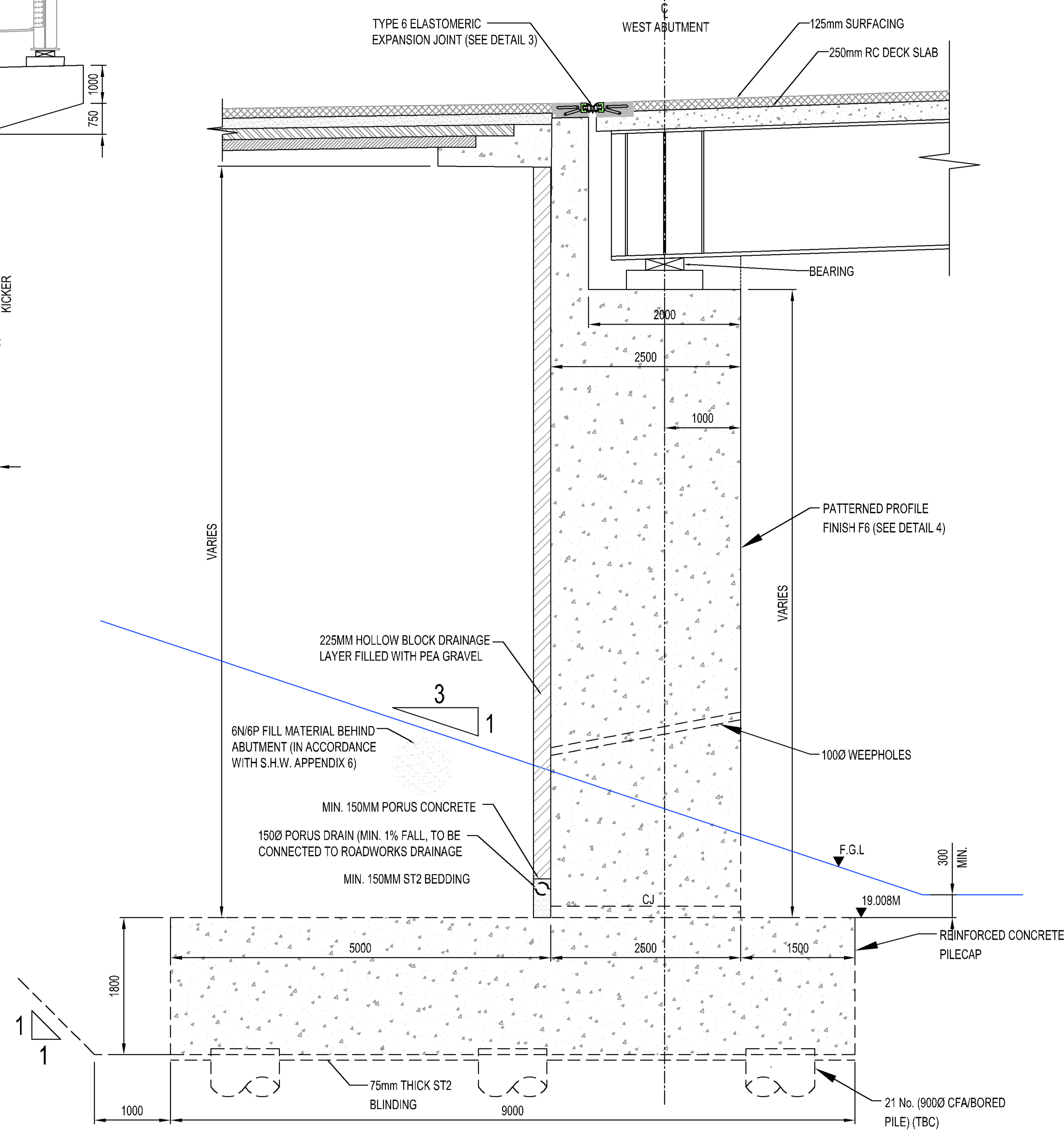
PIER ELEVATION AT GANTRY LOCATION

SCALE 1:100



PATTERNED PROFILE FINISH (F6) - DETAIL 4

SCALE 1:10



TYPICAL CROSS SECTION THROUGH ABUTMENT

SCALE 1:50

GENERAL NOTES

1. REFER TO DRAWING HE551462-WSP-SBR-BCH-DR-S-00101 FOR NOTES.

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

CONSTRUCTION

C01 – WORKING AT HEIGHT
C02 – PERSONNEL AND PLANT ENCROACHING THE LIVE RAILWAY
C05 – HEAVY LIFTING OF STEEL GIRDERS
C08 – INSTABILITY OF GRP PANELS
C09 – PILED FOUNDATION CONFLICT OPEN MINES
C11 – WORK CLOSE TO LIVE TRAFFIC

SAFETY, HEALTH AND ENVIRONMENTAL SYMBOL LEGEND

INDICATES A RESIDUAL RISK AS A WARNING

Rev.	Date	Description	By	Chk'd	App'd
P02	17/12/18	PIER ELEVATION AT GANTRY LOCATION UPDATED	JW	RM	HM

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http://www.wspgroup.com

Client: Working on behalf of highways england

Project Title: A1 BIRTLEY TO COALHOUSE

Drawing Title: ALLERDENE VIADUCT OUTLINE GENERAL ARRANGEMENT SIX SPAN OPTION (SHEET 4 OF 4)

Scale	Drawn	Checked	Approved	Authorised
AS SHOWN	JW	RM	HM	HM
Original Size: A1	Date: 17/12/18	Date: 17/12/18	Date: 17/12/18	Date: 17/12/18

Drawing Status: For Information | Suitability: S0

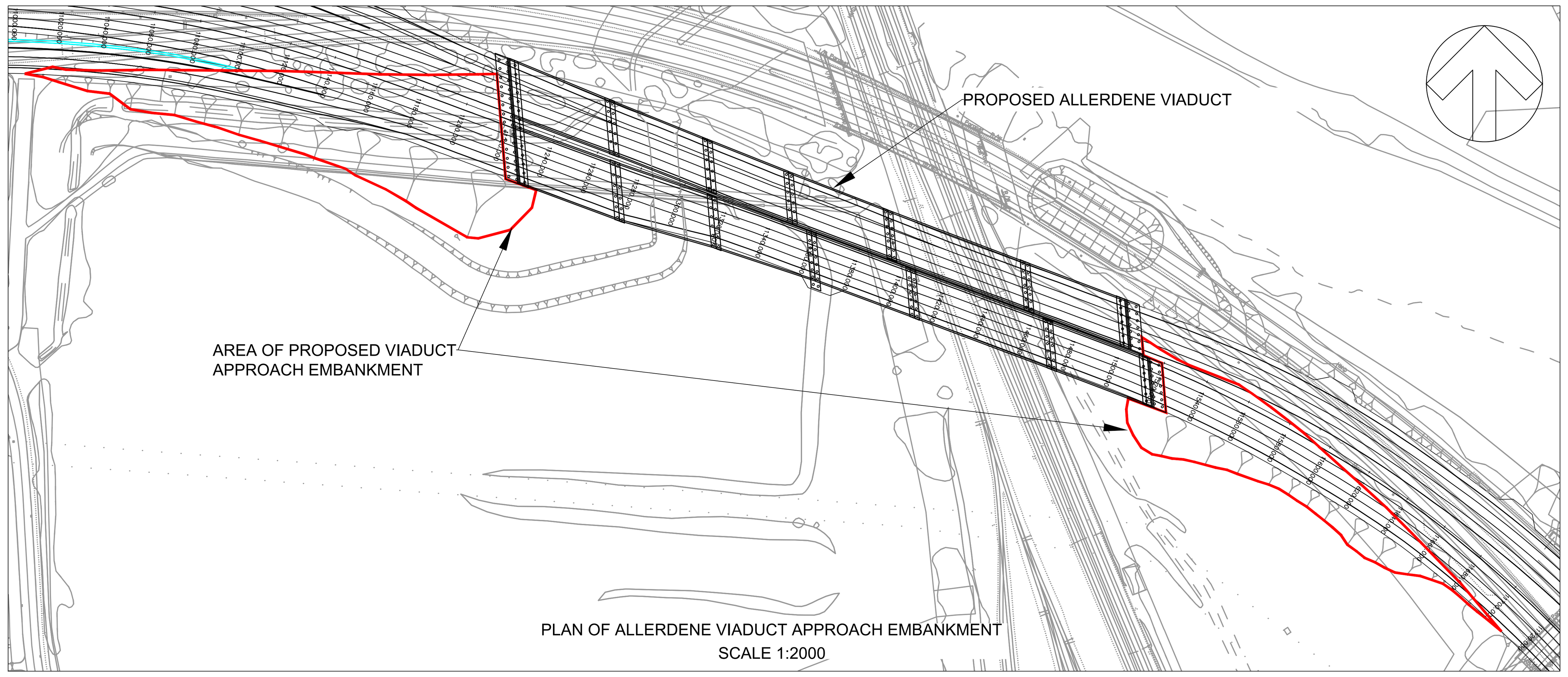
Drawing Number: Project HE551462 | Originator WSP | Volume SBR | Location BCH | Type DR | Role S | Number 00105

Project Ref. No.

Revision: P02

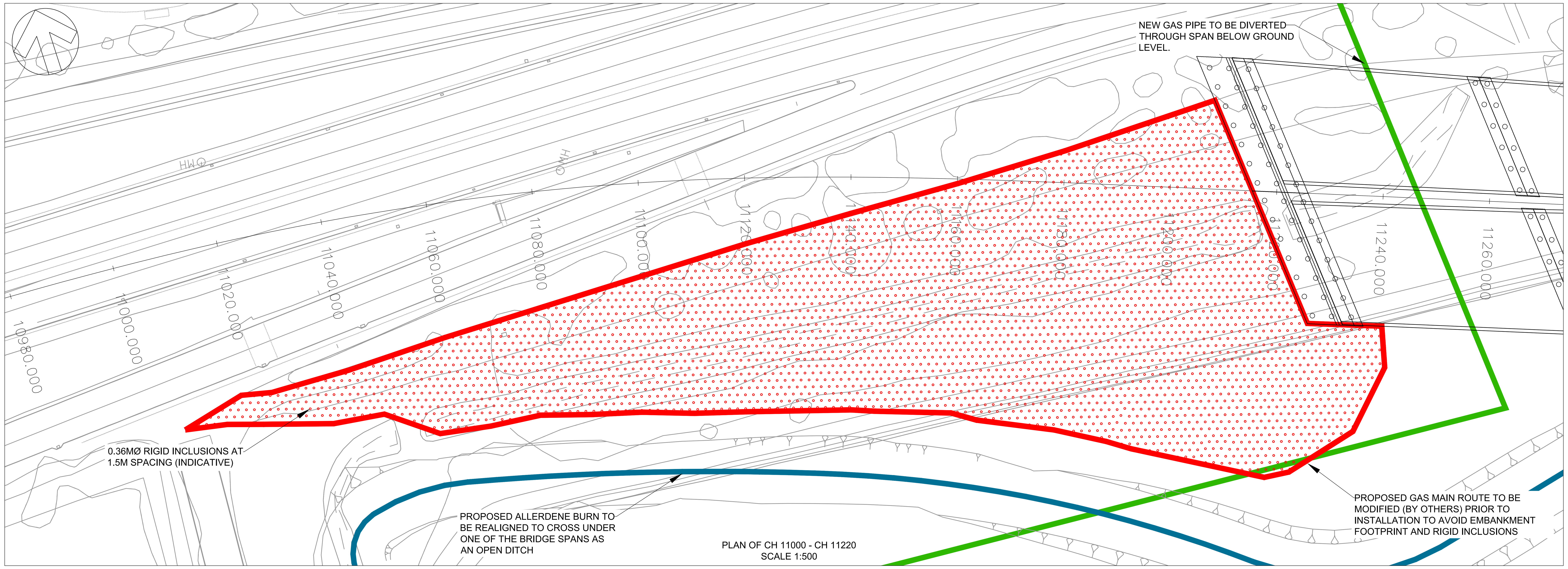
APPENDIX D-2

EMBANKMENT DETAILS

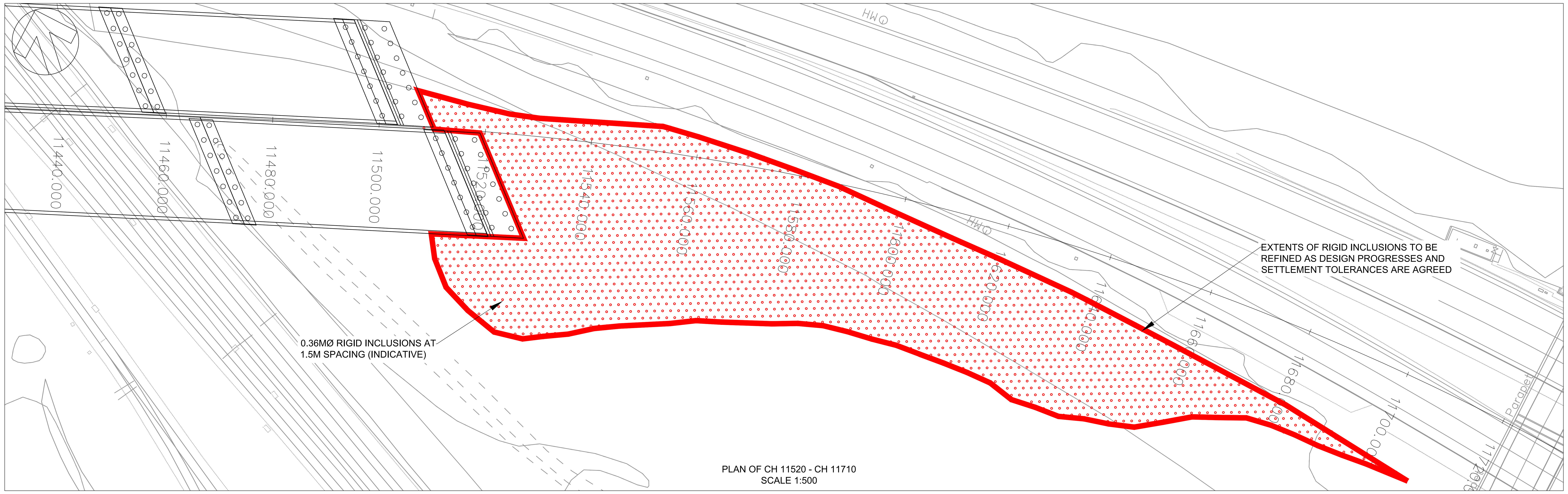


PLAN OF ALLERDENE VIADUCT APPROACH EMBANKMENT
SCALE 1:2000

APPROXIMATELY 5,700 RIGID INCLUSIONS



PLAN OF CH 11000 - CH 11220
SCALE 1:500



PLAN OF CH 11520 - CH 11710
SCALE 1:500

KEY:

DO NOT SCALE

- EXTENT OF RIGID INCLUSIONS BENEATH EMBANKMENT
- 000.000 SCHEME CHAINAGE
- PROPOSED GAS MAIN
- PROPOSED ALLERDENE BURN

RIGID INCLUSIONS

X SPACING

NOTES:

1. DO NOT SCALE FROM DRAWING.
2. DRAWING FOR INFORMATION ONLY.
3. THIS DRAWING IS TO BE READY IN CONJUNCTION WITH DRAWING HE551462-WSP-HGT-BCH-DR-GE-00109.
4. POSITION OF RIGID INCLUSIONS ARE INDICATIVE ONLY. FINAL LOCATIONS, SPACING AND EXTENTS OF RIGID INCLUSIONS TO BE DETERMINED FOLLOWING DETAILED DESIGN.
5. DESIGN OF ANY TEMPORARY WORKS REQUIRED SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
6. THE INDICATIVE SPACING OF THE RIGID INCLUSIONS ARE BASED ON THE MOST LIKELY GROUND CONDITIONS AND MOST LIKELY MATERIAL PROPERTIES. REFER TO THE : A1 BIRTLEY TO COAL HOUSE: ALLERDENE EMBANKMENT GROUND IMPROVEMENT TECHNICAL MEMO FOR DETAILS OF HOW RIGID INCLUSIONS SPACING VARIES WITH THE WORST AND BEST CASE GROUND CONDITIONS AND MATERIAL PROPERTIES.

REV	DATE	BY	DESCRIPTION	CHK	APP
P01	23/10/2018	BW	INITIAL ISSUE	BT	CP

DRAWING STATUS: S2 - FOR INFORMATION

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wsp.com

CLIENT: HIGHWAYS ENGLAND

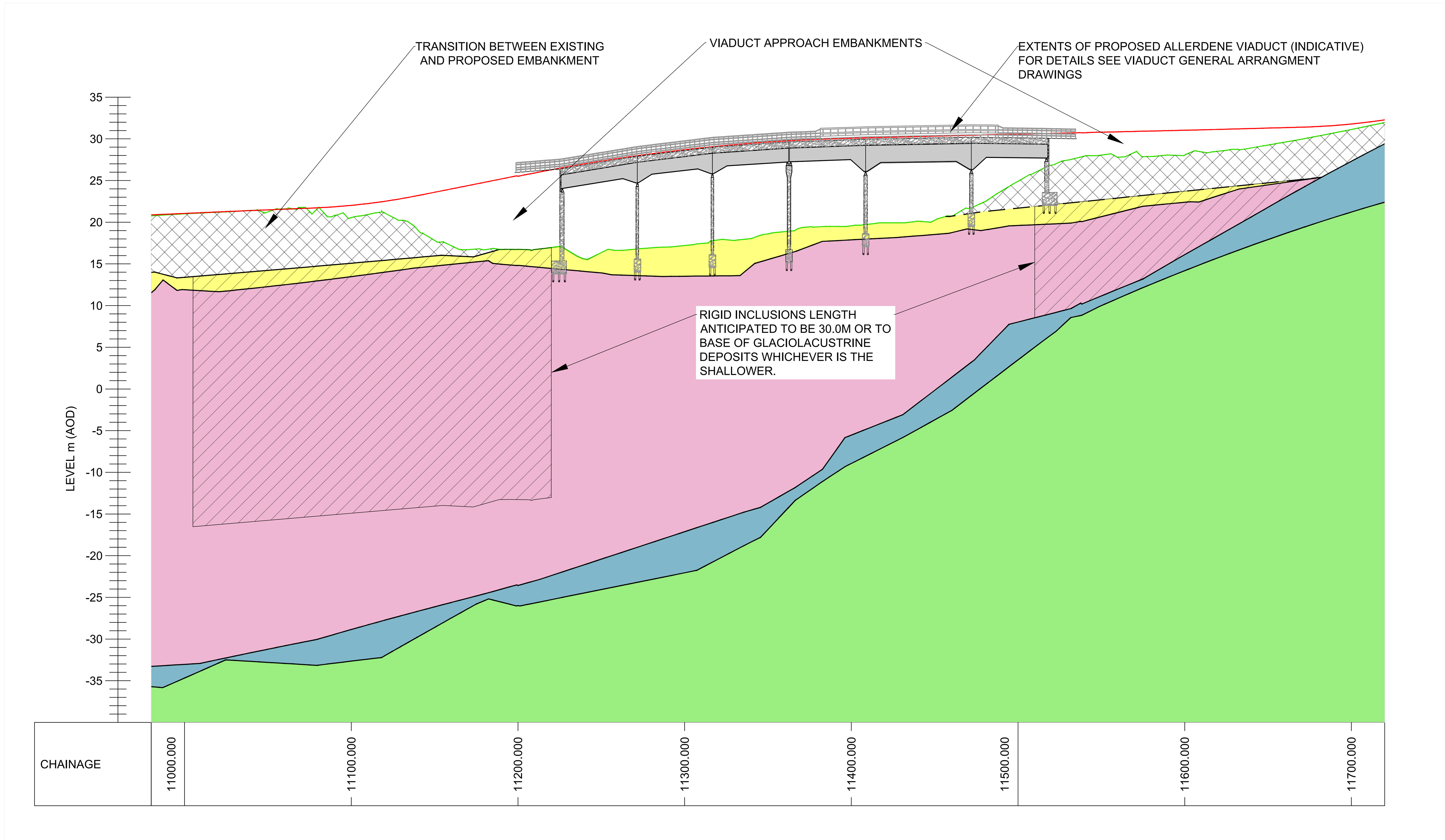
ARCHITECT:

SITE/PROJECT: A1 ROAD IMPROVEMENTS COAL HOUSE JUNCTION (J67) TO BIRTLEY JUNCTION (J65)

TITLE: ALLERDENE VIADUCT INDICATIVE GROUND IMPROVEMENT OPTION - RIGID INCLUSIONS

SCALE @ A1:	CHECKED:		APPROVED:
AS SHOWN	BT		CP
PROJECT NO:	DESIGNED:	DRAWN:	DATE:
70015226	RJ	BW	March 19

DRAWING No:	REV:
HE551462-WSP-HGT-BCH-DR-GE-00108	P01



LONG SECTION THROUGH CENTRE LINE OF ALLERDENE
VIADUCT AND APPROACH EMBANKMENTS
HORIZONTAL SCALE: 1:2,000
VERTICAL SCALE: 1:400

KEY: DO NOT SCALE

- MADE GROUND
- ALLUVIUM
- GLACIOLACUSTRINE DEPOSITS
- GLACIAL TILL
- ROCK
- PROPOSED RIGID INCLUSIONS
- PROPOSED GROUND LEVEL
- EXISTING GROUND LEVEL
- STRATA BOUNDARIES
- INDICATIVE STRATA BOUNDARIES

NOTES:

1. DO NOT SCALE FROM DRAWING.
2. DRAWING FOR INFORMATION ONLY.
3. THIS DRAWING IS TO BE READY IN CONJUNCTION WITH DRAWING HE551462-WSP-HGT-BCH-DR-GE-000108.
4. POSITION OF RIGID INCLUSIONS ARE INDICATIVE ONLY. FINAL LOCATIONS, SPACING AND EXTENTS OF RIGID INCLUSIONS TO BE DETERMINED FOLLOWING DETAILED DESIGN.
5. DESIGN OF ANY TEMPORARY WORKS REQUIRED SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.
6. THE INDICATIVE SPACING OF THE RIGID INCLUSIONS ARE BASED ON THE MOST LIKELY GROUND CONDITIONS AND MOST LIKELY MATERIAL PROPERTIES. REFER TO THE : A1 BIRTLEY TO COAL HOUSE: ALLERDENE EMBANKMENT GROUND IMPROVEMENT TECHNICAL MEMO FOR DETAILS OF HOW RIGID INCLUSIONS SPACING VARIES WITH THE WORST AND BEST CASE GROUND CONDITIONS AND MATERIAL PROPERTIES.

REV	DATE	BY	DESCRIPTION	CHK	APP
P01	11/10/2018	BW	INITIAL ISSUE	BT	CP

DRAWING STATUS: S2 - FOR INFORMATION

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wsp.com

CLIENT: HIGHWAYS ENGLAND

ARCHITECT:

SITE/PROJECT: A1 ROAD IMPROVEMENTS COAL HOUSE JUNCTION (J67) TO BIRTLEY JUNCTION (J65)

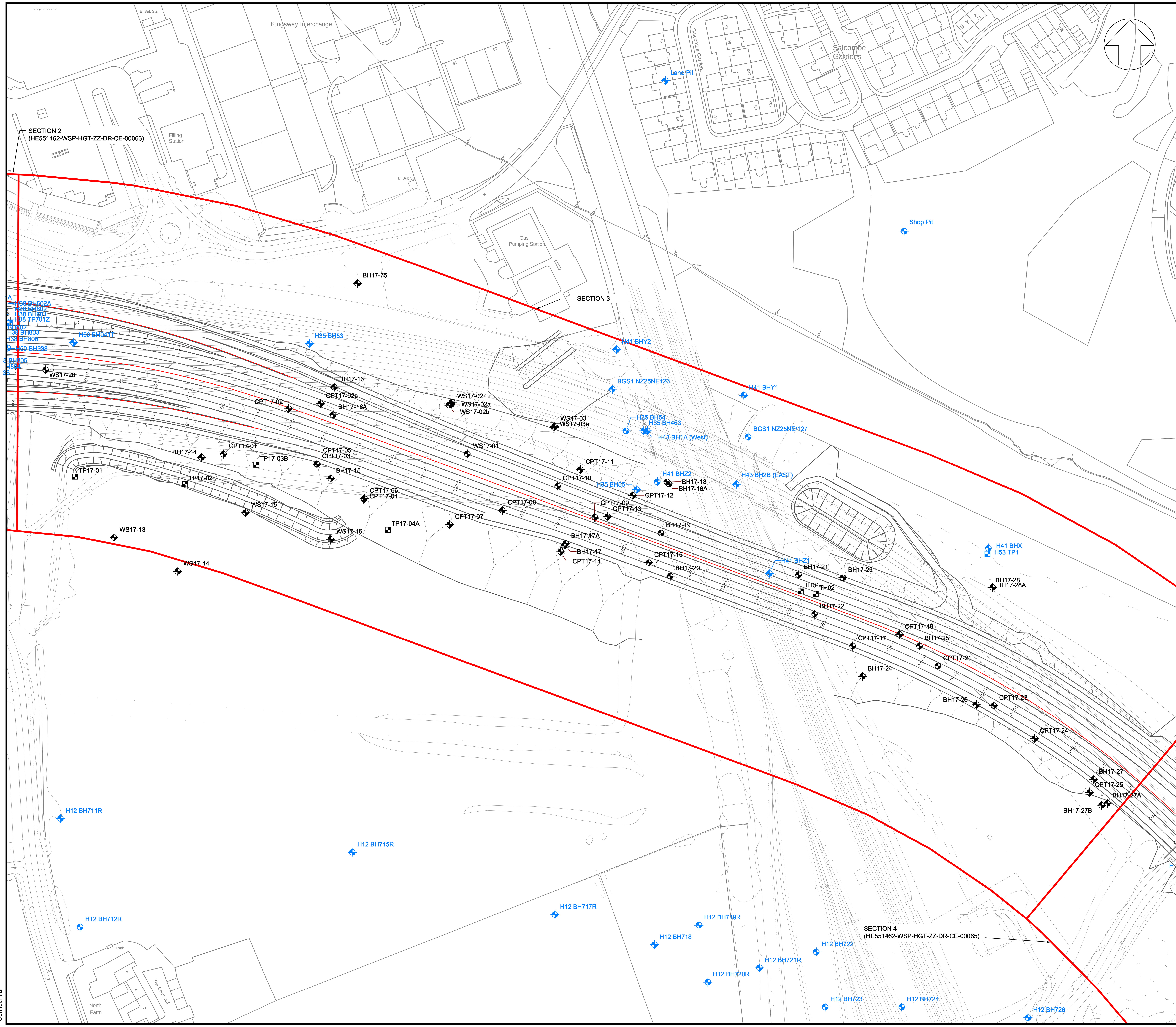
TITLE: ALLERDENE VIADUCT INDICATIVE GROUND IMPROVEMENT OPTION - RIGID INCLUSIONS

SCALE @ A1: AS SHOWN	CHECKED: BT		APPROVED: CP
PROJECT NO: 70015226	DESIGNED: RJ	DRAWN: BW	DATE: March 19

DRAWING No: HE551462-WSP-HGT-BCH-DR-GE-00109 REV: P01

DO NOT SCALE

Millimetres 0 10 100



KEY:

- HISTORICAL BOREHOLE/WINDOW SAMPLE
- HISTORICAL TRIAL PIT
- 2018 INVESTIGATION BOREHOLE/WINDOW SAMPLE/CPT
- 2018 INVESTIGATION TRIAL PIT

GROUND INVESTIGATION SOURCE:

BH17-XX	WSP 2018 INVESTIGATION
BGS-XX	BRITISH GEOLOGICAL SURVEY BOREHOLE
H03-XX	GATESHEAD WESTERN BYPASS MARCH 1993
H12-XX	GATESHEAD WESTERN BYPASS 1996-1997
H35-XX	GATESHEAD WESTERN BYPASS JANUARY 1967
H38-XX	GATESHEAD WESTERN BYPASS NOVEMBER 1969
H41-XX	GATESHEAD WESTERN BYPASS SEPTEMBER 1967
H44-XX	NORTHDENE FOOTBRIDGE MARCH 1970
H46-XX	EIGHTON LODGE IMPROVEMENT SEPTEMBER 1969
H47-XX	BIRTLEY BYPASS MOTORWAY DECEMBER 1965
H50-XX	KINGSWAY ROUNDABOUT OCTOBER 1983
H53-XX	EIGHTON LODGE IMPROVEMENT AUGUST 1985
H68-XX	GATESHEAD WESTERN BYPASS JULY 1970

DELINEATED EXTENTS OF SECTIONS FOR REPORTING (I.E NOT SITE BOUNDARIES)

NOTES:

1. REFER TO GROUND INVESTIGATION FACTUAL REPORT (REF: HE551462-CAX-VGT-ZZ-RP-VG-00001) FOR 2018 INVESTIGATION RECORDS AND EXPLORATORY HOLE CO-ORDINATES.
2. REFER TO HAGDMS RECORDS FOR HISTORICAL INVESTIGATION RECORDS AND EXPLORATORY HOLE CO-ORDINATES.

Rev.	Date	Description	By	Eng' Ch'k	Disc' Ch'k	App'd
P01.2	05/12/18	First Revision	---	---	---	---

Suitability: Work In Progress

Status: S0

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http://www.wspgroup.com

Client: highways england

Project Title: A1 BIRTLEY TO COAL HOUSE

Drawing Title: SECTION 3 EXPLORATORY HOLE LOCATION PLAN

Scale	Drawn	Eng. Check	Approved	Authorised
N/A	---	---	---	---
Original Size	Date	Date	Date	Date
A1	---	---	---	---

Drawing Number

HE PIN	Originator	Volume			
HE551462	WSP	HGT			
Section	Type	ID	Direction	Type	Role
ZZ			DR	CE	00064

Revision

PW Stage Code: 3

Confidential

WSP Project Number: 70041947

HE551462-WSP-HGT-ZZ-DR-CE-00064

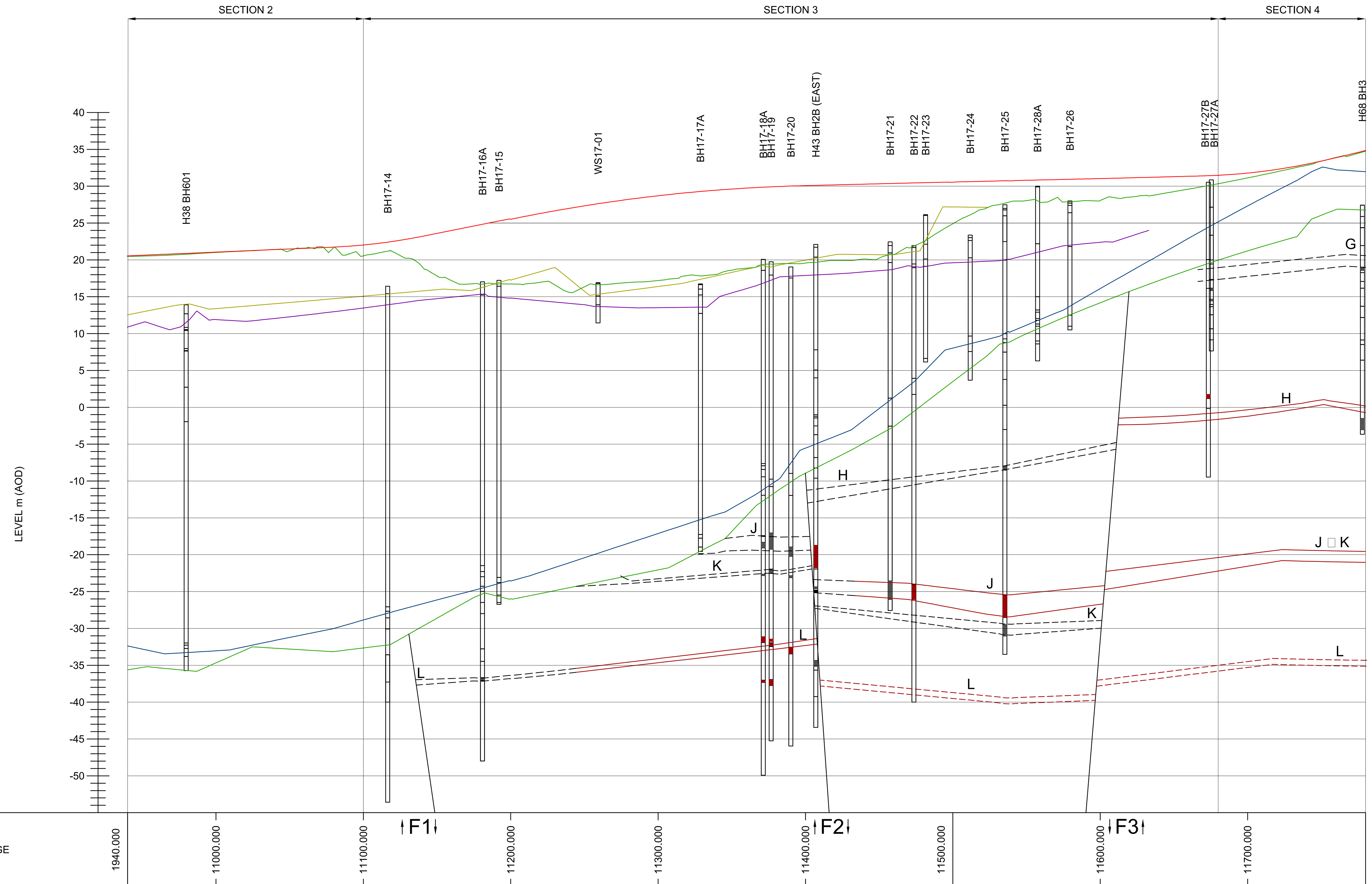
DO NOT SCALE

NOTES:

1. AREA BETWEEN TOP OF SUPERFICIAL DEPOSITS AND EXISTING GROUND TO BE ASSUMED AS MADE GROUND.
2. MINING RISK CATEGORIES EXPLAINED IN COAL MINING RISK ASSESSMENT REPORT HE551462-WSP-VGT-ZZ-RP-VG-00001□

SEAM REFERENCE	STANDARD N.C.B. SEAM REFERENCE	WORKED SEAM THICKNESS (m)	SEAM THICKNESS (m)
MAIN	G	N/A	0.3□
MAUDLIN	H	1.1 - 1.52	0.5 - 3.1□
DURHAM LOW MAIN	J	0.85	0.13 - 2.5□
BRASS THILL	K	N/A	0.23 - 1.5□
HUTTON	L	UNKNOWN	0.9 - 2.1□□

□ BASED ON RECORDED INTACT THICKNESS IN EXPLORATORY HOLES
□□ BASED ON BGS GEOLOGICAL MAP



STRUCTURES			ALLERDENE APPROACH	ALLERDENE VIADUCT	ALLERDENE APPROACH	
PERCEIVED COAL MINING RISK	EARTHWORKS		LOW	N/A	LOW	
	STRUCTURES			HIGH		
	MINE GAS		LOW	HIGH	LOW	
MITIGATION	EARTHWORKS	FORMATION INSPECTION AND SUITABLE DESIGN OF LOAD TRANSFER PLATFORM AND RIGID INCLUSIONS		N/A	FORMATION INSPECTION AND SUITABLE DESIGN OF LOAD TRANSFER PLATFORM AND RIGID INCLUSIONS	
	STRUCTURES			GROUND INVESTIGATION AND DRILLING AND GROUTING OF BRIDGE BRIDGE PIERS.		
	MINE GAS			WORKS TO BE UNDERTAKEN IN ACCORDANCE WITH COAL AUTHORITY PERMIT AND HSE GUIDANCE.		
				GAS MONITORING TO BE UNDERTAKEN IN EXCAVATIONS AND CONFINED SPACES		

SCALE:
HORIZONTAL 1:2,000
VERTICAL 1:400 (5x EXAGGERATION)

KEY:

- EXISTING GROUND LEVEL
- PROPOSED GROUND LEVEL
- TOP OF ALLUVIUM
- TOP OF GLACIOLACUSTRINE DEPOSITS
- TOP OF GLACIAL TILL
- ROCKHEAD
- INFERRED COAL SEAM BASED ON STRATIGRAPHIC SEQUENCE AND RELATIONSHIP TO COAL AUTHORITY RECORDED WORKINGS AND/OR COAL OR VOIDS RECORDED ON BOREHOLE LOGS
- COAL AUTHORITY RECORDED WORKINGS (ELEVATION SHOWN ON COAL AUTHORITY PLANS OR BOREHOLE RECORDS)
- INFERRED COAL AUTHORITY RECORDED WORKINGS (ELEVATION NOT SHOWN ON COAL AUTHORITY PLANS OR BOREHOLE RECORDS)
- COAL SEAM WITHIN BOREHOLE
- WORKED COAL SEAM WITHIN BOREHOLE

FAULTS:

F1: THROW □20-23m
F2: THROW □6-8m
F3: THROW □2-3m

REV	DATE	BY	DESCRIPTION	CHK	APP
P01	21/09/2018	BW	INITIAL ISSUE	AH	BD

DRAWING STATUS: S2 - FOR INFORMATION

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wsp.com

CLIENT: HIGHWAYS ENGLAND

ARCHITECT:

SITE/PROJECT: A1 ROAD IMPROVEMENTS COAL HOUSE JUNCTION (J67) TO BIRTLEY JUNCTION (J65)

TITLE: GEOLOGICAL LONG SECTION COAL MINING RISK - SECTION 3 OPTION 2

SCALE @ A1:	CHECKED:		APPROVED:
AS SHOWN	AH		BD
PROJECT NO: 70015226	DESIGNED: FR	DRAWN: BW	DATE: September 18

DRAWING No: HE551462-WSP-HGT-BCH-DR-GE-00105 REV: P01

Appendix E

OUTLINE BUILDABILITY METHODOLOGY – HUB CONTRACTOR

A1B2C-Viaduct Option

Construction Methodology-Revision A

Area 4 – Ch1200 to Ch1700 off-line section

An elevated viaduct consisting of a 4-span approach to the North of the new Allerdene Rail bridge and a single span approach to the South of the new Allerdene rail bridge is proposed.

The construction methodology for this option is described below.

Preliminary Works

Site clearance over the footprint of the works would be carried out followed by the establishment of haul roads and laydown areas for the works. Grouting works to the underlying coal measures would then be undertaken beneath the proposed pier and abutment locations. Temporary driven sheet piling is required to retain the existing carriageway at the Southern and Northern extents of the Viaduct, followed by excavation in front of these piles. Piling platforms in the form of a 500mm deep granular layer will then be installed at the pile locations, allowing access for bored piling rigs to undertake their works involving the installation of 900 diameter piles at the piers and abutments.

Abutment Works

Following installation of piling, abutment construction at the two viaduct abutment may proceed with the construction of RC pile caps. Abutment wall construction will follow, involving erection of temporary access scaffolding, installation of reinforcement, and installation of a proprietary formwork system by crane. Concreting of the abutment will be undertaken using a 32m concrete pump and following curing the formwork shall be removed by mobile crane.

Viaduct Pier works

In conjunction with abutment works, the pier construction shall be undertaken commencing with the construction of the RC pile cap. Following this, access scaffolding shall be erected allowing installation of the reinforcement cage then erection of a proprietary formwork system by 80t mobile crane. Concrete to the piers shall be carried out with a 32m concrete pump and following curing, formwork shall be stripped with the 80T crane.

Viaduct Deck Works

The form of the deck comprises steel beams with an in situ concrete deck. The steel beams shall be factory fabricated and brought to site where a 500T crane shall offload the individual beams where they shall be paired together then lifted into position as braced pairs. On completion of the bridge beam installation, Omnia deck panels and cantilever formwork shall be erected using a 100t crane. Following this operation, deck reinforcement and formwork shall be placed, with the assistance of a 100t service crane. Deck concreting may then proceed using a 32m concrete pump, with concreting being undertaken in the sequence prescribed. On curing, finishing works may then be undertaken to include waterproofing, kerbing, parapets and surfacing. The cantilever formwork components may then be removed by crane.

Tie In Works

Final tie in works between the existing embankment and the new abutment walls remains to be completed. These works include the installation of rigid inclusions utilising a specialist rig at a 1.5m grid spacing following which a 1m deep granular drainage layer will be installed using a D6 dozer and compaction plant, overlain with a geogrid separation layer. On completion of these operations, the earthworks tie in will be installed in compacted layers with a D4/D6 dozer and pneumatic compaction roller. Imported 6N granular material will be placed immediately behind the abutment and class 2 fill for the remainder. On completion of the earthworks, drainage, roadworks and finishes may be completed.

Appendix F

DESIGNER'S RISK ASSESSMENT

T446: Design Risk Management Schedule

Project No	70041947-00	Project Name	A1 Birtley to Coal House - Allerdene Bridge- Viaduct Option

Guidance Notes *(see guidance notes page for more details)*

Design risk management should be an integral part of the overall design development and designers should think of it in terms of considering constructability, maintainability, etc. Designers only need to document their consideration of risks in this simple risk management schedule format. There is no requirement for quantitative design risk assessments to be carried out/documented and these should be avoided

** Risks should be considered in a logical sequence relating to the location/operational environment, constructability/instability, operability (normal/emergency), maintainability (inc routine cleaning, replacement, etc.), and alteration/decommissioning/dismantling/demolition, and should be categorised against those headings,*

CIRIA guidance documents C755, C756, C686, C607, etc. provide a useful checklist and detailed guidance on the identification of risks to be considered during design and how those risks might be addressed - see detailed guidance notes for more details

§ Significant residual risks are those which are unusual, not obvious, difficult to manage, or where critical design assumptions apply. The documentation by designers of residual risks that cover well-known and understood hazards should be avoided.

Ref	Risk Category* & Phase where appropriate, *e.g. location/environment, construction, operation, maintenance, alteration/demolition*	Work Element/Location (where appropriate)	Hazard or Risk Issue Identified	Risk Management Owner	Design ERIc Action Required *(e.g. hazard elimination/risk mitigation action, information to be provided to others)*	Significant Temporary Works Requirements/Management Arrangements and/or any Special Erection/Installation Sequences or Requirements	Design Action Status/Final Resolution Notes *(e.g. traceability of ERIc action, communication of significant residual risk, critical design criteria, etc.)*	Significant Residual Risk§	Date Logged/ Reviewed	Raised By
A01	Construction	Allerdene Viaduct	Working at height	Contractor	Use of GRP/GRC planks will minimise the working at height. Consideration to be given to lifting of girders in pairs with the planks in place between girders. The formwork for the string course and worker protection barriers will also be in place before the lifting of the edge beam. This procedure will further reduce working at height and provide a safe working platform.	Large assembly room required on site to deliver girders and set in pairs prior to lift. Crane and associated pad required.	Note on drawing to highlight the risk associated with works at height - particularly during the beam lift.	Y	20/09/2016	Rakesh Mehta
A02	Construction	Allerdene Viaduct	Personnel and Plant Encroaching the Railway	Contractor	All works to be designed so that they can be constructed within safe working zones or during railway possessions as agreed with NR.	Temporary work minimised by use of lifting/launching of steel beams	Works Information to state requirement for some possession working. Contractor team to be made aware of NR working environment risks (PTS training) . Note to be place on drawings	Y	20/09/2016	Rakesh Mehta/Hitan Mistry
A03	Construction/Operation/Maintenance	Allerdene Viaduct	Damage to services, electrocution	Contractor	Service requirements to be confirmed prior to constructions. Details to be included in appendix 1/16 of the works information. All services to be located within the verges (above soffit level) to simplify access without disruption to the rail way.	None	Appropriate note/reference to be put on drawings relating to the proposed service ducts provided and their location. Appropriate note/reference to be put on drawing for the location of existing services.	N	20/09/2018	Rakesh Mehta
A04	Construction	Allerdene Viaduct	Long beam will require strict delivery arrangements and transportation to site will be problematic, leading to potential road side incidents.	Designer	Detailed design to ensure fabricated girders are manageable not excessively long etc.) to ensure they can be delivered to site with minimal logistical risks.	Access to construction area to be designed as part of TTM plan.	Contractors to consider method of delivery and erection. Defined loading and unloading areas to be shown on drawings	N	20/09/2018	Rakesh Mehta
A05	Construction	Allerdene Viaduct	Heavy lifting - steel beams - risk of unstable load due to lifting points not aligning with centre of gravity	Designer / Contractor	The beams will be lifted in pairs to minimise the risk of instability and high torsion buckling of single beams. Design to consider designated lifting points to limit risk on instability.	Appropriate craneage to be used with a lifting plan. Contractor will need to ensure cranes are adequately sized and positioned.	Heavy lifting risk to be recorded on drawings	Y	20/09/2018	Rakesh Mehta/Hitan Mistry
A06	Construction	Allerdene Viaduct	Deep excavations for open/pad foundation for abutment construction. Potential risk of collapsing of excavation, entrapment of personnel, overturning of plant and vehicles.	Designer	CFA/ bored piled foundation for abutments eliminates risk of deep excavations	Temporary works minimised		N	20/09/2018	Rakesh Mehta
A07	Construction	Allerdene Viaduct	Working with concrete - In-situ concrete deck construction require handling of large volumes of concrete, Shuttering requires significant temporary works. Also large reinforcement cages with dangers from impaling and lifting of bars, working at heights etc.	Designer	In-situ concrete works for the bridge deck has been limited by the proposed installation of steel beams which reduces concrete operations on site. The in-situ deck slab would use permanent formwork that eliminates additional site operations associated with the removal of formwork.		Details of steel beams (size/length etc.) and indicative permanent formwork to be defined on drawings.	N	20/09/2018	Rakesh Mehta
A08	Construction	Allerdene Viaduct	Instability/movement of GRP deck planks, create gaps and risk of tools/materials falling onto the live railway	Contractor	Concreting to be done in a controlled manner, to ensure planks are not dislodged	Contractor to implement a suitable SSOW		Yes	20/09/2018	Rakesh Mehta/Hitan Mistry
A09	Construction	Allerdene Viaduct	Presence of the old coal Mining area, undermine foundations	Contractor/designer	Depth of bridge piled foundation conflict with old mine workings. Grouting work for to fill the void area to control settlement around the pile foundation. Volume of grouting required diff to quantify	Contractor to implement a suitable method of working to eliminate impact to railway track		Yes	20/09/2018	Rakesh Mehta
A10	Construction	Allerdene Viaduct	Working with poor ground - Issue of significant settlement	Contractor/designer	Geotechnical investigation and detail assessment will be carried out to propose suitable improvement to reduce settlement to acceptable limit			N	20/09/2018	Rakesh Mehta
A11	Construction	Allerdene Viaduct	Working closure to existing live highway	Contractor	All works to be designed so that they can be constructed within safe working zones or during lane closure as agreed with HE.	Temporary work along the existing embankment to minimise lane closure	Works Information to state requirement for temporary retaining wall. Note or details to be place on drawings	Yes	20/09/2018	Rakesh Mehta/Hitan Mistry
A12	Construction	Allerdene Viaduct	Instability of large gantry during installation over the substructure	Contractor/designer	Designer to design safe connection and contractor to establish safe working system for installation			No	18/10/2018	Rakesh Mehta
A13	Construction	Allerdene Viaduct	Site vehicles damaging public road/footpath and level crossing. Mud on roads, airborne contamination during/after transit.	Contractor	Identify agreed route where disruption will be minimised and how the site will be accessed by construction traffic during the works.	Temporary highway works may be required. Wheel washing facility to be used on site to minimise mud tracked onto road network. Tarpaulins and straps to be checked before deliveries leave site.	Contractor to plan all site deliveries and make suppliers aware of these. To be defined in TTM plan.	N	20/09/2018	Rakesh Mehta
A14	Construction	Allerdene Viaduct	Use of hazardous materials	Designer / Contractor	Designer to minimise use of hazardous materials. Contractor to adhere with COSHH regulations where hazardous materials are unavoidable.		No unusual hazardous materials anticipated. Considered to be within experience of a competent contractor and/or covered by normal Contractor site controls.	N	20/09/2018	Rakesh Mehta
A15	Construction	Allerdene Viaduct	Spray applied material causing environmental contamination	Contractor	Contractor to take adequate measures to avoid contamination.		The maximum wind speed should not exceed 13 mph for light materials (such as primers): a higher limit of 20 mph is normally applied for membranes that cure rapidly.	No	20/09/2018	Rakesh Mehta

T446: Design Risk Management Schedule

Project No	70041947-00	Project Name	A1 Birtley to Coal House - Allerdene Bridge- Viaduct Option

Guidance Notes *(see guidance notes page for more details)*

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** Risks should be considered in a logical sequence relating to the location/operational environment, constructability/instability, operability (normal/emergency), maintainability (inc routine cleaning, replacement, etc.), and alteration/decommissioning/dismantling/demolition, and should be categorised against those headings,*

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A16	Construction	Allerdene Viaduct	Slip, trips and falls	Contractor	Contractor to keep tidy site and ensure safe means of access on slopes.		Considered to be within experience of a competent contractor and/or covered by normal Contractor site controls.	N	20/09/2018	Rakesh Mehta
A17	Construction	Allerdene Viaduct	Tripping or falling on rebar	Contractor	Use of mushroom caps to protect projecting rebar.		Considered to be within experience of a competent contractor and/or covered by normal Contractor site controls.	N	20/09/2018	Rakesh Mehta
A18	Construction	Allerdene Viaduct	The site may be accessible by public footpaths	Contract	Appropriate site compound to be put in place including a fenced area to exclude members of the public from the site works, with temporary diversion of public footpaths during the works. If any		Considered to be within experience of a competent contractor and/or covered by normal Contractor site controls.	N	20/09/2018	Rakesh Mehta
A19	Construction	Allerdene Viaduct	Construction plant and materials encroaching or falling on adjacent railway	Contractor	Piling technique to be reviewed by Contractor at the intermediate piers adjacent to the tracks to reduce the risk of the encroachment/falling onto adjacent railway.			N	18/10/2018	Rakesh Mehta
A20	Maintenance of structure	Allerdene Viaduct	Working adjacent to/over a railway line	Designer	Future inspection and maintenance should be undertaken under full possessions.		Details to be appropriately recorded in the H&S file upon handover of the structure.	N	18/10/2018	Rakesh Mehta
A21	Maintenance of structure	Allerdene Viaduct	Working at height	Designer	Use MEWP / underbridge unit and appropriate PPE.		Details to be appropriately recorded in the H&S file upon handover of the structure.	N	18/10/2018	Rakesh Mehta
A22	Maintenance of structure	Allerdene Viaduct	Jacking operation for replacement bearings	Bridge Owner	Work to be carried out under low or no traffic conditions on bridge by trained and briefed persons. Bridge design to incorporate accessible jacking locations. Viaduct structural form split into two 3 span structures to simplify bearing types required, increasing durability and ease of installation.		-Details to be appropriately recorded in the H&S file upon handover of the structure.	N	18/10/2018	Rakesh Mehta
A23	Maintenance	Allerdene Viaduct	Painting of structural members induce risk associated with working at height/disruption to railway.	Bridge Owner	Proposed structure comprise weathering steel girders. Therefore the risks associated with maintenance painting operations are eliminated.	-	-	N	20/09/2018	Rakesh Mehta
A24	Demolition	Allerdene Viaduct	Removal of deck during demolition leading to sudden collapse.	Demolition contractor/ designer	Design to consider demolition sequence. Contractor should demolish superstructure reverse to construction sequence.	-	-	N	20/09/2018	Rakesh Mehta
A25	Operation	Allerdene Viaduct	Vehicle collision and falls onto railway. Compromise safety of trains	Bridge Owner	Bridge design proposes the installation of a high containment VRS (H4a) system to reduce the risk of errant vehicles falling onto the railway.			N	20/09/2018	Hitan Mistry
A26	Construction	Allerdene Viaduct	Installation of articulation slab. Requires significant concreting works over railline. Adjacent decks are also subject to as-built tolerances.	Designer	Articulation slab to consist of discretised precast units for elimination of in-situ concreting works over the rail line. Design to allow sufficient flexibility in cover slab dimensions to reflect as-built deck positions.			No	17/12/2018	James Littlewood

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Issue 3.0

Appendix G

GEOTECH RISK REGISTER

A1 Birtley to Coal House

Document Reference: 70041947_A1B2CH_Rev1_11072018

Date: 11 July 2018

Background

1. The A1 between junction 65 (Birtley) to junction 67 (Coal House) is planned to be upgraded. As part of these improvements additional lane capacity is to be provided and the existing Allerdene Railway Bridge is to be replaced.

2. In accordance with HD22/08 a Statement of Intent and a Preliminary Sources Study Report have been completed. These informed the scope of the ground investigation.

3. Several ground related risks were identified at the time that the PSSR was prepared.

4. In advance of the ground investigation fieldwork campaign the preliminary design has been progressed.

5. The preliminary design has developed plans based on matching the existing form of the A1 at this location, which comprises approach embankments to a single span bridge over the East Coast Mainline.

6. Traditionally, this form of solution would represent the option offering the following, in no particular order of relative importance, although the CDM risks may take precedence:

    - Lowest cost
    - Shortest construction programme
    - Lowest maintenance cost and risk
    - Lowest risk to workers and the public during construction and maintenance – lowest CDM risk

7. The total long-term settlement of the embankments and the time for that settlement to take place are matters which have raised the introduction of a multi-span bridge or viaduct as an option.

8. It is recognised that there are multiple risks and constraints to the construction of a new route and the following risk register has been prepared to set those risks out and suggest likely mitigations. Most of these mitigations can be explored at preliminary design stage. This risk register will require regular updates as more information becomes available and possibly more risks will be described as the design moves from a preliminary stage to detailed design.

A1 BIRTLEY TO COALHOUSE GEOTECHNICAL RISK REGISTER

The following risk assessment reviews the possible geotechnical risks to the scheme or the design of the scheme and their potential impact. The appropriation of risk is considered against the probability and impact of the said event. The consequences of these risks have been divided into four types: No Action, Significant, Substantial and Critical. Table 1 provides the methodology for determining the level of consequence.

Table 1: Risk Assessment Methodology.

Probability		Impact		Risk Score	Consequence
1	Neglibible	1	Minor	1 – 3	No action
2	Unlikely	2	Moderate or economic	4 – 8	Significant
3	Probable	3	Major	9 – 11	Substantial
4	Likely	4	Fatal / critical	12+	Critical

Where a significant risk rating is calculated it is recommended that the risk be further examined to appropriate a no action or action response. Where a substantial risk is encountered, an item investigation should be carried out to clarify and allow the designers to manage the risk. A critical risk refers to a health and safety issue or where failure would be catastrophic and would require review prior to investigation and the mitigation of the risk at all stages of the design process.

An assessment of the identified hazards has been carried out in accordance with the requirements of HD22/08 'Managing Geotechnical Risk', as illustrated in Table 2.

Table 2: Geotechnical Risk Register

Ref No.	Risk/Hazard	Pre-control Measures			Consequence	Design / construction / maintenance Mitigation	Post Control Measures			Risk / mitigation Action
		Probability	Impact	Risk Score			Probability	Impact	Risk Score	
	Settlement									
1	Settlements beneath the highest part of the planned earthworks could in theory be in the range 500-1000mm. The duration for the settlements to take place has been estimated to be up to 15-25 years,	3	3	9	At the interface with structures the differential settlement would require maintenance interventions to avoid a marked change in vertical alignment. Away from structures the settlement might cause damage to drainage, and pavement and is likely to require maintenance interventions to maintain the safety standard for the road.	At the interface with structures a transition would be detailed where the earthworks are supported on a load transfer platform that in turn is supported by rigid inclusions such as Controlled Modulus Columns or piles. These would be designed to limit long term settlements to within acceptable limits. Away from the structure there are options to either accelerate the settlements by the introduction of vertical drains, support the earthworks on a LTP and rigid inclusions/piles and if necessary to introduce lightweight fill in order to reduce the overall quantum of settlement. These options are considered separately. **The post control measure score is for a supported transition zone.**	2	3	6	Ensure that the tender documents set out the requirements for transition zones and set sensible and achievable limits for the total and differential settlement that are agreed on by the geotechnical, highway, bridge and maintenance teams.
2	Embankment settlement accelerated by the introduction of band or sand drains. Spacing and depth of treatment to allow settlement to take place within the construction programme. Risk is that settlement rate predictions are not realised.	3	3	9	Settlement takes longer than anticipated and the amount of residual settlement might delay completion or require early-post opening maintenance such as re-surfacing. .	The only truly reliable way to determine the mass behaviour of the soils underlying the site would be to undertake an instrumented field trial. This might increase confidence in the rate of settlement or might equally confirm that accelerating the rate of settlement is not feasible. Other mitigations could include surcharging or the introduction of lightweight fill to limit the quantum of settlement.	2	3	6	Consider against the potential cost savings a band drain only solution might offer whether a field trial is appropriate.

Ref No.	Risk/Hazard	Pre-control Measures			Consequence	Design / construction / maintenance Mitigation	Post Control Measures			Risk / mitigation Action
3	Settlement below the toes of settlement reducing piles or inclusions designed to support the weight of the embankment through skin friction. Settlement could be as a result of stress changes due to unsupported embankment shoulders or distribution of load from the main embankment loading through the toe of the piles/ inclusions	3	2	6	Settlement is of an amount that requires maintenance intervention.	Carry out more detailed analysis to examine the likelihood of significant stress changes in the zone below the piles/inclusions. Install band darins between piles or inclusions to accelerate the settlement. Consider lightweight fill to reduce the amount of settlement.	2	2	4	More detailed modelling to be completed including FEM where necessary.
	Design Approval									
4	Embankment supported on LTP and rigid inclusions / piles to negate settlement rate risk. Risks around design approval for rigid inclusions or piles acting in skin friction only in some zones as depth to rock is in excess of the normal depth range for inclusions and most forms of pile. If piles were adopted in order to achieve a toe in to rocket is unlikely these could be installed economically to depths of up to 45m.	3	2	6	Design delay whilst approval obtained, tender process delayed, no compliant tenders. D&B tenderers do not fully appreciate the design required and decline to price.	Carry out some more detailed design including finite element modelling if required and obtain approval in principle. Speak to the market and check that appropriate contractors and design partners understand the design inputs required. Include requirements in tender packages for long term performance. Tender to require zone test Tender to require outer piles to be reinforced as is common with partial width treatments.	2	2	4	Carry out some design, engage with the market.

Ref No.	Risk/Hazard	Pre-control Measures			Consequence	Design / construction / maintenance Mitigation	Post Control Measures			Risk / mitigation Action
5	Lightweight fill to reduce settlement. Expanded clay, pfa or structural polystyrene and tyre bales are all options with varying risks. Pfa is in short supply and therefore likely to be expensive and does not offer much by way of weight reductions. Expanded clay is low risk but will add costs and will reduce total settlement to between 120 and 250mm but the rate remains the same. Structural polystyrene is expensive and may offer long term durability risk with respect to fuel spillage and /or combustion Quantum of settlement as per expanded clay. Tyre bales have probably never been used on this scale of earthwork previously. Risks are limited and the opportunity may not be that great.	3	2	6	Material costs increase and the rate of settlement does not increase and some maintenance still required.	Decide during detailed design over which zones the total settlement needs to be limited and adopt lightweight fill in those areas.	2	2	4	Decide where a suitable lightweight fill might add value to the programme and reduction of maintenance.
	Rail interface									
6	Risk of settlement or more likely heave if Controlled Modulus Columns are adopted in the near vicinity of the railway given that they can be an energetic displacement method and the underlying soils are not soft.	3	3	9	Movement of NR asset.	Engage with the specialist contractors to understand likely stress changes from installation. Consider the use of a cut off shear wall between the zone of CMC and the rail OR more likely change to CFA piles where no stress change can occur. This would offer a lower risk and probably lower cost risk mitigation. Monitoring of the East Coast Main line during the works	2	3	6	Decide that a piled LTP is required for the transitions irrespective of the solutions for the main earthworks.

Ref No.	Risk/Hazard	Pre-control Measures			Consequence	Design / construction / maintenance Mitigation	Post Control Measures			Risk / mitigation Action
	Gas Main									
7	Gas main is to be diverted but new earthworks would impose load on the main and cause settlement.	3	3	9	Amount of settlement likely to be adverse to the main and NGN approval unlikely to be obtained if measures to protect the main are not adopted.	Support the earthworks above the main on a piled slab with appropriate transitions zones each side that could comprise piled LTP, rigid inclusions lightweight fill or a combination of these. Depending on NGN requirements piles might have to extend to rock which given the depths involved might limit the form of piles available.	2	3	6	Engage with NGN as early as possible.
	Culvert									
8	New culvert required but new earthworks may cause adverse settlement.	3	2	6	Culvert damaged flow characteristics not maintained.	Consider piling the culvert, with appropriate transitions zones each side, that could comprise piled LTP, rigid inclusions lightweight fill or a combination of these.	2	2	4	Appropriate level of input to preliminary design.

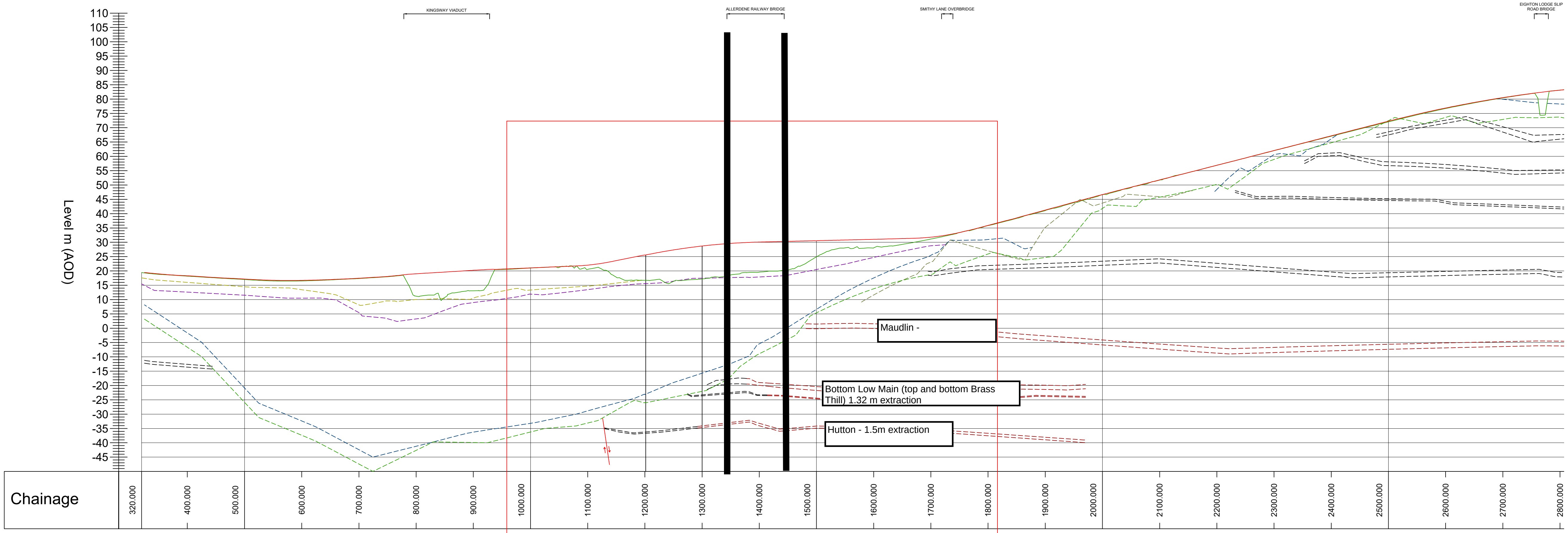
Ref No.	Risk/Hazard	Pre-control Measures			Consequence	Design / construction / maintenance Mitigation	Post Control Measures			Risk / mitigation Action
	Piling									
9	Piling to support bridge piers in the deeper lacustrine deposits may require support fluid.	3	2	6	Increased cost, programme and construction risk such as risk of pile collapse requiring remedial design and construction.	Engage with specialist contractor and select a form and size of pile that is appropriate to the ground conditions and the depths to rock head.	2	2	4	Carry out some design, engage with the market
	Mining									
10	Collapse of shallow mineworking beneath piled foundations for viaduct	4	3	12	Failure of viaduct foundation	Pressure grout beneath viaduct peers to minimise risk of shallow mineworking collapse. Extend pile foundations below the level of the workings. See attached sketch for relative depths of the likely worked seams and hence length of piles.	2	3	6	Speak to specialist piling contractors concerning depth limits and methods of forming the piles though significant thicknesses of superficial deposits and potentially broken rock.
11	Collapse of shallow mine workings affecting piled foundations for the Allerdene Bridge.	4	3	12	Failure of bridge foundations.	Pressure grouting of shallow mine workings to be undertaken in advance of foundation construction Pile foundations to be extended through potential workings to competent strata. See attached sketch for relative depths of the likely worked seams and hence length of piles.	2	3	6	Speak to specialist piling contractors concerning depth limits and methods of forming the piles though significant thicknesses of superficial deposits and

Ref No.	Risk/Hazard	Pre-control Measures			Consequence	Design / construction / maintenance Mitigation	Post Control Measures			Risk / mitigation Action
										potentially broken rock.
12	Grouting of shallow workings beneath the Allerdene Bridge abutments inducing collapse of shallow mine workings beneath the East Coast Railway	2	4	8	Settlement of the NR Asset	Engage with NR at early stage. Engage with grouting contractors to select a method approach to minimise / mitigate the risk. Consider grouting beneath the East Coast Mainline using inclined boreholes to stabilise potential workings in advance of grouting beneath the bridge abutments. Monitoring of the East Coast Main line during the works	1	4	4	Engage with NR at early stage. Engage with grouting contractors
13	Collapse of shallow mine workings beneath the Allerdene Bridge approach embankment when supported on LTP and rigid inclusions / piles	3	3	9	Impact on the foundation / formation of the embankment Long term serviceability of the embankment, drainage and pavement	Further detailed assessment and modelling of likely impact of shallow mineworking collapse through the drift deposits, rigid inclusions / piled soil block and LTP. Possible inclusion of a further high strength basal geotextile above the LTP Grouting	2	3	6	Formalise the mining study and consider likelihood of a collapse migrating through rock cover and significant thicknesses of superficial deposits.
14	Collapse of shallow mine workings beneath the Allerdene Bridge approach embankment if unsupported earthworks solution adopted (i.e. constructed with vertical drains beneath).	3	3	9	Impact on the foundation / formation of the embankment reflected depression at road surface Long term serviceability of the embankment, drainage and pavement	Use a high strength basal grid or geotextile at the base of the embankment to minimise impact of surface settlement on the embankment. Use a piled or rigid inclusion transition tp move the area of risk away from the bridge / earthwork interface.	2	3	6	If an unsupported embankment is deemed appropriate consider the risk of void migration through rock cover and superficial deposits.

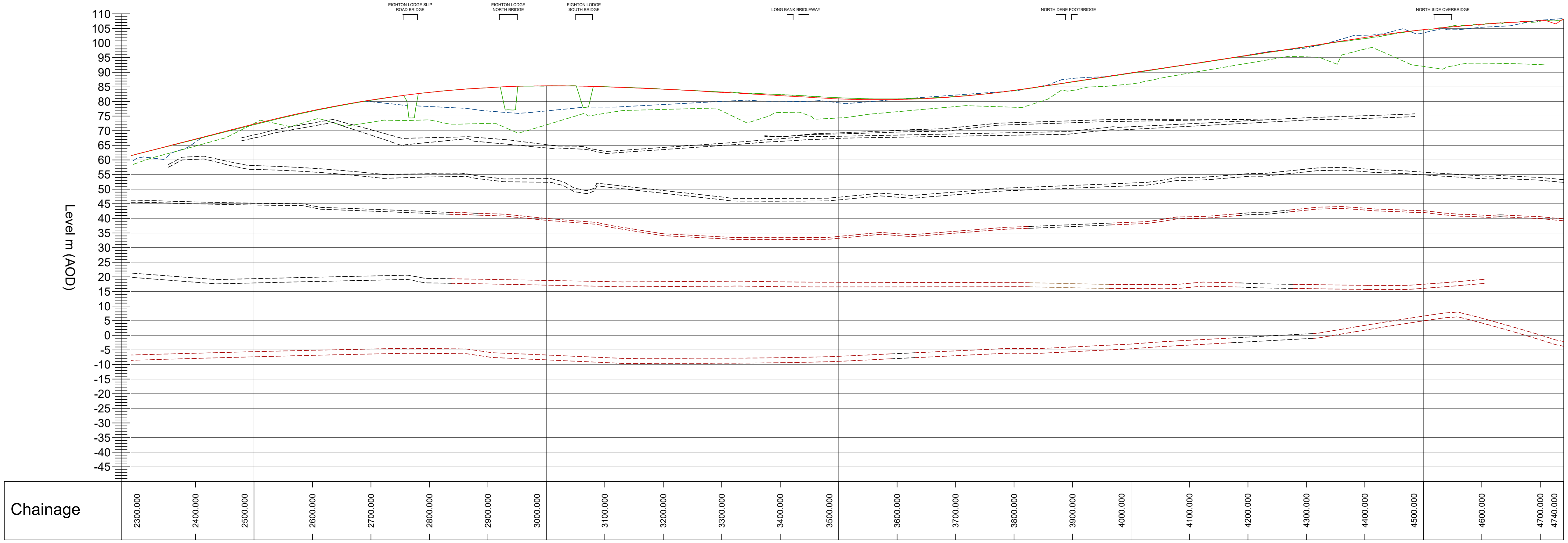
DO NOT SCALE

NOTES:

1. HIGH MAIN AND METAL SEAM ARE SHOWN TO BE UNWORKED DUE TO ABSENCE OF ABANDONMENT PLANS.
2. AREA BETWEEN TOP OF SUPERFICIAL DEPOSITS AND EXISTING GROUND TO BE ASSUMED AS MADE GROUND.



SCALE:
HORIZONTAL 1:4,000
VERTICAL 1:800 (5x EXAGGERATION)



SCALE:
HORIZONTAL 1:4,000
VERTICAL 1:800 (5x EXAGGERATION)

KEY:

- EXISTING GROUND LEVEL
- PROPOSED GROUND LEVEL
- TOP OF ALLUVIUM
- TOP OF GLACIOLACUSTRINE DEPOSITS
- TOP OF GLACIAL TILL
- TOP OF COMPLETELY WEATHERED BEDROCK
- ROCKHEAD
- COAL SEAM
- KNOWN AREA OF WORKED COAL
- LIKELY WORKED COAL

ORDER OF COAL SEAMS:
(HIGH TO LOW)

1. HIGH MAIN AND TOP HIGH MAIN
2. METAL
3. FIVE QUARTER
4. MAIN (YARD)
5. MAUDLIN
6. DURHAM LOW MAIN
7. BOTTOM LOW MAIN
8. HUTTON

REV	DATE	BY	DESCRIPTION	CHK	APP
P01	01/01/1901	XXX	FIRST ISSUE	XXX	XXX

DRAWING STATUS:
S0 - WORK IN PROGRESS

wsp

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wsp.com

CLIENT:

ARCHITECT:

SITE/PROJECT:

TITLE:

SCALE @ A1: Custom | CHECKED: | APPROVED:

PROJECT NO: | DESIGNED: | DRAWN: | DATE: July 18

DRAWING No: 3D COAL SEAM MODEL | REV: P01

Appendix H

WSP/HE SES CLOSE OUT COMMENTS

APPROVAL IN PRINCIPLE	Name of Project:	Birtley to Coal House Scheme – PCF Stage 3 – SOR No. 11
(Bridges and other Highway Structures)	Name of Bridge/Structure:	Allerdene Viaduct
	Structure Ref No:	TBC

Safety Engineering & Standards (SES) Record Sheet					
Scheme Name:	Birtley to Coal House Scheme – PCF Stage 3 – Allerdene Viaduct	Comments Sheet Document Control			
		Comment sheet version	Date HA comment sheet	Date Designer's reply sent	Notes
Document Ref	HE551462-WSP-SBR-S3-BR010-X-RP-CB-00001-P01.2	A	25/01/2019	22/03/19 Updated Response 28/03/19	
		B			
AIP version		C			
		D			
AIP Date	19 December 2018	E			

No	Section	Initial comment (HE response) and further comments on Designer's reply	Designer's reply	Accepted by HE
1	Executive summary and other parts of this SOR	Bullet point: "Simplify the work to accommodate existing Allerdene Culvert" – this option allows to completely eliminate existing Allerdene Culvert and presents long term benefits in terms of maintenance and access. Similarly statement "Simplify proposed NGN diversion/ protection works" - Viaduct Option eliminates the need of protection works to diverted NG pipe. This should be made clear. Please amend (also applicable to other parts of this document).	Noted relevant statements to be amended throughout document. 27/03/19 Minor text amendment to exec summary	

2	Executive summary and other parts of this SOR	Bullet point starting: " Formal AIP submission to NWR.. agreement in principle.." - other parts of this document seems to suggests that NRW already gave agreement in principle to Viaduct Option.	We have received verbal agreement in principal to the concept of a viaduct for the replacement of Allerdene bridge. The objective of the viaduct AIP submission to NWR is to acquire written formal feedback/approval of this proposal. To be clarified in the report where required. 27/03/19 Minor text amendments to relevant sections of the report	
3	2.3 – Allerdene Viaduct	"Initial assessment of the potential ground improvement options has indicated that further residual settlement could still occur over a 40 to 50y period.." – in other parts of this document the residual settlement of 50-100mm following rigid inclusion and subsequent ongoing maintenance work is estimated to occur within less then 50y period. Is that because the residual settlement after 30y is small and won't result in need for maintenance? Otherwise please make consistent. Maintenance associated with long term settlement should be clearly highlighted as a big liability to Option 1 as it will require constant monitoring and remedial works. "A viaduct option ensures <25mm .." – I presume it refers to settlement but something is missing there. Can you confirm 25mm is feasible given geotechnical design report is not ready and that 3 span continuous structure is proposed? Paragraph stating: "The road alignment is unaffected although solutions for Allerdene Culvert and the advance Norther Gas diversion will differ for each design solution.". Why is this not simply saying that the need for new Allerdene Culvert and for expensive pilling solution to protect NG diversion will be eliminated? Clearly this is an advantage of this option?	Wording to be amended to provide clarity on the following 1) Consistent reference to residual settlement period 2) Magnitude of settlement – this shall be based on the refined analysis results Reference to maintenance liabilities to be reviewed in light of refined settlement analysis recently completed. Wording to be amended to clarify the following: 1. The design of the foundations would be to *limit settlements to <25mm*. 2. Both the single span and the viaduct structures will be designed to settle <25mm, it's the approach embankments that will settle. Will make this clear 3. The approach embankments to the viaduct still have a similar level of settlement and need for ground improvement, text to be amended accordingly. 27/03/19 Paragraph 2.3 upon further review not considered to add value so removed and section 2 re-numbered accordingly.	

6	3.1	"The use of rigid inclusions is the preferred ground improvement option on the basis of cost and smallest impact on programme" - please explain how cost and impact on programme can be estimated if no geotechnical design report is available? Has NWR been consulted about the risk of ground movement if Option 1 is selected and has it been priced accordingly (including cut-off shear wall or similar)? The risk margin (both financial and programme related) appears to be significant given no detailed information regarding the soil condition exists and the geotechnical risk register contains mostly vague statements? "..would require a pre-determined allowance for settlement to be build in to the slab design.." – removing the need for this design is another clear benefit of the viaduct option. Paragraph starting: "The coal-mining related risks…" - agree that viaduct option would require grouting in 7 locations but embankment option already requires grouting in at least 4 locations – 2 abutments, both sides of culvert pilled foundation and both sides of NG relieving slab plus 2 cut-off shear walls to help limit settlement to NWR asset (extend down to glaciolacustrine deposit level) that might end up to be set of large dimeter reinforced concrete piles. This should be clearly communicated with programme and buildability implications. Note that this SOR shows the pilled foundation for culvert and reliving slab extending down to rock level which will cause the same issues in terms of pilling method, pile diameter and will need to include negative skin friction consideration.	WSP have worked collaboratively with Morgan Sindall who have engaged with specialist supplier who has reviewed the available GI and determined that this method is feasible in these ground conditions. The specialist supplier has also provided a budget costing and rate of installation which has been fed into the costings and programme for this option. There is float within the programme for this option which allows for some programme risk before it impacts on the critical path and therefore extends the construction period for the scheme. The ground investigation has been completed and the preliminary designs are based on the findings of this. GIR has been issued in draft and HE SES comments are currently being addressed. Cut off shear walls are currently not anticipated within the design, based on the preliminary finite element analysis conducted recently, which indicates minimal ground movement at the nearest rail. The less piling to rockhead the less treatment of mine workings required. The preliminary design currently includes piled culvert and NGN slab, although the specialist ground improvement contractor that has been advising the work anticipates that these can be completed using rigid inclusions that would not extend to rockhead and building in allowances for settlement (i.e. void or compressible fill between ground and cover slab). Negative skin friction has been considered and is within the risk register (in Section 5.2).	

			Details of the above are to be included in section 3.1 where applicable. 27/03/19 Upon further review response considered adequate to close out comment without amendment to the report. We hope this is ok.	
7	4.1	"Recent meetings with NWR have confirmed their agreement in principle to a viaduct structure" – see comment 2 above and make consistent. Is this in writing from NWR	We have received verbal agreement in principal to the concept of a viaduct for the replacement of Allerdene bridge. The objective of the viaduct AIP submission to NWR is to acquire written formal feedback/approval of this proposal. To be clarified in the report where required. 27/03/19 Minor text amendment	
8	4.1	Please explain why: a) Not to extend the viaduct up to the tie-in with the existing embankments to avoid earthworks (and probably minimise the extent of NG diversion and to take benefit or already over-consolidated ground b) Not to include information that the Viaduct length can be reduced if this is more economical as long as it's far away from NWR asses to warrant minimal track movement. Is there no other option but single span and 6 span structure?	The reason for this was to provide sufficient clearance/access for construction whilst mitigating the impact on the existing A1 upon which traffic shall be maintained during the works. The tie-in could be reviewed/adjusted at detailed design subject to further investigation/analysis. We have been tasked with looking at the optimum alternative solution that best mitigates the major construction challenges/risks associated with the single span extended embankment option, these include: · Reduce the impact of the approach earthwork embankment settlement during both construction and in service as much as reasonably practicable · Reduce the impact of the new bridge construction over the railway and potential ground movement beneath the ECML · Simplify the proposed NGN diversion works · Simplify the work around Allerdene culvert	

		c) Why rigid inclusions are deemed necessary in proximity of and under the existing embankment where over-consolidated ground should be expected (drawing 00107)?	Our view is an extended viaduct length would provide the most robust solution to address ALL the above. Brief details of why smaller span structures have not been considered was highlighted in the conclusion. Some of this information shall be highlighted in section 4.1 of the report. Rigid inclusions are needed within the existing embankment footprint where the proposed embankment is higher than the existing (i.e. increased loading), including on the existing embankment slopes/shoulder. 27/03/19 Upon further review response considered adequate to close out comment without amendment to the report. We hope this is ok.	
9	General	Please confirm the cost of Option 2 excludes cost of Allerdene Culvert extension and NG relieving slab protection. Similarly, please confirm Option 1 includes these two structures.	For Option 2 (viaduct), the Allerdene Culvert will be made an open channel and the NGN diversion will be between the piers. This has been accounted for in the cost estimates. Costs within Option 1 include for both the culvert extension and protection slab. 27/03/19 Clarification provided in response no change to report required.	
10	4.4	"The limited risk of settlement would be mitigated via rigid inclusions (of a much-reduced number compared with the embankment). " - the drawings and estimates (6.2) seems not to differentiate between the density of rigid inclusions proposed for both schemes. Has this been communicated to HE to allow for adequate pricing of both options?	Density/spacing of rigid inclusions is anticipated to be the same for either option, the area to be treated reduces, hence the overall number of inclusions reduces. 27/03/19 Clarification provided in response no change to report required.	

11	4.4	"The embedment depth of the rigid inclusions is anticipated to be 30m or to the base of glaciolacustrine deposit, whichever is shallower" – to the West end of the proposed structure, the glaciolacustrine deposit is 48m deep (assuming current ground model is correct). Why not extent it down to the suitable layer? Is 30m depth the limitation of this method? This leaves 18m of weak soil layer to consolidate.	Current ground model is based on the 2018 and historical ground investigation results. 30m is as recommended by the specialist ground improvement contractor that has been advising on this work. This is a function of the ground conditions stiffening with depth, the maximum depth of current readily available techniques and reducing anticipated settlements to manageable / tolerable levels. 27/03/19 Clarification provided in response no change to report required. Note further details relating to geotechnical queries have been added to Section 5.	
12	Table 4.5	Assess to bearings for maintenance – IAN 124 requires 120y or 50y design life (50y subject to TAA approval). The 30-40y quoted here conflicts with other sections of this SOR where design life as low as 25y is given (for example Table 6.2.1). Please make consistent in line with IAN 124.	IAN124 is now replaced by BD100/16. Reference to the bearing design life to be amended to align with BD100/16. We are unable to identify suppliers of mechanical bearing with a 120yr design life. Based on consultation with specialist supplier (EKSPAN), 50yrs appears to be the max. 27/03/19 reference to design life structural elements updated accordingly	
13	Table 4.5	Central reserve – why no CSB is proposed? IAN 124 requires design life up to 50y so CSB would be ideal.	CSB or Steel are both applicable, preference to be confirmed at detailed design. 27/03/19 Clarification provided in response no change to report required.	
14	Table 4.5	Agreed differential settlement risk still exists but it small compared with the embankment option.	Noted 27/03/19 no change to require required	

15	Table 4.5 - Lifting	"Girders shall be lifted in pairs with permanent GRP formwork in place." – a) Other sections of this SOR appear to suggest the GRP won't be attached during lifting. Please make consistent. b) Maximum span over ECML is 63.4m. Mass of each girder (BF 0.9x0.08; TF 0.6x0.05; W 2.2x0.025) is 1232kg/m. Assuming somehow the girders can be spliced once lifted into position at the points of contra-flexure, with the position of splice say 0.15L form support, then the mass of single girder is 63.4x0.7x1.232t=54.7t. Allowing 5% for bracings, shear studs etc and 2% for GRP it is 58.6t per beam. If full 63.4m is lifted it's 83.65t. A pair of beams would therefore be either 110t or 167t. There are 8 pairs in total. This SOR seems to suggest 500t crane but such a crane won't be able to lift the shorter pair of beams unless it was positioned in the middle of ECML and that implies Christmas possession only (that can't be guaranteed) therefore a huge risk and programme implications. Please explain: 1) what crane size is proposed. 2) what is the intended crane position.	Consideration to the feasibility of lifting pairs of girders with GRP panels in placed to be reviewed at detailed design. Wording to be amended accordingly. The details within the SOR referred to the method of installation for the intermediate spans and not the ECML spans. The intermediate span beams are of weight 38T each, so paired up and allowing for bracing would be circa 85T. A 500t Crane such as a LiebherrLTM 11000 would have a capacity of 126T at a radius of 30m when positioned between the piers. This would be adequate for lifting of braced pairs. For lifting of the ECML spans, a braced pair would be of the order of 160T and a 1000t Crane such as a Leibherr LTM 1800 would be required which has a capacity of 160T at 48m radius. The crane would be positioned directly behind the North abutment for lifting. This is approaching the limits for this crane and it may be necessary to lift the braced pairs without the GRP panels and edge falsework which would require positioning on a separate possession. 27/03/19 Minor text amendments to the "lifting of girders" information. Also reference made to anticipated crane requirements for the ECML span girder lift.	

16	Table 4.5 -Lifting	"Girders shall be cut and spliced on site (points of contra flexure) to simplify transport to site. " – please explain: a) Are the girders proposed to be placed on some sort of temporary support during splicing? b) Is lifting and splicing requiring a possession? c) Is it feasible to splice 6.7m over ground level, next to OHL and beam that is 2.2m deep? d) Is there no safer way of doing it? Please review construction method to ensure buildability.	Based on liaison with Morgan Sindall it is anticipated splicing would be undertaken on temporary trestles adjacent to the lifting area prior to lifting. This would then be done at ground level and outside of the possessions. 27/03/19 Clarification provided in response no change to report required.	
17	Table 4.5 – construction of parapet plinths	This section seems to suggest that Paraslim temporary formwork is attached to the edge girder during lifting. This will further increase the weight. Please provide evidence that lifting contractor has been consulted and what would be the crane platform position and intended capacity.	The paraslim temporary formwork weight is approx. 0.22T per lin m and so for intermediate spans of length 45m would add 10T to the lift. This is within the capacity of the 500T crane for intermediate spans but would require review of ECML spans to ensure within capacity of intended crane. Wording to be amended accordingly. 27/03/19 Minor text amendments to the "Construction of parapet plinths section"	
18	General	Outline construction methodology in Appendix F produced by Morgan Sindall recommends 500t crane. This appears to be wrong and should have been challenged by WSP. 500t crane lifting capacities suggest the radius would need to be less than 10m. Please confirm the intended crane position and capacity. Any work that requires possession (especially Christmas possession) should be clearly stated in the programme risk register and on the drawings. Please add information about work during Christmas Possession to the construction sequence.	As stated above, a 500T crane such as as a Liebherr LTM 11000 would be capable of such a lift for the intermediate spans, a 1000T crane would be required for ECML spans. Intended crane position for intermediate spans is between the piers and for ECML span is behind North abutment. 27/03/19 Clarification provided in response no change to report required.	

19	5.1	Sentences: "If the Allerdene Viaduct Option is progressed through detailed design, additional specific ground investigation will be required at the pier locations" and "As the current ground investigation was designed…." What are the boreholes positions? If as shown on drawing 99 then there appears to be enough information for the viaduct option especially given the size of each pile cap? Single span option requires drilling and grouting for both abutments but this SOR appears to ignore any requirement for grouting for Culvert and NG slab foundations when comparing with Option 2. Have these (Culvert and NG pipe) locations been properly investigated as part of the single span option? If yes, then they appear to be close to proposed piers.	The ground investigation was scoped and conducted before the viaduct option was included. As per the informative guidance in BS EN 1997-2, there should be *"for special structures (e.g. bridges, stacks, machinery foundations), two to six investigation points per foundation"*, hence the requirement for additional GI. This has been acknowledged and agreed with the Highways England Project Team and SES Geotechnical Advisor. 27/03/19 Minor updates to the report text included. Reference added to exploratory hole location plans and long section.	
20	5.1	Why are the fault lines not shown on the drawings (especially F1 that is below the zone of influence of the proposed viaduct)?	Faults are shown on Geotechnical long sections included in Appendix C (HE551462-WSP-HGT-BCH-DR-GE-00099) and Appendix E (HE551462-WSP-HGT-BCH-DR-GE-00105). 27/03/19 Clarification provided in response no change to report required.	

21	5.2 - Excessive ground movement related to compressible superficial deposits.	The current proposal is proposed the East approach embankment transfers the load onto competent founding strata through rigid inclusions in already over-consolidated region. The West approach embankment is well offset from ECML. This clause suggests viaduct construction is causing settlement when in fact it minimises it. The settlement under East approach embankment should be low and West embankment is well offset from the railway line. Please reword to indicate the negative skin friction is limited to abutments either side or is this suggesting other areas too? Please explain how is the movement of ECML possible for Viaduct Option. Primary risk impact section should be also reviewed as pilled foundations give the lowest possible settlement and ground movement (especially with proper pilling methodology).	Noted, anticipated settlement from the viaduct option is away from the ECML, so this risk of ground movement is significantly reduced. Wording to be updated accordingly. 27/03/19 Risk associated with excessive ground movement is still the same. The mitigation of this risk is to build the viaduct, to increase the distance between the approach embankments and the ECML. As such, the risk remains, but the impact has been updated to include details as per comments. Risk classified as low/medium.	

22	5.2 – Instability caused by shallow mine workings.	Design – please explain why series of simply supported spans are not considered to minimise the risk? Just a note that this risk is similar for single span option that includes pilled foundation to both abutments, culvert and NG slab.	It is noted that a series of simply supported spans could reduce the risk of major structural damage (superstructure) in comparison to a continuous viaduct structure. However, there would be an increase in cost (due to increase construction depth) and maintenance liabilities associated with joints. The risk is greater for the viaduct option given the number of foundations. Refer to response to Comment 6. 27/03/19 Clarification provided in response no change to report required.	
23	6.1 and 7	There should be information that Viaduct option allows for de-risking the whole issue of interface with NWR assets and allows for designing-out Allerdene Culvert and NG slab with all the implications to programme and cost.	Reference to the impact on Allerdene culvert and NGN is provided in the buildability factor review. Impact on NWR was previously referred. Based on the refined analysis recently completed. Further details shall be provided relating to the risk of ground movement and its impact on the ECML. 27/03/19 Impact on NWR and Impact on A1 Traffic expanded to reference additional settlement analysis which shows the risk is not as significant as previously anticipated.	

24	6.2	Initial Capital Cost and Construction programme – how can this be estimated given ground model is not finalised hence the method and cost of ground stabilisation can change for Option 1 and ECML interface remains large risk for single span option?	Sufficient work had been undertaken to develop a robust ground stabilisation proposal, and understand the issues related to the interface with ECML. This includes feedback / discussions with the buildability contractor. Further ground modelling work has been undertaken to develop the proposal so that a decision on the final option can be supported. 27/03/19 Clarification provided in response no change to report required.	
25	6.2	The number of rigid inclusions – the density appears to be the same for both options (by comparison of the area subject to ground improvement on each drawing) yet this SOR states that the density of rigid inclusions will be lower for Viaduct option. Please add note to table 6.2.3.	Density/spacing of rigid inclusions is anticipated to be the same for either option, the area to be treated reduces, hence the overall number of inclusions reduces. Wording to be amended accordingly 27/03/19 above referred in table 6.2.3 within the row referring to rigid inclusion installation	

26	6.2 – Table 6.2.1	Why resurfacing is anticipated every 5 years for 30 years period if the report suggests ongoing settlement over 50y? Please include information that it's over large area (preferably state the total area needing periodic maintenance every 5 y). Why no information is included that due to ongoing settlements the safety fences, drainage, any underground services, gantries, etc. might require ongoing maintenance and repairs too and earthworks might require reprofiling? This is a huge liability – has this been included in the pricing?	Settlement period/impact on carriageway to be reviewed Approx. area to be resurfaced to be provided. Maintenance due to settlement to be revised based on the further refined analysis (based on ground improvement in the form of rigid inclusions). Further details of the findings from the refined analysis to be included in the relevant sections of the report. 27/03/19 Minor text amendment to table to reflect above	
27	6.2 – Mechanical Joint Replacement and bearing replacement	As before IAN 124 recommends up to 50y in service life (joints) and minimum 50y (bearings). Please explain statement "Service Life highly dependent on workmanship during installation"? Does it imply lack of quality control? This statement could be applied to earthworks, welding, splicing on site, concreting, pilling, holding down systems (parapets) and almost every aspect of construction work. Please amend.	Service life to align with BD100/16 (supersedes IAN124) Noted reference to workmanship to be removed. 27/03/19 reference to design life of structural elements updated accordingly	
28	6.2 – VRS renewal	Throughout this report only costs/ issues within the footprint of each bridge seems to be considered. This appears unfair given that Viaduct Option removes large part of the risk included in the embankment option. When discussing VRS renewal please also include all the VRS for approach embankment for Option 1 especially given accelerated deterioration due to ongoing settlement. Please give length/ area to allow comparison.	Distinction to be made in the extent of the VRS and safety barrier required for the single span and viaduct option to aid comparison of the two options. 27/03/19 table updated accordingly	

29	6.2 - Embankment landscaping	Please give area to allow comparison.	Approx. embankment landscaping areas to be calculated for both options to aid comparison. 27/03/19 areas provided	
30	6.2	"Based on the above, it is anticipated the maintenance liabilities associated with the single span option would be less onerous over 120y period." Please explain how was that decided given no ground model exists, interface issues with NWR appear more onerous for Option 1 and that embankment option requires 30-50y ongoing, frequent maintenance and resurfacing which will cause traffic congestion and loss to the economy (provided it can be designed to NWR satisfaction).	Details of the maintenance liabilities to be reviewed in light of the additional analysis recently completed which shows the risk of embankment settlement for the single span option (based on rigid inclusions) is not as significant as originally anticipated. 27/03/19 reference made to additional settlement analysis which indicate risk of track movement and settlement is not as significant as originally anticipated	
31	6.2	Please add comparison between NWR interface issues for each option.	See response to comment 23.	
32	6.2 and 7.1	"The preferred option would require a compromise regarding the long term liabilities associated with the bigger viaduct structure.." – please remove unless satisfactory answer to comment no. 26 & 30 above exists. It is surprising so little is said about the critical issue of interface with NWR assets and it's all postponed until design stage. No information is given in this SOR about the way in which track movement can be managed. Please add.	The conclusions from the additional settlement analysis recently completed shall be referred to demonstrate the risk to NWR infrastructure is not as significant as initially anticipated. 27/03/19 reference made to additional settlement analysis where appropriate. This highlights the risk of track movement and settlement is not as significant as originally anticipated	
33	7.1	"simplify the work to accommodate existing Allerdene Culvert" – this is not true. The Culvert is no longer needed. Please reword.	Noted to be reworded. 27/03/19 upon review previous statement "the existing allerdene culvert can be removed in its entirety and readily replaced with an open burn …. " appears adequate.	

34	General	Settlement predictions appear a bit unreliable given GDR has not been finalised yet and huge risk given proximity of ECML. The whole report is centred on the assumption that embankment option is somehow better yet all the geotechnical works and settlements are based on judgement only due to lack of report and credible ground model as demonstrated by ambiguity of geotechnical risk register. Please reword and consider refining risks and costs to allow informed selection of the preferred option.	Settlement predictions have been based on the GI data. A GDR would not be prepared at Stage 3. The ground model is as per the GIR, which has been issued in draft. Reference to the recently completed additional analysis will demonstrate that when taking into consideration rigid inclusions the settlement risk is not as significant as originally anticipated. As previously agreed with the HE SES the aim of the report was to identify the most robust structural solution to mitigate the following significant risk and challenges associated with the single span option. These included · Reduce the impact of the approach earthwork embankment settlement during both construction and in service as much as reasonably practicable · Reduce the impact of the new bridge construction over the railway and potential ground movement beneath the ECML · Simplify the proposed NGN diversion works · Simplify the work around Allerdene culvert Our view was a viaduct would provide the most robust solution to address ALL the above. It was also agreed that a high level of comparison of the two options would be provided in the SOR. One of the main drivers for this was to provide a single source document that could be referred by the Delivery Partner/HE to assist them in selecting the preferred option to be developed at Detailed Design. 27/03/19 Various sections of the report updated to include reference to the settlement analysis which indicate risk of settlement/track movement significantly reduced were rigid inclusions introduced as a form of ground improvement.	

35	7.2	Bullet point – sections of this report seems to suggests approval in principle for viaduct option has been given (see 4.1) but in reality, it appears that AIP was submitted for single option for which approval was given then followed by informal approval for Viaduct Option during recent meeting with NWR. Is this correct?	See response to comment no.2	
36	Appendix B	No viaduct option shown.	This was just a schematic scheme plan based on the original single span option. Reference to this to be removed and appendices updated accordingly 27/03/19 Schematic plan updated to reference both the single span and viaduct option	
37	Appendix C	The parapet does not look like solid H4a type and no transition is shown. For comments regarding lifting see Viaduct Option drawings.	This is an outline GA – comments are noted and details regarding the parapets/transition shall be refined at detailed design by the delivery partner based on the preferred option. 27/03/19 No change to dwg at this stage	
38	Drawing 0055	Please incorporate TAA comment re. Allerdene Culvert (slab foundations) when re-submitting and amend the drawing. For Culvert - please add information the piles need to extent to rock head (same as for NG slab). Note 4 - is it still valid or should it be amended?	Noted, drawing to be reviewed to align with recent Allerdene culvert SOR submission. Note 4 to be revised based on the above. 27/03/19 Upon further review drawing ending 0055 to be removed as causing confusion	

39	Drawing 0055 and 107	The way rigid inclusions are shown on these two drawings is confusing. Drawing 107 seems to suggests rigid inclusions are installed under culvert and NG slab yet drawing 0055 shows they are not. Please make consistent. Please review notes on the geotechnical drawings and drawing numbering as there seems to be two separate drawing 107 and notes referring to other drawings that are not included. Why no cut-off shear wall (or similar) is identified on the drawing to help protect ECML? Is should be on either side of the track down to rock level.	Noted. Details on drawings 0055 and 107 to be reviewed and updated accordingly. 27/03/19 Upon further review drawing ending 0055 to be removed as causing confusion. Minor amendment to dwg 00107 to address comments Refer to response to Comment 6 re: cut off wall.	
40	Drawing 107 – cross section through Ch. 1120	What is the ditch showing? Is there geogrid reinforced granular load transfer matt on the top?	Ditch is shown indicatively, details to be developed at detailed design. 27/03/19 Upon further review drawing number to be updated to avoid confusion. Reference to grid also removed as not considered to add any value at this stage.	
41	Drawing 00099	It would be good to show the boreholes position on plan as well to see how they align with the viaduct option (and show intended pile cap position). Is no gas monitoring proposed for the section with the bridge?	Comments are noted, expect this shall be actioned at detailed design. No gas monitoring was conducted as part of the GI at the express request of HE SES Geotech Advisor at the time. 27/03/19 Borehole plan reference included	

42	Appendix D – 1.1.6	Is the culvert referenced here located within the settlement zone of the proposed works? Do we know location of all NWR assets affected? Has NWR asset search been carried out?	The existing section of the culvert referred is outside the settlement zone of the proposed works. NWR asset search has not be conducted at this stage 27/03/19 Upon further review Appendix D technical memo has been removed as it does not add any significant value to the report. Appendices numbering to be updated accordingly	
43	Appendix D – 1.1.7	"The design of culvert replacement…" – no culvert is required for Option 2. Please remove or clarify this is valid for option 1 (single span bridge) only.	Noted clarity to be provided. 27/03/19 Appendix D to be removed	
44	Appendix D – 1.2.2 and 1.2.3	Why is this paragraph referring to culvert extension design? Please remove.	Noted to be removed. 27/03/19 Appendix D to be removed	
45	Appendix D – 1.2.5	This bullet point is typo and should be removed.	Noted to be removed 27/03/19 Appendix D to be removed	
46	Appendix D	Is the whole section describing Allerdene Culvert modelling parameters relevant here if no culvert is needed? Please consider rewording.	Allerdene culvert memo, shall remain for information only. However, comments highlighted shall be addressed for the final submission 27/03/19 Appendix D to be removed	
47	Appendix D - 1.2.11	Apparent signs of significant degradation? WSP has previously proposed extending Alledene culvert with the existing section being in good condition. What has changed?	To align with the recent Allerdene Culvert SOR 27/03/19 Appendix D to be removed	

48	General	For single span option - why do we divert NG if we could install slab in the current location?	There are 3No. existing NGN gas mains under the existing embankment that would be required to be diverted as part of the proposed scheme. As an efficiency it is proposed that the NGN gas transfer station located to the north of the existing A1 to be relocated to the south and have 1No. of combined gas mains under the proposed new A1 embankment. This has been agreed with NGN who have confirmed this would also be of value (monetary contribution agreed with HE for the works) to them. 27/03/19 Clarification provided in response no change required to the report	
49	Appendix E – drawing 102	Why some of the piers are in the same position for each half of the proposed viaduct? The structure is on 25deg. skew resulting in staggered piers yet towards the West End the span lengths differ resulting in piers in the same location (i.e. not staggered). Is this intentional?	The position and span are such that adequate back spans are provided to the critical main bridge span over the ECML. In addition, span configuration is such that towards the west end the pier and abutments are aligned to provide a clear opening and avoid staggered supports where possible. By ensuring the end abutment is along the same line means a retaining wall structure between the staggered abutment is avoided were possible. 27/03/19 Clarification provided in response no change to the dwg.	

50	Appendix E – drawing 102	Why some of the piers are encroaching onto ECML East land boundary? The substructures should be offset form the track to allow green zone working. Why is the span over ECML longer than for the single span option?	The span and position of supports are such that the vertical clearance to the rail line can be maintained whilst limiting the construction depth and size of girders to within manageable limits regarding logistics and installation. Whilst the piers are encroaching ECML land they are considered to have sufficient lateral clearance from the nearest running rail to allow for a temporary fence line to be constructed to facilitate access/construction outside of possessions. The construction sequence shall be reviewed in further at detailed design stage. The clear span is similar for both options. 27/03/19 Clarification provided in response no change to the dwg.	
51	Appendix E – drawing 102	Note 5 – for NWR interface, this should have already been done for single span option? Note 6 - see comments regarding total weight and lifting.	There has been some consultation but expect further discussion will be required during detailed design. See previous response regarding total weight and lifting 27/03/19 Clarification provided in response no change to the dwg.	
52	Appendix E – drawing 102	Specific notes – "The existing Allerdene Bridge Lanes can be closed.." why any of the lanes over the existing bridge need to be closed? The tie-in works are away from either end. Is it to allow construction plant movement? Similar note is included in the construction sequence.	The construction sequence has been development based on high level consultation with the support contractor Morgan Sindall. The construction sequence shall be finalised during the detailed design phase. 27/03/19 Clarification provided in response no change to the dwg.	

53	Appendix E – drawing 102	Construction sequence – stage 5. Is WSP referring to Form 01 of Form A? Is this referring to NWR TAA? Please clarify.	Form A is the correct reference for the OLE AIP document 27/03/19 Clarification provided in response no change required to the dwg.	
54	Appendix E – drawing 102	Stage 12 - position of the crane to be confirmed. If this has not been done already, please confirm it a.s.a.p including crane capacity or else WSP is risking proposing non-buildable solution. This is risk that should have been shown on the drawing including that of interface with NWR (track movement etc) and lack of GDR. Stage 13 suggests GRP attached after steel beams in place – this contradicts other sections – please make consistent Stage 19 – this is steel composite deck not RC deck. This will affect proposed demolition sequence (no crash mat but rather lifting of the beams). Please amend. Stage 20 – what concrete below half joints does it refers to? Stage 22 - can WSP confirm the piers can be removed outside of possession?	The construction sequence has been development based on high level consultation with the support contractor Morgan Sindall. The construction sequence shall be reviewed/finalised during the detailed design phase. 27/03/19 No change required to dwg at this stage	
55	Appendix E – drawing 103	Please show anticipated splice position. The parapet over railway does not look like 1.8m h4A solid infill parapet.	Noted, this is an outline general arrangement drawing. Comments shall be communicated to the detailed design delivery partner and addressed at detailed design should the viaduct be the preferred option. 27/03/19 No change required to dwg at this stage	
56	Appendix E – drawing 105	Should there not be transverse stiffeners at jacking point locations? Please shown F6 finish to piers.	Noted, this is an outline general arrangement drawing. Comments shall be communicated to the detailed design delivery partner and addressed at detailed design should the viaduct be the preferred option. 27/03/19 No change required to dwg at this stage	

57	General	Do we have the original maintenance records from when the existing approach embankments were built? How where they stabilised? This information would provide a clue as to what to expect on site (it's almost like having an access to field test results). Has attempt been made to identify this information?	We do not have this information; however, we shall communicate the importance of this to the detailed design delivery partner for further investigation if required.	
58	Drawing 109	As already stated before – what the ditch on cross section through Ch. 11120 represents and why is it covered by geogrid reinforced granular load transfer platform? Is the transfer platform required for rigid inclusions?	Comments are noted, drawings provide outline details to be further developed at detailed design if the viaduct is the preferred option. 27/03/19 Minor update to drawing, geogrid detail removed at this stage.	
59	Appendix F	Preliminary works – "Temporary Driven sheet pilling.." - does it refer to Eastern and Western extent of North face? Please amend as it currently states Southern and Northern. 500T crane – please check lifting radius and capacity and confirm intended crane position. It might be the case that 500T is inadequate unless positioned in the middle of ECML which might not be acceptable to NWR and might severely affect construction programme (lifting during Christmas possessions only). The construction programme might need to be revised unless bigger crane is sourced. Need for Christmas Possession booking should be stated on the drawings.	The construction sequence has been development based on high level consultation with the support contractor Morgan Sindall. The construction sequence shall be reviewed/finalised during the detailed design phase. See previous response regarding the cranage requirements. 27/03/19 No change required to dwg at this stage	

60	Appendix G	A01 & 05 - confirm crane position and crane type required. A03 - "all services are to be located above the soffit.." do you mean within verges? Otherwise there are access issues. A05 – is this referring to lateral torsional buckling? A09 - Hazard identified – "*working with*"? Please amend. A08, 09 and 12 – Design action status – currently not added to the drawing. Please add. A13 – what "*level crossing"* is this risk referring to? A19 – can we definitively say bored technique will work or is specialist contractor input required? Has NWR confirmed this would allow for pilling outside of possession? A21 - aren't the piers in green zone? Where is the need to inspection in possession coming from? A26 - assuming articulation slab is the central reserve slab - why not propose in situ solution for all spans not over the railway?	The designers risk assessment is a live document that shall be reviewed and updated as the scheme/design progresses. Comments are noted and the DRA shall be amended where required. 27/03/19 DRA updated accordingly.	
61	Appendix H	Please confirm all the geotechnical issues have been included in both option pricing and also in project risk register and reflected in proposed programme.	We confirm geotechnical issues have been included in the pricing of both options/risk register and programme 27/03/19 Clarification provided in response no change required to the report	
62	General	The proposed beams have haunches towards the support. Please confirm there is 6.7m headroom over the whole section of Network Rail land. Otherwise this is not future proofing the railway and might be rejected.	Correspondence with NWR to date showed they have no aspirations regarding future expansion of the track. The main focus was to provide the 6.7m clearance to the rail gauge over the existing lines. This has been provided. In addition, the haunches are within 4.5m of the support face. Any new tracks so close to the supports would result in the need to strengthen the supports against impact (which is unlikely). 27/03/19 Clarification provided in response no change required to the report	

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