A1 Birtley to Coal House

Scheme Number: TR010031

Applicant's Responses to ExA's Second Written Questions - Appendix 2.0F - Structure Options Report 2 - Allerdene Culvert

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Birtley to Coal House Improvement Scheme

Structure Option Report

Allerdene Culvert

Structure no. (/A1//443.00/Q)

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Highways England Company Limited registered in England and Wales number 09346363

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A1 BIRTLEY TO COAL HOUSE IMPROVEMENT SCHEME

STRUCTURE OPTION REPORT 2

ALLERDENE CULVERT

Highways England

Date: Feb 2019

Project No: HE PIN 551462
WSP Ref: 70015226

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APPENDICES

EXECUTIVE SUMMARY

WSP have been commissioned under the CDF contract to progress the Stage 3 Preliminary design works to increase the capacity of the route between A1 Junction 65 (Birtley) to Junction 67 (Coalhouse). The scheme involves upgrading from the existing Dual 2-Lane All-Purpose provision to a Dual 3-Lane All-Purpose Provision for this section of the road.

Studies to date show the existing Allerdene culvert (located north of the existing Allerdene Railway Bridge) would require structural modification and extension to the south (downstream) end to accommodate the proposed improvement works to the A1 alignment. This Structures Options Report has been prepared to assess the constraints/challenges associated with the structural modifications to the existing Allerdene culvert.

The existing Allerdene culvert comprises 2.49m wide x 1.79m high Armco (10 gauge) galvanised steel multi-plate pipe (assumed to be MP100) with an overall length of approximately 78m. The ground conditions and the estimated magnitude of settlement pose a significant risk to the works at Allerdene culvert. To minimise the risk associated with settlement, in particular differential settlement between the existing and new culvert section, it is considered that complete replacement of the existing culvert would provide the most robust solution.

It is important to note that the settlement risk and any associated mitigation/controls at Allerdene culvert will need to be considered in the wider context of the new A1 embankments leading up to and beyond the new Allerdene Railway bridge. This is important to ensuring the settlement risk is not managed in isolation, and that an appropriate solution is provided to ensure the entirety of the new embankment construction (around Allerdene bridge) does not compromise the overall works and construction programme.

To accommodate the new A1 alignment, a new culvert is required up to 116m in length to replace the existing. The northern extent of the existing culvert (circa 38m long) will be ‘opened’ up (into a ditch) once the existing A1 carriageway embankment has been removed, following the traffic switch onto the new carriageway.

The following options were considered for the proposed replacement culvert.

- Option A: Precast Concrete Box – Indicative Construction Cost £610k*
- Option B: Steel Corrugated Pipe – Indicative Construction Cost £275k*
- Option C: Steel Corrugated Arch/Piled foundation – Indicative Construction Cost £590k*

The proposed options were assessed and compared based on a number of key factors. The studies to date show Option B (corrugated pipe structure) to be the most favourable option followed very closely by Option C (Corrugated Arch/Piled Foundation). The preference would be based on sensitively of the proposed structural form to settlement and how this may impact the programme.

Based on the study to date, it is recommended that Option B Corrugated Pipe structure is further reviewed and developed at detailed design for the Allerdene Culvert replacement works.

During the detailed design stage, it is advisable that the following analysis be undertaken in collaboration with the Highways England Project team on the basis they will have a significant impact on the Allerdene Culvert improvement works

- Further refined analysis to confirm culvert founding methodology. This would include detailed 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 interaction with the existing and proposed earthworks.

- Review the scope to reduce the overall length of the culvert by approximately 30m by the provision of 1 in 2 slopes as oppose to the current 1 in 3 slope provisions (potential cost saving)

1. INTRODUCTION

1.1 PROJECT BACKGROUND

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

1.1.2 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 the Highways England's strategic road network serving the metropolitan area of Tyne and Wear.

1.1.3 This project is located between J65 (Birtley) and J67 (Coal House) on the NGWB and is approximately 4.2km 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.

1.1.4 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.

1.1.5 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 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.

1.1.6 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.

1.1.7 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).

1.1.8 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.

1.1.9 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.

1.1.10 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.

1.1.11 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.

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

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

1.1.14 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 the July 2017 that “Option 1a with the offline replacement of Allerdene Bridge should be the recommended route” [2].

1.2 PREFERRED ROUTE

1.2.1 Between J65 (Birtley) and J66 (Eighton Lodge), the carriageway is to be widened mostly symmetrically on each side of the carriageway by 1 lane, resulting in 3 lanes plus lane gain/drop.

1.2.2 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.

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

1.3 PRELIMINARY DESIGN

1.3.1 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) [3]. 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.

1.3.2 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.

1.4 REPORT OBJECTIVES

1.4.1 This Structures Options Report has been prepared to assess the constraints/challenges associated with the structural modifications/extension of the existing Allerdene Culvert.

1.4.2 The report shall provide a recommendation on the preferred structural solution to be further developed at detailed design stage.

1.4.3 Upon confirmation and sign off, this report shall provide Highways England with sufficient information/justification for seeking approval/funding to progress the scheme within the next stage of development.

2. EXISTING STRUCTURE

2.1 GENERAL DESCRIPTION

2.1.1 Allerdene Culvert (commissioned in the 1970s) is defined in SMIS with the following discrete structure number and key:

- /A1//440.00/Q/
- STKEY 8879

2.1.2 The culvert is located at OS Grid Reference 425370E, 558520N.

2.1.3 Allerdene Culvert carries the A1 dual two lane all-purpose trunk road, and is adjacent to the existing Allerdene Railway Bridge which spans the London to Edinburgh East Coast Main Line (ECML) high speed railway.

2.1.4 The existing culvert comprises 2.49m wide x 1.79m high Armco (10 gauge) galvanised steel multi-plate pipe (assumed to be MP100) with an overall length of approximately 78m. Skew angle of the structure to the A1 carriageway above is circa 35°.

2.1.5 The fill depth to the roof of the culvert is approximately 8m.

2.1.6 The culvert comprises North and South reinforced concrete headwalls, wingwalls and aprons.

2.1.7 The culvert carries a watercourse beneath the existing A1 connecting drainage ditches on either side of the carriageway. The watercourse is currently maintained by the Environment Agency.

2.1.8 Refer to Appendix B for further details of the existing structure.

2.2 STATUTORY UNDERTAKERS INFORMATION

2.2.1 Details of existing services within the scheme boundary are shown on the following service information plans provided in Appendix C:

- HE551462-WSP-VUT-BCH-DR-D-00001-P02

2.2.2 There are currently no services shown to be affected by the proposed extension of the existing culvert.

2.2.3 The following services are located immediately to the South West of the existing culvert opening. However, they are due to be re-located as part of Northern Gas Networks (NGN) operation to construct a distribution plant adjacent to Lamesley Road near Junction 67 and therefore should not restrict works to extend the culvert:

- Northern Gas intermediate pressure pipe
- Northern Gas regional high-pressure pipe

2.2.4 Mandatory diversion of any statutory undertakers required shall be carried out as part of the wider highway realignment works.

2.3 INSPECTION SUMMARY

2.3.1 The structures management information system (SMIS) database shows record of the following inspections for the existing structure:

INSPECTION TYPE	INSPECTION DATE	AGENT
General Inspection	21/06/2016	A-One+ - Area 14
General Inspection	20/05/2014	A-One+ - Area 14
Principal Inspection	11/06/2012	A-One+ - Area 14
General Inspection	07/01/2011	A-One+ - Area 14
General Inspection	17/11/2008	A-One+ - Area 14
Principal Inspection	15/01/2007	A-One+ - Area 14
General Inspection	08/11/2004	A-One+ - Area 14

Table 2-1: Allerdene Culvert Inspection Summary

2.4 PREVIOUS MAINTENANCE WORK UNDERTAKEN

2.4.1 Record information shows the following maintenance work has previously been carried out on the structure:

- 2010 – Debris removed from the invert. Vegetation cleared,
- 2000 – Silt and debris removed.

2.5 OUTSTANDING MAINTENANCE WORK

2.5.1 The latest 2016 general inspection report by A-One+ identified the following outstanding maintenance actions:

- Blast clean, over clad, and weld new sections over existing areas of corrosion and apply epoxy liner to barrel.
- Remove all debris from invert.
- Cracking up to 5mm 2no. South East & West wingwalls – crack inject. Mastic sealants debonding to North East and West walls – replace. South East wingwall joint to the South end has opened up to 20mm in places and cracking has taken place to the South end section of the culvert – historic – seal and monitor.
- Cut back vegetation encroaching on the north and south structure features and embankments.

2.5.2 In summary, the inspection reports indicate the existing culvert to be in fair condition.

3. GROUND INVESTIGATION

3.1 EXISTING GROUND CONDITIONS

3.1.1 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 geotechnical parameters defined in the Ground Investigation Report (GIR), which is due to be completed towards the end of PCF Stage 3 – Preliminary Design, and the comprehensive ground investigation (GI) undertaken between November 2017 and June 2018 by Central Alliance (factual report reference HE551462-CAX-VGT-ZZ-VG-00001). The factual report shall be finalised towards the end of PCF Stage 3.

3.1.2 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.

3.1.3 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 and the 2017-2018 GI factual report, the following ground conditions are anticipated beneath the at the culvert location:

- **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 culvert 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.

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

3.1.5 Four faults affecting the bedrock are recorded (on the geological maps) around the culvert location. 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.

3.1.6 Five coal seams (Maudlin, Durham Low Main, Brass Thill, Hutton and Plessey – details of which are listed below) are recorded at shallow depth beneath rockhead within the vicinity of the wider embankment at the culvert location. 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.

3.1.7 During the recent GI, groundwater strikes were recorded within the boreholes in the vicinity of the proposed culvert. Groundwater monitoring installations have been installed within eleven of these exploratory holes. Records from the groundwater strikes and monitoring near the proposed culvert 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 complete by May 2019.

3.2 RISKS ASSOCIATED WITH FOUNDATION WORKS

3.2.1 The geotechnical risks for the wider site are presented within the PSSR. These risks have been reviewed and further assessed in the 'Live' Project Risk Registers. Pertinent geotechnical risks in relation to the proposed culvert options are summarised in the table below.

Table 3-1 Geotechnical risks of proposed Allerdene culvert options

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/near the proposed culvert	**Design** - detailed design to take account of proposed loadings and design appropriate ground improvement works to reduce settlements and ground movement,	**High**
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 (likely grouting) during construction	**Design** – targeted, specific GI at each pier/abutment location. Detailed design to take account of the anticipated and recorded mine workings (refer to the CMRA for the scheme). **Construction** and **operational** collapse of the running surface / structures.	**Medium**
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).			

3.3 REVIEW OF FOUNDATION REQUIREMENTS

3.3.1 Given the height of the proposed embankment, large settlements (up to 1m) are anticipated to occur. To manage this settlement, ground improvement measures below the proposed embankment footprint are likely to be required.

3.3.2 Based on the information to date, it would be prudent to avoid retaining the existing culvert and extending this as required with a new culvert section. This would significantly de-risk the culvert works regarding differential settlement. In addition, the provision of a new culvert would completely remove the maintenance liabilities inherent with the existing culvert whilst also removing the complexities associated with the interface between the existing and proposed structure.

3.3.3 There are three proposed options for the new replacement culvert, details of which are discussed in section 4 of the report.

- Option A - installation of precast concrete box culvert,
- Option B - installation of steel corrugated pipe, and,
- Option C - installation of a steel corrugated arch with piled foundations.

3.3.4 The above options assume that suitable ground improvements (or measures to limit settlement) are required as part of the wider embankment design, including the culvert location. As such differential settlement would be managed as part of these works.

4. STRUCTURAL OPTIONS

4.1 GENERAL

4.1.1 The proposed A1 carriageway will be widened to 3 running lanes in each direction (D3UAP in accordance with TD 27). The widening shall be carried out offline to the south (downstream) of the existing A1 carriageway. Refer to Appendix A for further details.

4.1.2 The existing culvert connects the surface water drainage from the highway to the wider drainage network. It is therefore important to ensure any new structure should not degrade hydraulic capacity from what is currently provided. A high-level assessment of the culvert capacity considering the material properties, gradient, dimensions and shape of the existing culvert determined a future capacity of 5.5m^3/s or more should be provided.

As highlighted in section 3 of this report, the ground conditions and magnitude of settlement pose a significant risk to the works at Allerdene culvert. To minimise the risk associated with settlement, particularly differential settlement between the existing and new culvert section, it is considered that complete replacement of the existing culvert would provide the most robust solution.

To accommodate the new A1 alignment, a new culvert is required up to 116m in length to replace the existing. The northern extent of the existing culvert (circa 38m long) will be 'opened' up (into a ditch) once the existing A1 carriageway embankment has been removed. The maximum depth of cover to the roof of the new culvert would be 10m.

4.1.3 It is anticipated culvert works would be phased such that the new culvert is constructed offline whilst traffic is maintained on the existing A1 alignment. Traffic will be switch onto the new alignment over the new culvert to enable outstanding works to be complete to the existing culvert section. New headwalls, wing walls and apron shall be installed to both the upstream and downstream ends of the culvert. Refer to appendix E-4 for details of an indicative construction sequence for the new culvert. Details of the construction sequence shall be confirmed during detailed design upon further liaison with the Principal Contractor.

4.1.4 The following options have been considered for the proposed new culvert.

- Option A: Precast Concrete Box – Refer to the GA in appendix E-1
- Option B: Steel Corrugated Pipe – Refer to the GA in appendix E-2
- Option C: Steel Corrugated Arch/Piled Foundations – Refer to the GA in appendix E-3

4.1.5 As previously highlighted, the above options assume that suitable ground improvements (or measures to limit settlement) are required as part of the wider embankment design. As such differential settlement would be managed as part of these works.

4.2 OPTION A: PRECAST CONCRETE BOX

4.2.1 The proposed precast concrete box culvert would be constructed using precast concrete box culvert units. The proposed box would have internal dimensions of 3.0m wide by 2m high.

4.2.2 The concrete box units could be transported to site in discrete lengths and then lifted into position and installed as per manufacturer guidelines.

4.2.3 The estimated construction cost (excluding preliminaries) for this option is £610k. This is based on previous similar type schemes and does not include for cost associated with any ground improvement works required to minimise the magnitude of the overall settlement.

4.3 OPTION B: STEEL CORRUGATED PIPE

4.3.1 This option considers the proposed steel corrugated pipe culvert to be constructed using steel corrugated pipe units (MP200 steel multi-plate). The proposed pipe would have an internal dimension of 3.12m wide by 2.49m high.

4.3.2 The steel pipe units would be transported to site as flat sheets and erected on site as per manufacturer guidelines.

4.3.3 Backfilling operation would need to be carried out in a staged manner to prevent compromising the structural integrity of the corrugated pipe in its temporary condition. However, the risk of collapse during construction, in comparison to option C, is mitigated by the back and bedding surround to be provided to support the underside of the pipe.

4.3.4 The estimated construction cost (excluding preliminaries) for this option is £275k. This is based on previous similar type scheme and does not include for cost associated with any ground improvement works required to minimise the magnitude of the overall settlement.

4.4 OPTION C: STEEL CORRUGATED PIPE

4.4.1 This option considers the proposed steel corrugated pipe culvert to be constructed using steel corrugated arch units (MP200 steel multi-plate) with reinforced concrete foundations. The proposed arch would have an internal dimension of 3.0m wide by 2.07m high.

4.4.2 To further mitigate and control the impact of settlement over the culvert, this option considers the piled foundations to the arch (it is assumed these would be designed to accommodate the horizontal and vertical trust at the footing position) with appropriate transition zones (that could comprise a piled LTP, rigid inclusions, lightweight fill or a combination of these) either side of the culvert.

4.4.3 The steel arch units would be transported to site as flat sheets and erected on site as per manufacturer guidelines. Backfilling operation would need to be carried out in a staged manner to prevent compromising the structural integrity of the corrugated arch in its temporary condition.

4.4.4 The estimated construction cost (excluding preliminaries) for this option is £590k. This is based on high level information available from specialist suppliers and reference to previous similar type schemes. The cost includes for the arch and structural piled foundations only. Similar to the other options, the cost associated with suitable ground improvements (or measures to limit settlement) as part of the wider embankment construction has not been included.

5. COMPARISON OF OPTIONS

5.1 ASSESSMENT OF OPTIONS

5.1.1 The options have been compared based on the following features:

- Initial capital cost
- Whole life cost
- Construction Programme
- Buildability
- Disruption to A1 traffic
- Health & Safety Risks
- Aesthetics

5.1.2 These factors have been scored on a scale of 1-3. A score of 1 represents a poor performance, 2 average and 3 represents the best performance on a given factor. The option with the highest cumulative score is considered the most viable solution.

5.2 RANKING TABLE

5.2.1 The table below sets out scores attributed to the key features assessed and compared for each of the three options:

KEY FACTORS	OPTION A: PRECAST CONCRETE BOX	OPTION B: STEEL CORRUGATED PIPE	OPTION C: STEEL CORRUGATED ARCH
Initial Capital Cost	1	3	2
Whole Life Cost	2	2	2
Construction Programme	1	1	3
Buildability	2	2	2
Disruption to A1 Traffic	2	2	2
Health & Safety Risks	2	3	1
Aesthetics	3	2	2
Total scores	**13**	**15**	**14**

Table 5-1: Ranking table for proposed options A-C

5.2.2 The rationale behind the scoring is as follows:

- Initial capital cost: Indicative construction cost (including structural foundations-Option C) show the corrugated pipe Option B to be the most cost effective of the three options and therefore received the highest score.

- Whole Life cost: All three options were scored equally regarding long term maintenance liabilities. It is important to note that for all three options it is expected that some residual settlement to the wider embankment over the culvert would occur after construction (period of 35-40 yrs) during which re-surfacing would need to be undertaken at more frequent intervals

- Construction programme: Option C scored highest based on the risk and impact of settlement could be more readily managed and controlled with piled structural foundations, therefore the impact on the programme is likely to be less onerous/better controlled.

- Buildability: All the options scored equally for this factor. Option A and B are complicated by the need for ground improvement works prior to installation of the culvert (more sensitive to potential settlement delays during construction). In comparison Option C is complicated by the in-situ RC/Piling works for the foundations.

- Disruption to A1 Traffic: During initial construction, all three options would involve the works needing to be phased to ensure minimum levels of traffic (2 lanes both directions) is maintained. All three options are considered equal when considering the impact on traffic.

- Health & Safety Risks: Option C scored the least due to the risks associated with in situ concrete works and rebar cage assembly. Option A scored second highest based on precast elements being fabricated in controlled, clean conditions where risks can be managed to a greater degree than on site. However due to the size and difficult access, the risks associated with lifting elements/plant is most onerous with Option A. Excavation and backfill are common to all three options. Option B is considered the simplest of the three options and therefore the least onerous when considering safety on site.

- Aesthetics: Option A scored most favourably as precast concrete units are considered to provide a cleaner, sharper finish that is less susceptible to vegetation and algae growth over its lifetime.

5.2.3 Based on the scores above, Option B (corrugated pipe structure) appears to be the most favourable option followed very closely by Option C (Corrugated Arch/Piled Foundation). The preference would be based on sensitively of the proposed structural form to settlement and how this may impact the programme.

5.2.4 The final culvert founding methodology 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 interaction with the existing and proposed earthworks.

5.2.5 Subject to further geotechnical analysis and the impact of potential ground improvements under the embankment area, the piles for option C may become obsolete thereby clearly inclining towards Option B as the preferred solution.

6. CONCLUSION & RECOMMENDATIONS

6.1 CONCLUSION

6.1.1 Studies to date show the existing Allerdene culvert (located north of the existing Allerdene Railway Bridge) would require structural modifications and extension to the south end to accommodate the proposed improvement works to the A1 alignment.

6.1.2 The existing Allerdene culvert comprises 2.49m wide x 1.79m high Armco (10 gauge) galvanised steel multi-plate pipe (assumed to be MP100) with an overall length of approximately 78m. The existing culvert is deemed to be in fair condition.

6.1.3 The ground conditions and the estimated magnitude of settlement pose a significant risk to the works at Allerdene culvert. To minimise the risk associated with settlement, differential settlement between the existing and new culvert section, it is considered that complete replacement of the existing culvert would provide the most robust solution.

6.1.4 It is important to note that the settlement risk and any associated mitigation/controls at Allerdene culvert will need to be considered in the wider context of the new A1 embankments leading up to and beyond the new Allerdene Railway bridge. This is important to ensuring the settlement risk is not managed in isolation, and that an appropriate solution is provided to ensure the entirety of the new embankment construction does not compromise the overall works and construction programme.

6.1.5 To accommodate the new A1 alignment, a new culvert is required up to 116m in length to replace the existing. The northern extent of the existing culvert (circa 38m long) will be 'opened' up (into a ditch) once the existing A1 carriageway embankment has been removed, following the traffic switch onto the new carriageway.

6.1.6 The following options were considered for the proposed replacement culvert.

- Option A: Precast Concrete Box – Indicative Construction Cost £610k*
- Option B: Steel Corrugated Pipe – Indicative Construction Cost £275k*
- Option C: Steel Corrugated Arch/Piled foundation – Indicative Construction Cost £590k*

6.1.7 The studies to date show Option B (corrugated pipe structure) to be the most favourable option followed very closely by Option C (Corrugated Arch/Piled Foundation). The preference would be based on sensitively of the proposed structural form to settlement and how this may impact the programme.

6.1.8 Subject to further geotechnical analysis and the impact of potential ground improvements under the embankment area, the piles for option C may become obsolete thereby clearly inclining towards Option B as the preferred solution. In addition, there may be scope to reduce the overall length of the culvert by approximately 30m by the provision of 1 in 2 slopes as oppose to the current 1 in 3 slope provision (potential construction cost saving).

6.2 RECOMMENDATION

6.2.1 Based on the study to date, it is recommended that both Option B Corrugated Pipe structure is further reviewed and developed at detailed design for the Allerdene Culvert replacement works.

6.2.2 During the detailed design stage, it is advisable that the following analysis be undertaken in collaboration with the Highways England Project team on the basis they will have a significant impact the Allerdene Culvert improvement works

- Further refined analysis to confirm the culvert founding methodology. This would include detailed 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 interaction with the existing and proposed earthworks.

- Review the scope to reduce the overall length of the culvert by approximately 30m by the provision of 1 in 2 slopes as oppose to the current 1 in 3 slope provisions.

Appendix A

INDICATIVE SCHEMATIC PLANS OF THE PREFERRED ROUTE

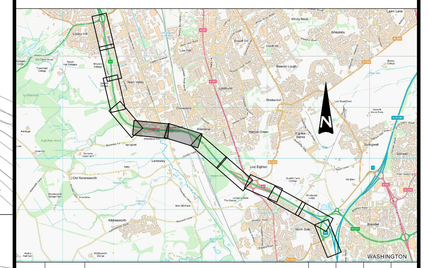
highways england

APPENDIX A-1

PREFERRED ROUTE PLANS

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



RETAIL WORLD TEAM VALLEY

KINGSWAY VIADUCT UNDERBRIDGE; STRUCTURE KEY 16271. STRUCTURE TO BE WIDENED TO ACCOMMODATE WIDENED CARRIAGEWAY.

JUNCTION 67 - COAL HOUSE (424955,558553)

A1 SB

A1 NB

CUTLINE A

CUTLINE B

BANESLEY LANE

COACH ROAD

Lady Park Farm

The Bungalow

Lady Park Cottage

LAMESLEY ROAD

RIVER TEAM

REPLACEMENT GAS TRANSFER STATION

GAS TRANSFER STATION TO BE REPLACED PRIOR TO A1 BIRTLEY TO COAL HOUSE SCHEME

ALLERDENE CULVERT; STRUCTURE KEY 8879. STRUCTURE TO BE EXTENDED TO ACCOMMODATE REALIGNED CARRIAGEWAY.

ALLERDENE RAILWAY UNDERBRIDGE; STRUCTURE KEY 8880. BRIDGE TO BE DEMOLISHED FOLLOWING THE CONSTRUCTION OF THE NEW BRIDGE.

PROPOSED ATTENUATION POND.

ALLERDENE CULVERT TO BE EXTENDED

CHOWDENE BANK

CUTLINE C

EAST COAST MAINLINE

PROPOSED GAS TRANSFER STATION SITE

DRAINAGE DITCH TO BE REALIGNED

PROPOSED ALLERDENE UNDERBRIDGE TO BE CONSTRUCTED OFFLINE.

PROPOSED MAINTENANCE ACCESS TRACK

Rev.	Date	Description	By	Eng' Ch'k	Disc' Ch'k	App'd
P01	05/09/16	FOR INFORMATION	JAC	---	---	---
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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F+ 44 (0) 113 395 6201
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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
1:1000	J.Singh	M.Birkett	N.Rawcliffe	---
Original Size	**Date**	**Date**	**Date**	**Date**
A1	26/07/18	26/07/18	26/07/18	---

Drawing Number: HE551462 S2 | Originator: WSP | Volume: HGN | Section | Type | ID: X | Direction: DR | Type: CH | Role: 01003 | Number

Revision: P08

PW Stage Code: 3

Confidential

WSP Project Number: 70041947

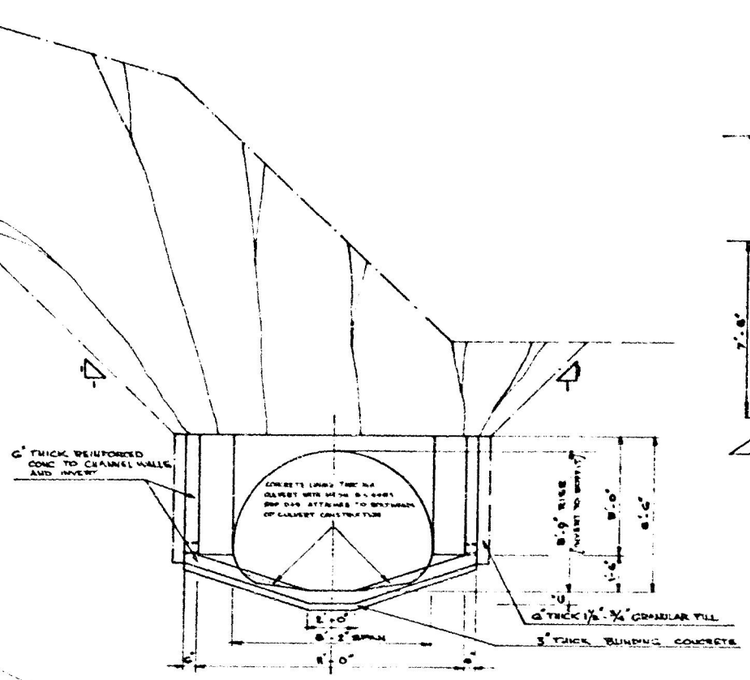
HE551462-WSP-HGN-S2_X-DR-CH-01003

Appendix B

AS BUILT INFORMATION

APPENDIX B-1

AS BUILT INFORMATION



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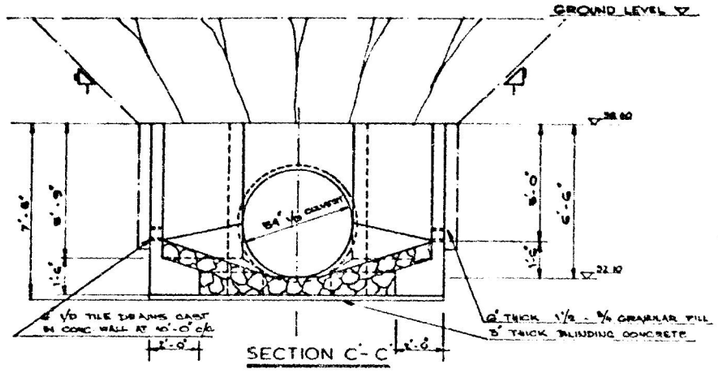

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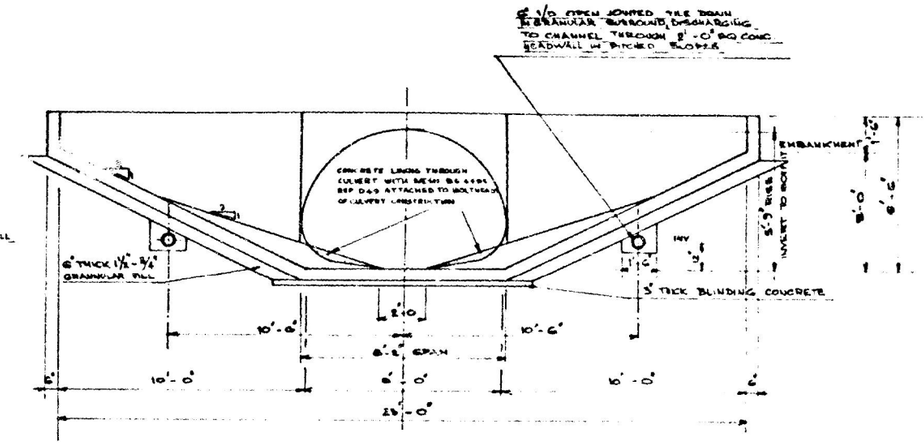
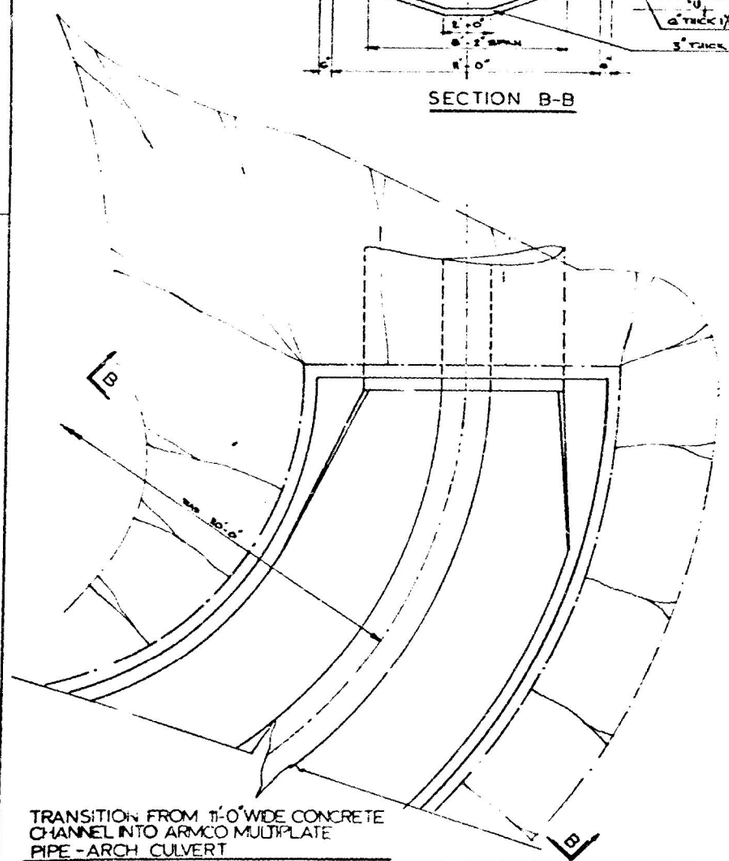


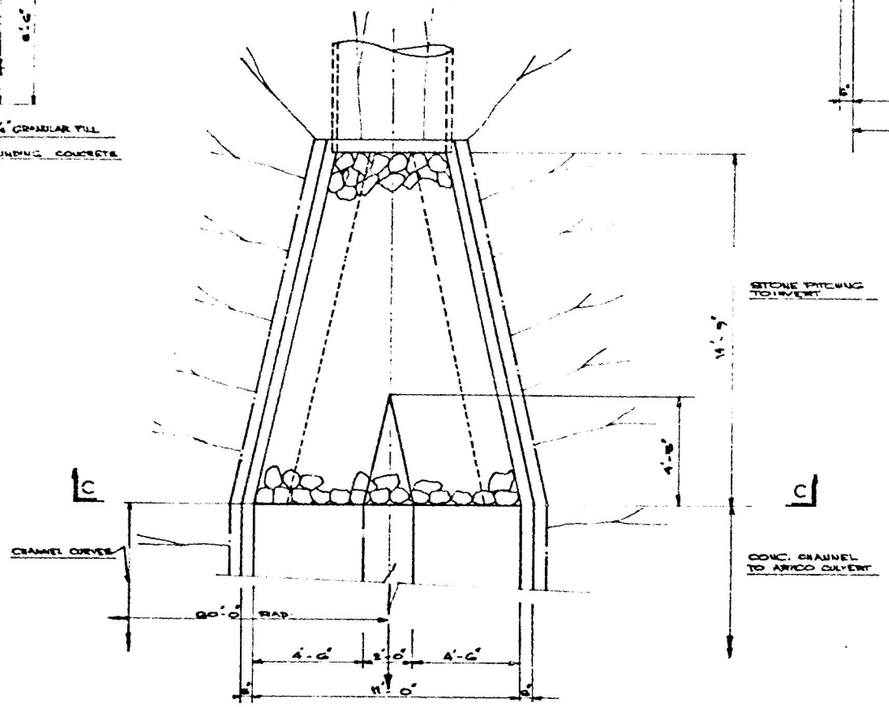
SECTION A—A

note :

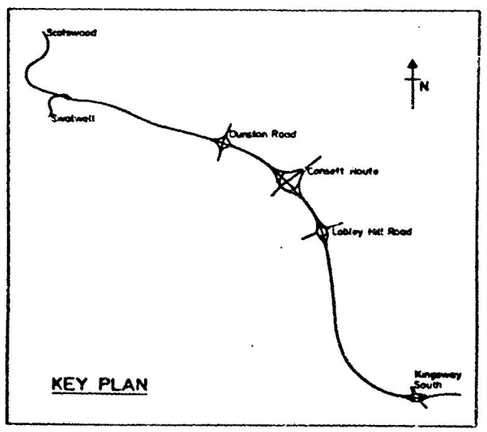
THIS DRG TO BE READ IN CONJUNCTION WITH DRG No 2653-07-253



TRANSITION FROM 11'-0" WIDE CONCRETE CHANNEL INTO ARMCO MULTIPLATE PIPE-ARCH CULVERT



TRANSITION FROM 54" 1/D CULVERT INTO 11'-0" WIDE CONCRETE CHANNEL.



BOROUGH PLANNER & ENGINEER, GATESHEAD	COUNTY ENGINEER & SURVEYOR, CO. DURHAM	CONSULTING ENGINEERS
J.L. HURRELL, B.Sc.Tech., C.Eng., M.I.C.E., F.I.Mun.E., A.M.T.P.I. SUCCESSOR TO J.W. RADCLIFFE, M.Eng., M.I.C.E., M.I.Mun.E., M.T.P.I.	J.R. TULLY, B.Sc., C.Eng., M.I.C.E., M.Inst.H.E., SUCCESSOR TO W.H.B. COTTON, M.Sc., M.I.C.E., M.I.Mun.E., F.I.H.E.	OVE ARUP & PARTNERS CONSULTING ENGINEERS

Revision	Drawn	Made by	Date
		Planned	Checked	Approved	Works order

GATESHEAD WESTERN BY-PASS

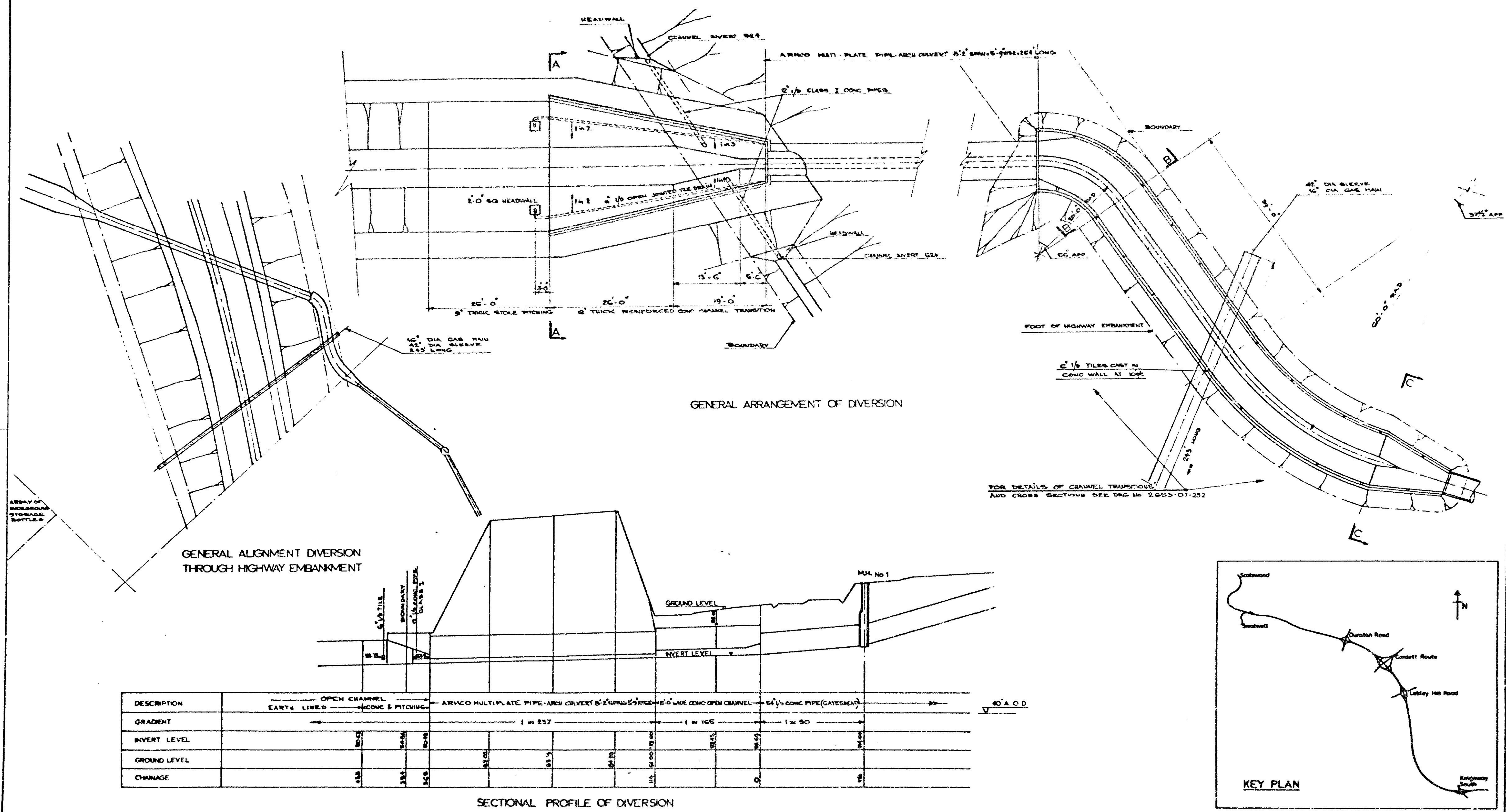
ALLERDENE CULVERT AND CHANNEL DIVERSION

DETAILS AND SECTIONS

Scales 1/8" & 3/8": 1 foot

Ove Arup & Partners Consulting Engineers — Job No. 2653 — Drawing No. 07-252

TENDER DRAWING



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CONSULTING ENGINEERS

OVE ARUP & PARTNERS CONSULTING ENGINEERS

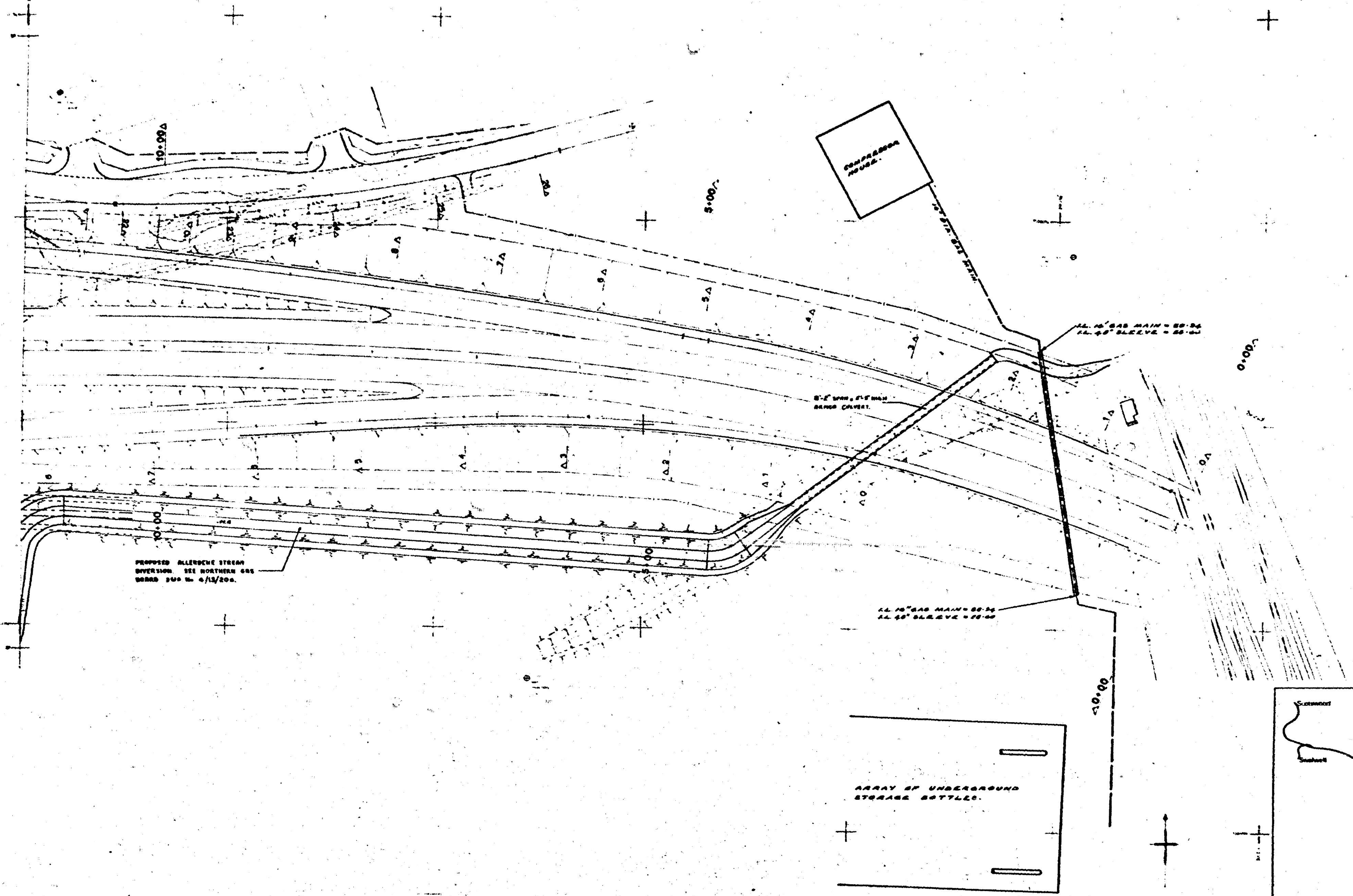
GATESHEAD WESTERN BY-PASS

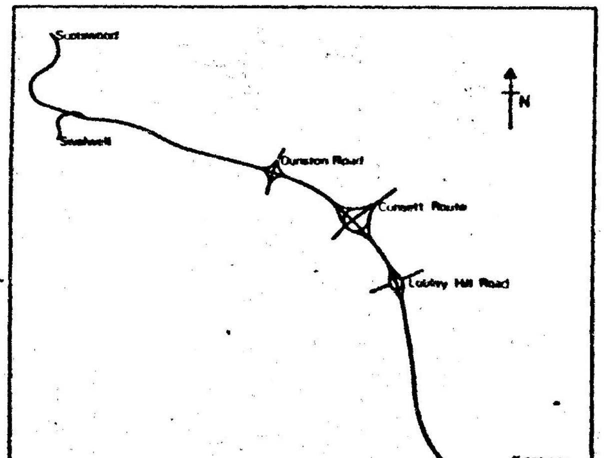
ALLERDENE CULVERT AND CHANNEL DIVERSION
GENERAL ARRANGEMENTS

Scales 1/8 and 1/500

Ove Arup & Partners Consulting Engineers — Job No. 2653 — Drawing No. 07 253

TENDER DRAWING 2653 -07 253





KEY PLAN

BOROUGH PLANNER & ENGINEER, GATESHEAD	COUNTY ENGINEER & SURVEYOR, CO DURHAM	CONSULTING ENGINEERS
J.L. HURRELL, B.Sc.Tech., C.Eng., M.I.C.E., F.I.Mun.E., A.M.T.P.I., SUCCESSOR TO J.W. RADCLIFFE, M.Eng., M.I.C.E., M.I.Mun.E., M.T.P.I.	J.R. TULLY, B.Sc., C.Eng., M.I.C.E., M.Inst.H.E., SUCCESSOR TO W.H.B. COTTON, M.Sc., M.I.C.E., M.I.Mun.E., F.I.H.E.	OVE ARUP & PARTNERS CONSULTING ENGINEERS

Revision	Mark	Made by	Date

The topographical information was prepared by BKS SURVEYS LTD from aerial photography dated 21 March 1987

Passed	Drawn	Appr. vol. issue
	Checked	Works issue

GATESHEAD WESTERN BY-PASS

ALLERDENE STREAM DIVERSION

Scale: Horizontal 1:500

Ove Arup & Partners Consulting Engineers — Job No / Drawing No

TENDER DRAWING — 2653 - 07 - 260

Appendix C

STATUTORY UNDERTAKERS INFORMATION

highways england

APPENDIX C-1

STATUTORY UNDERTAKERS DRAWINGS

DO NOT SCALE

Millimetres 0 10 100

A1

JUNCTION 67 - COAL HOUSE (424955,558553)

SAINSBURY'S

KINGSWAY SOUTH

CHOWDENE BANK

COACH ROAD

BANESLEY LANE

BANESLEY LANE

LAMESLEY ROAD

RIVER TEAM

SMITHY LANE

SMITHY LANE

EAST COAST MAINLINE

EXTENT OF WORKS

A1 SB

A1 NB

CUTLINE A

CUTLINE B

KEY

- EXISTING STRUCTURE
- PROPOSED STRUCTURE
- PROPOSED RETAINING WALL
- PROPOSED HIGHWAYS FENCE LINE
- EXISTING HIGHWAYS FENCE LINE
- NEW CARRIAGEWAY CONSTRUCTION
- EXISTING CARRIAGEWAY TO BE RETAINED
- PROPOSED DRAINAGE DITCH
- PROPOSED FOOTPATH DIVERSION
- EXISTING FOOTPATH
- BT — BT DUCT
- IC — INSTALCOM
- W — NORTHUMBRIAN WATER COMBINED
- W — NORTHUMBRIAN WATER FOUL
- W — NORTHUMBRIAN WATER ABANDONED
- W — NORTHUMBRAIN WATER SURFACE
- W — NORTHUMBRIAN WATER TREATED
- W — NORTHUMBRIAN WATER DISTRIBUTION
- W — NON NORTHUMBRIAN WATER PRIVATE
- G — NORTHERN GAS LOW PRESSURE
- G — NORTHERN GAS MEDIUM PRESSURE
- G — NORTHERN GAS INTERMEDIATE PRESSURE
- G — NORTHERN GAS REGIONAL HIGH PRESSURE
- T — VIRGIN MEDIA CABLE
- E — NORTHHERN POWER GRID CABLE
- C — VODAFONE CABLE
- IC01 — UTILITY REFERNCE

NOTES

1. LOCATION OF SERVICE PLANT SHOWN ON THIS DRAWING HAS BEEN OBTAINED FROM C2 STATUTORY UNDERTAKERS RETURNS AND IS SHOWN INDICATIVELY. THE STATUTORY UNDERTAKERS ARE TO SATISFY THEMSELVES OF THE LOCATION AND EXTENTS OF SERVICE PLANT.
2. REFER TO SECTION 3.10 OF THE TECHNICAL APPRAISAL REPORT FOR DETAILS OF THE DIVERSION WORKS PROPOSED.
3. ALL DIAMETERS OF WATER MAINS ARE MEASURED IN MILLIMETERS UNLESS OTHERWISE STATED.

IMPORTANT WARNING

THE INFORMATION CONCERNING THE LOCATION AND/OR DEPTH OF THE PUBLIC UTILITY APPARATUS IS PROVIDED ON THIS DRAWING AS AN INDICATIVE GUIDE ONLY. NO GUARANTEE AS TO THEIR CORRECTNESS IS GIVEN OR IMPLIED.

THESE DRAWINGS SHOULD NOT BE RELIED UPON IN THE EVENT OF EXCAVATIONS OR OTHER WORKS MADE NEAR TO THE APPARATUS, WHICH MAY EXIST AT VARIOUS DEPTHS AND MAY DEVIATE FROM THE MARKED ROUTE. IT SHOULD ALSO BE NOTED THAT A SINGLE LINE SHOWN ON THE PLAN MAY INDICATE THE PRESENCE OF MORE THAN ONE CABLE.

THE CONTRACTOR IS REQUIRED TO ENSURE THAT THE LOCATIONS OF BELOW GROUND SERVICES ARE ESTABLISHED CONFIRMED ON SITE PRIOR TO ANY EXCAVATIONS OR OTHER WORKS WHICH MAY EFFECT THE EXISTING SERVICES.

PRIOR TO ANY WORKS ON SITE, THE CONTRACTOR SHALL REFER TO:
HSG47 - AVOIDING DANGER FROM UNDERGROUND SERVICES (BY HSE)
HGS185 - HEALTH & SAFETY IN EXCAVATIONS (BY HSE)
CONSTRUCTION INFORMATION SHEET (CIS) 8 - SAFETY IN EXCAVATIONS (BY HSE)
GENERAL SERIES (GS) 6 - AVOIDANCE OF DANGER FROM OVERHEAD ELECTRIC LINES (BY HSE)

Rev.	Date	Description	By	Chk'd	App'd
	22/05/17				
P01	22/05/17	DRAFT	JS	SG	NGR
P02	23/05/17	Design update, NGN 111 added	JS	SG	NGR

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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
OPTION 1A - OFFLINE REPLACEMENT OF ALLERDENE RAILWAY BRIDGE
EXISTING STATUTORY UNDERTAKERS APPARATUS
SHEET 1 OF 3

Scale	Drawn	Checked	Approved	Authorised
1:1250	J.Singh	S.Ghosh	N.Rawcliffe	---
Original Size	Date	Date	Date	Date
A1	23/05/17	23/05/17	23/05/17	---

Drawing Status: INITIAL STATUS OR WIP
Suitability: S0

Drawing Number Project	Originator	Volume	Project Ref. No.
HE551462	WSP	VUT	
BCH Location	DR Type	D Role	00001 Number

Revision: P02

Appendix D

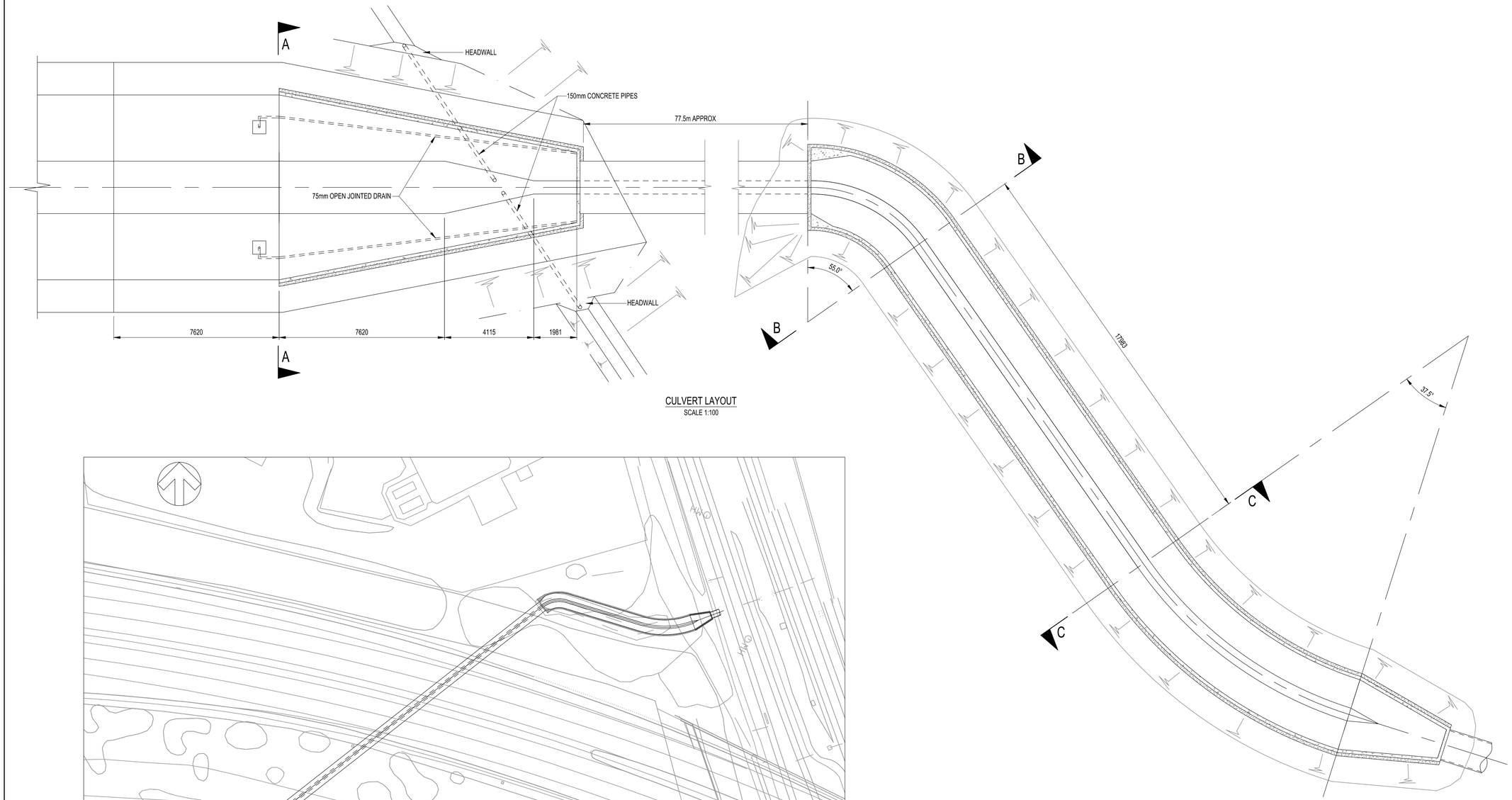
EXISTING STRUCTURE INFORMATION

highways england

APPENDIX D-1

EXISTING GENERAL ARRANGEMENT DRAWINGS

Suitability S0
Drawing number HE551462-WSP-SBR-CL001-SK-S-00001
Rev P01



CULVERT LAYOUT
SCALE 1:100

PLAN
SCALE 1:500

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METERS A.O.D UNLESS NOTED OTHERWISE.
3. DO NOT SCALE IN CASE OF ANY DOUBTS, OMISSIONS OR ERRORS, SEEK CLARIFICATION FROM DESIGNERS.

SAFETY, HEALTH AND ENVIRONMENTAL SYMBOL LEGEND

INDICATES A RESIDUAL RISK AS A WARNING

Suit	Rev	Date	Description	Des	Chk	App

Designer
WSP | PARSONS BRINCKERHOFF
Three White Rose Office Park, Millshaw Park Lane, Leeds, LS11 0DL
Tel: +44 (0)113 395 6200, Fax: +44 (0)113 395 6201
http://www.wspgroup.com

Client
highways england

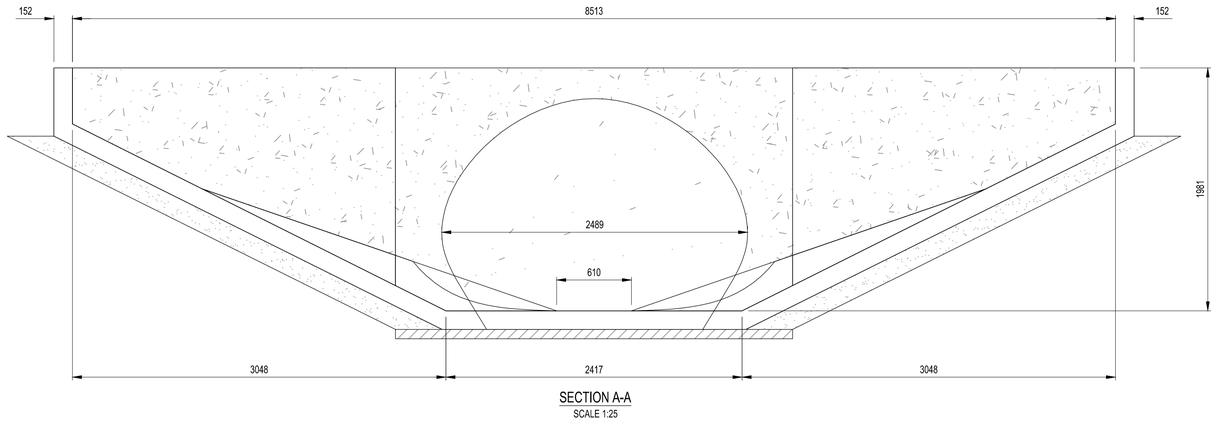
Project Title
A1 BIRTLEY TO COAL HOUSE

Drawing Title
ALLERDENE CULVERT
EXISTING GENERAL ARRANGEMENT
(SHEET 1 OF 2)

Scale	Drawn	Designed	Checked	Approved
AS SHOWN @ A1	RA	IM	RM	HM
Size	Date	Date	Date	Date
A1	26/01/2017	26/01/2017	26/01/2017	26/01/2017

Status: PRELIMINARY
Suitability: S0
Drawing Number: HE551462-WSP-SBR-CL001-SK-S-00001
Revision: P01

DO NOT SCALE
A1



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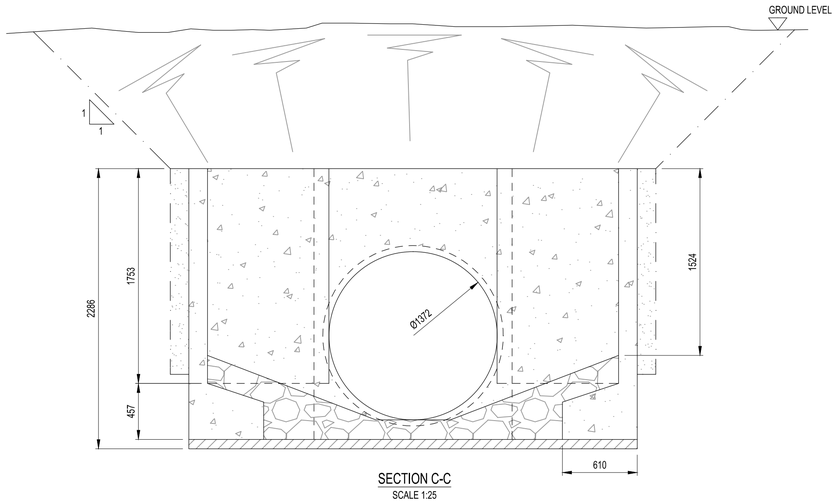

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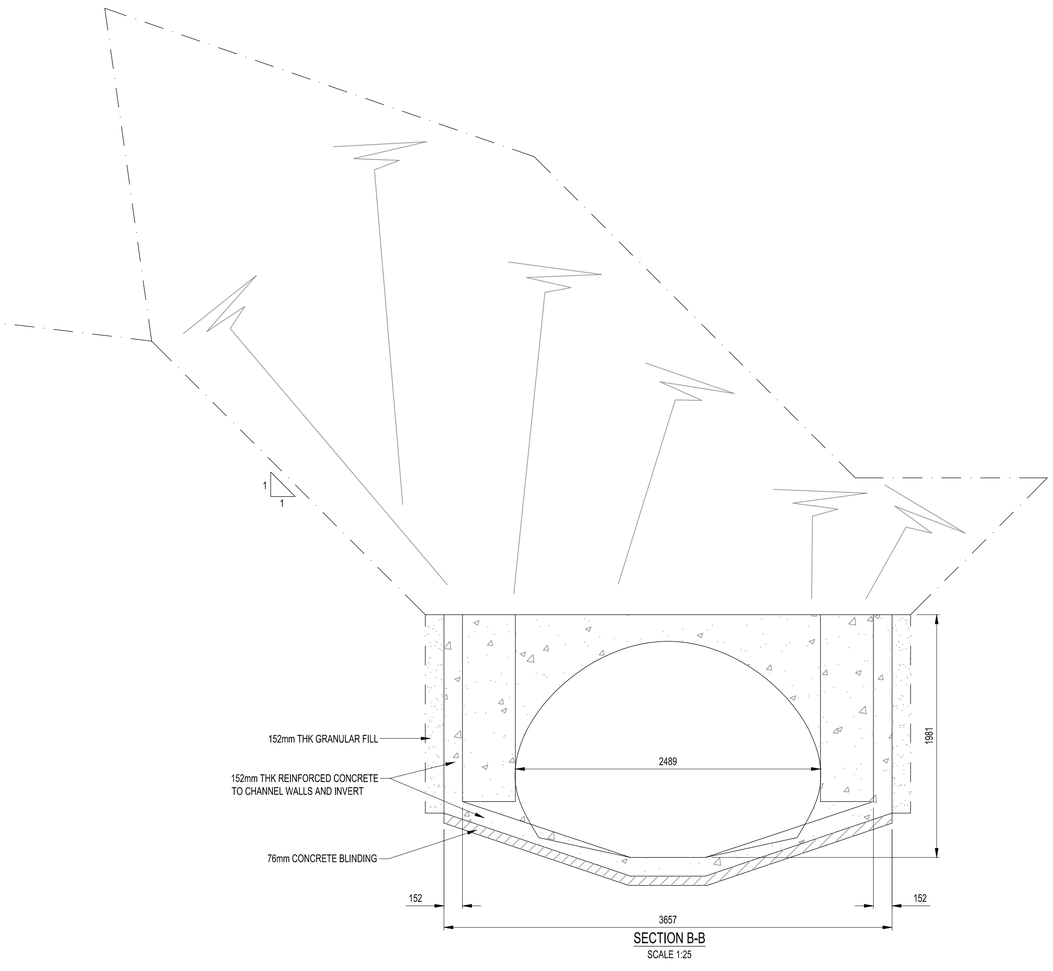
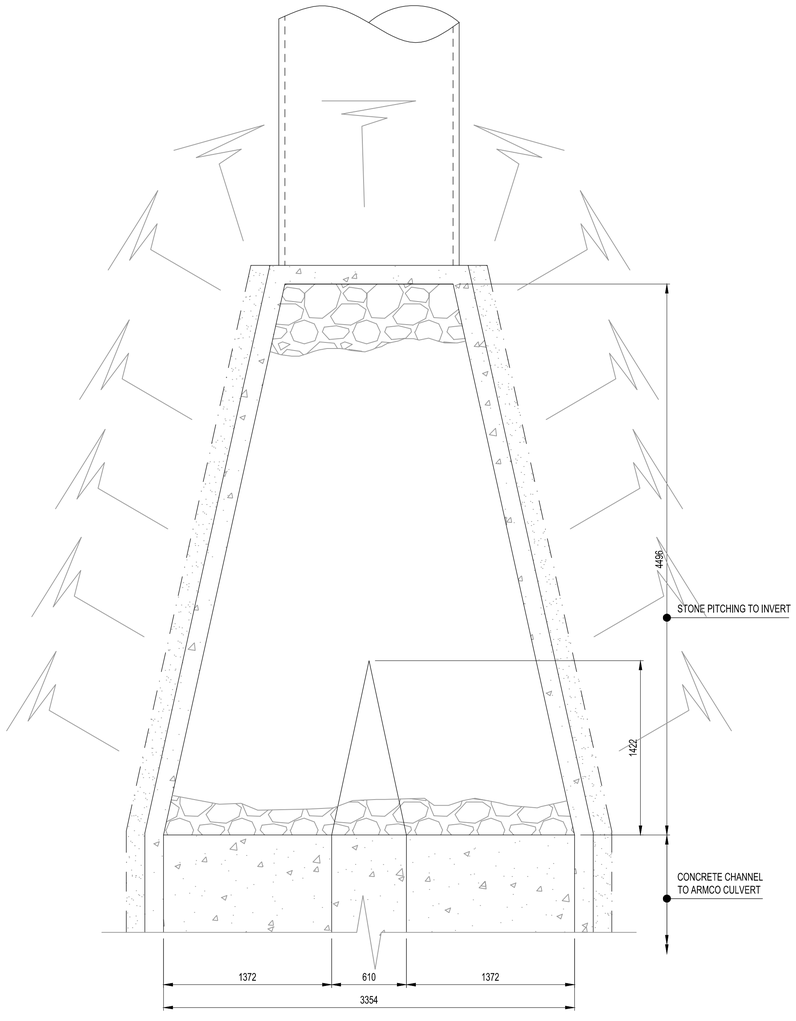


SECTION B-B
SCALE 1:25



TRANSITION FROM 54" Ø (1372mm) 1/D CULVERT INTO
11' (3354mm) WIDE CONCRETE CHANNEL
SCALE 1:25

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METERS A.O.D UNLESS NOTED OTHERWISE.
3. DO NOT SCALE IN CASE OF ANY DOUBTS, OMISSIONS OR ERRORS, SEEK CLARIFICATION FROM DESIGNERS.

SAFETY, HEALTH AND ENVIRONMENTAL SYMBOL LEGEND

INDICATES A RESIDUAL RISK AS A WARNING

Suit	Rev	Date	Description	Des	Chk	App

Designer

WSP | PARSONS BRINCKERHOFF

Three White Rose Office Park, Millshaw Park Lane, Leeds, LS11 0DL
Tel: +44 (0)113 395 6200, Fax: +44 (0)113 395 6201
http://www.wspgroup.com

Client

highways england

Project Title

A1 BIRTLEY TO COAL HOUSE

Drawing Title

ALLERDENE CULVERT
EXISTING GENERAL ARRANGEMENT
(SHEET 2 OF 2)

Scale	Drawn	Designed	Checked	Approved	
AS SHOWN @ A1	RA	IM	RM	HM	
Size	Date	Date	Date	Date	
A1	26/01/2017	26/01/2017	26/01/2017	26/01/2017	

Status: PRELIMINARY
Suitability: S0

Drawing Number: HE551462-WSP-SBR-CL001-SK-S-00002
Revision: P01

DO NOT SCALE

A1

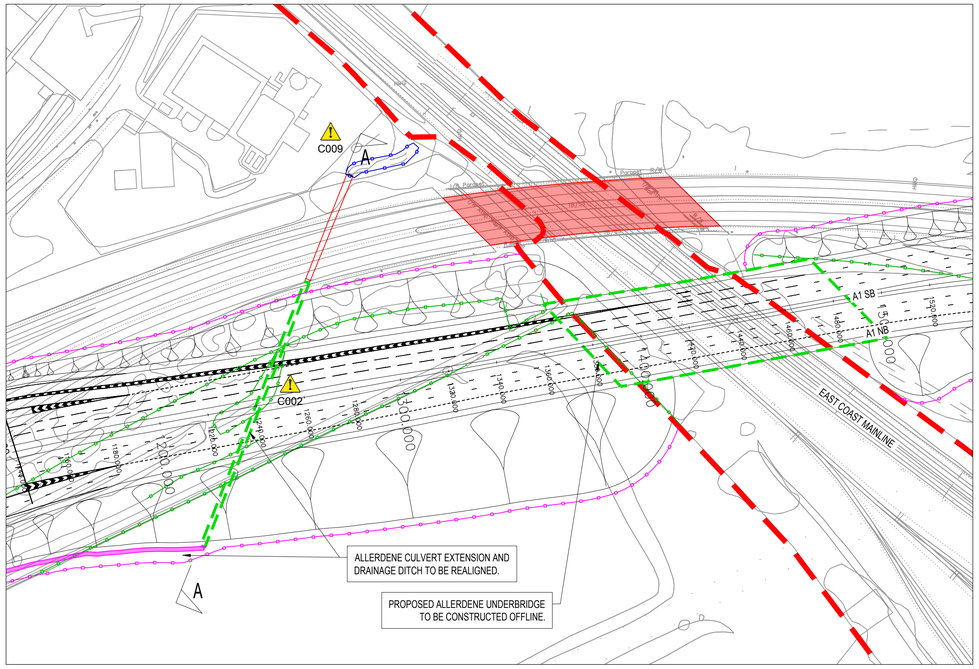
Appendix E

PROPOSED OPTION DRAWINGS

highways england

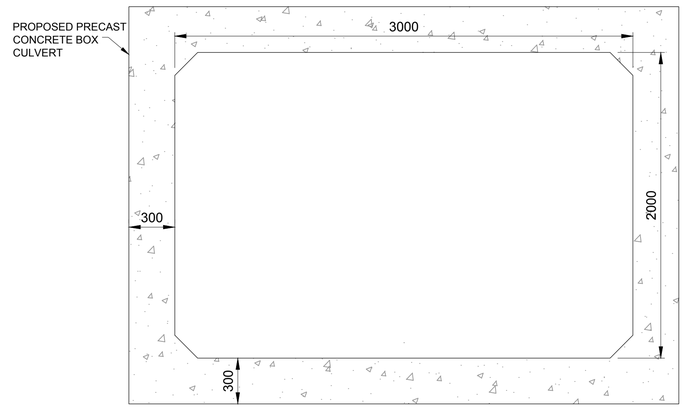
APPENDIX E-1

OPTION A: PRECAST CONCRETE BOX



PROPOSED HIGHWAY ALIGNMENT PLAN

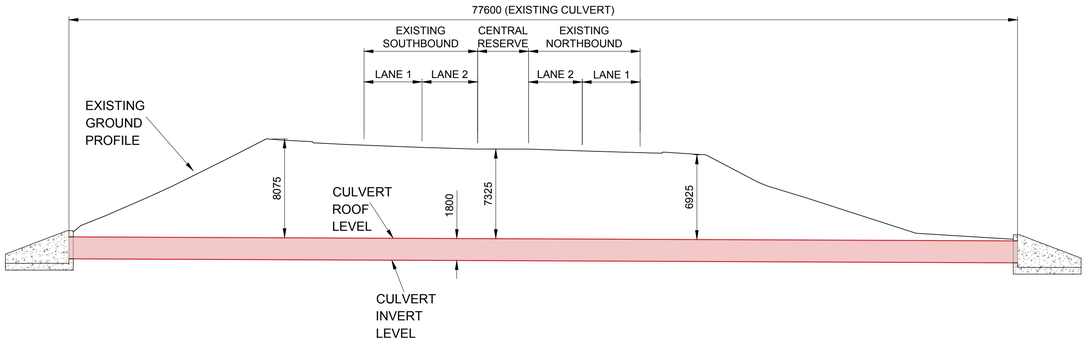
SCALE 1:1250



SECTION B-B

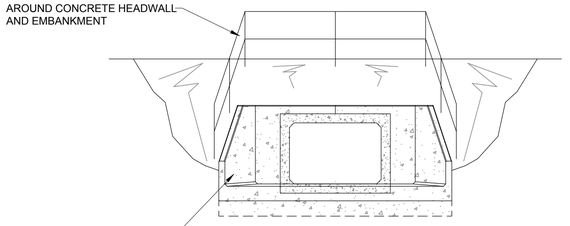
SCALE 1:20

	CROSS SECTIONAL AREA (m²)
EXISTING CULVERT	3.532
PROPOSED CULVERT	5.995



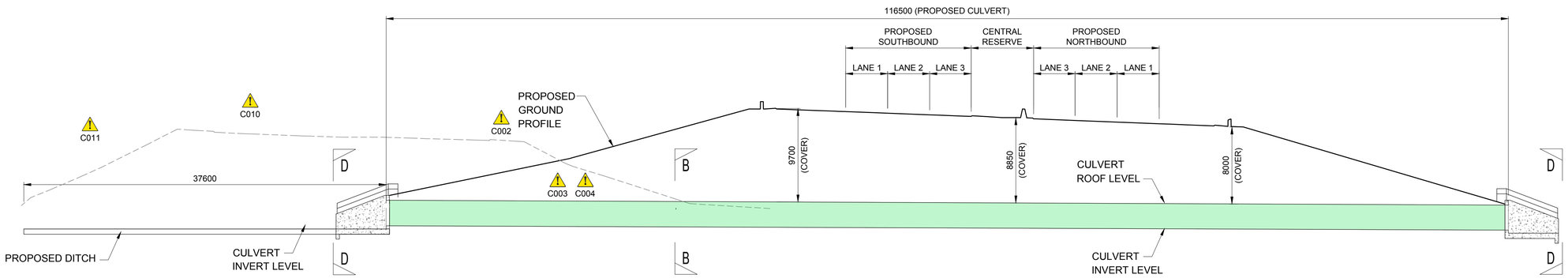
EXISTING LONGITUDINAL SECTION A-A

SCALE 1:250



SECTION D-D

SCALE 1:100



PROPOSED LONGITUDINAL SECTION A-A

SCALE 1:250

GENERAL NOTES

1) STRUCTURAL DETAILS PROVIDED ON THIS DRAWING IS INDICATIVE ONLY BASED ON LIMITED INFORMATION AVAILABLE TO DATE.
2) THE SIZE OF STRUCTURAL ELEMENTS ARE BASED PRELIMINARY CALCULATION AND PREVIOUS SIMILAR TYPE WORKS. ALL INFORMATION IS SUBJECT TO DETAILED DESIGN PRIOR TO FINAL CONFIRMATION.
3) DETAILS PROVIDED ARE FOR INFORMATION ONLY. INDICATIVE CONSTRUCTION COST ESTIMATES ARE BASED ON PREVIOUS SIMILAR TYPE WORKS.
4) THE FOLLOWING CRITICAL INFORMATION IS REQUIRED TO VERIFY THE FEASIBILITY OF THE PROPOSED OPTION AND DEVELOPED THIS FURTHER AT DETAILED DESIGN (IF PREFERRED)
   - TOPOGRAPHICAL SURVEY - CONFIRM GEOMETRIC PARAMETERS AND SITE CONSTRAINTS
   - SITE INVESTIGATION INFORMATION - CONFIRM FOUNDATION PARAMETERS
   - LIAISON WITH HIGHWAY ENGLAND - CONFIRM STRUCTURAL REQUIREMENTS
   - LIAISON WITH STATUTORY UNDERTAKERS - CONFIRM EXISTING/NEW SERVICES IMPACTED BY THE WORKS
5) ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
6) ALL LEVELS ARE IN METERS UNLESS NOTED OTHERWISE.
7) DO NOT SCALE IN CASE OF ANY DOUBTS, OMISSIONS OR ERRORS SEEK DESIGNER CLARIFICATION.
8) FOR CONSTRUCTION SEQUENCE SEE DRAWING: HE551462-WSP-SBR-CL001-DR-S-00004

KEY

- EXISTING STRUCTURE
- PROPOSED STRUCTURE
- PROPOSED RETAINING WALL
- PROPOSED HIGHWAYS FENCE LINE
- RETAINED EXISTING HIGHWAYS FENCE LINE (WHERE AVAILABLE)
- REMOVED EXISTING HIGHWAYS FENCE LINE
- NEW CARRIAGEWAY CONSTRUCTION
- EXISTING CARRIAGEWAY TO BE RETAINED WHERE VERTICAL ALIGNMENT PERMITS
- PROPOSED DRAINAGE DITCH
- NETWORK RAIL LAND BOUNDARY

SAFETY, HEALTH AND ENVIRONMENTAL SYMBOL LEGEND

⚠ INDICATES A RESIDUAL RISK AS A WARNING

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 C002 - EXPOSURE TO LIVE TRAFFIC DURING CONSTRUCTION
REF C003- COLLAPSE OF EXISTING PIPE CULVERT DURING CONSTRUCTION
REF C004- COLLAPSE OF TEMPORARY WORKS
REF C005- WORKING ADJACENT TO A WATER COURSE DURING CONSTRUCTION
REF C010- ENVIRONMENTAL RISK ON SITE
REF C011- DEMOLITION OF EXISTING PIPE CULVERT DURING CONSTRUCTION

REV	DATE	BY	DESCRIPTION	CHK	APP

DRAWING STATUS: FOR INFORMATION

Three White Rose Office Park, Millshaw Park Lane, Leeds, LS11 0DL
Tel: +44 (0)113 395 6200, Fax: +44 (0)113 395 6201
http://www.wspgroup.com

CLIENT: Working on behalf of highways england

PROJECT: A1 BIRTLEY TO COALHOUSE

TITLE: ALLERDENE CULVERT OPTION A PRECAST CONCRETE BOX

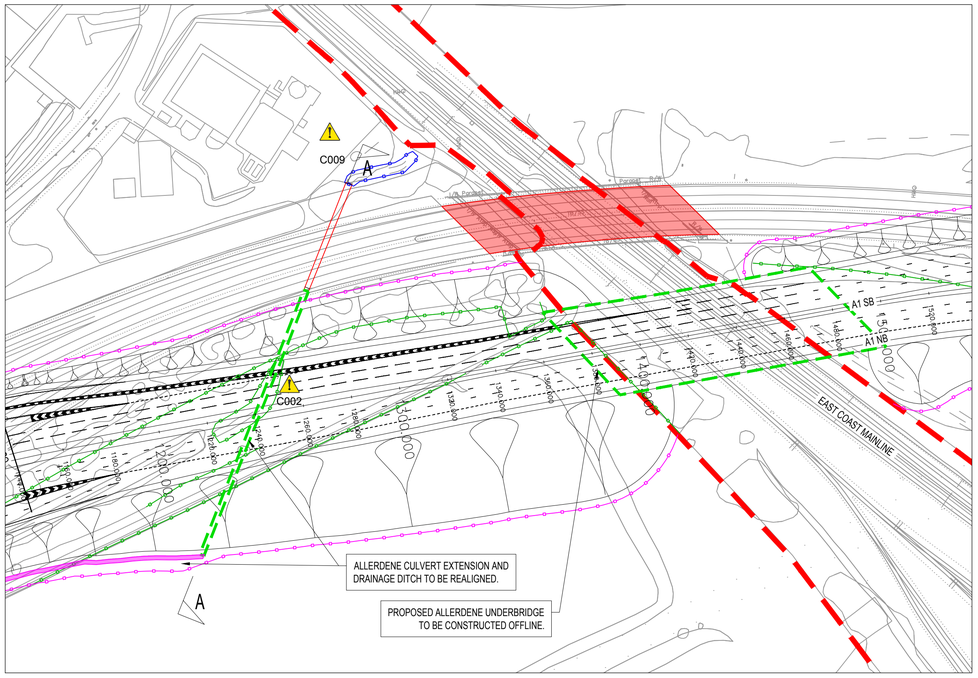
SCALE @ A1:	CHECKED:	APPROVED:
AS SHOWN	HM	HM
CAD FILE:	DESIGN-DRAWN:	DATE:
	MT- RA	JUNE 2018

PROJECT No:	DRAWING No:	REV:
70015226	HE551462-WSP-SBR-CL001-DR-S-00001	P02

highways england

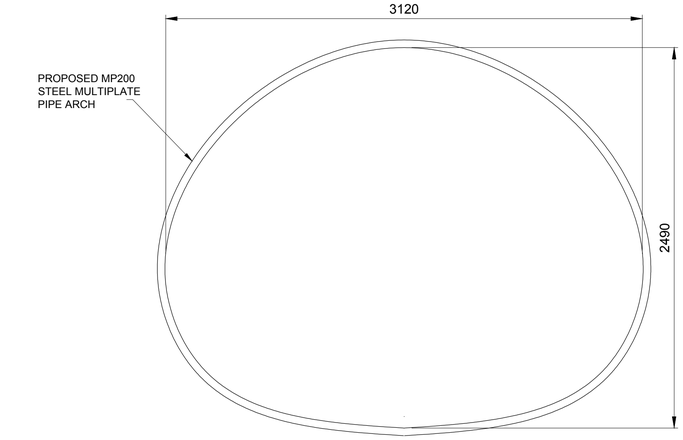
APPENDIX E-2

OPTION B: STEEL CORRUGATED PIPE



PROPOSED HIGHWAY ALIGNMENT PLAN

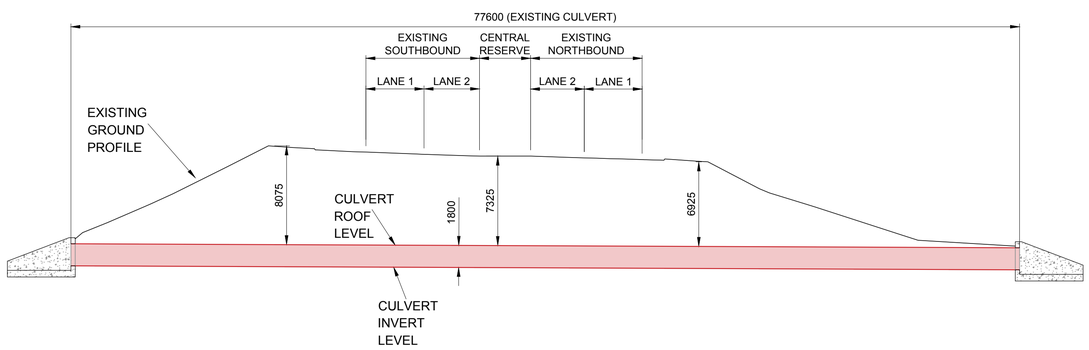
SCALE 1:1250



SECTION B-B

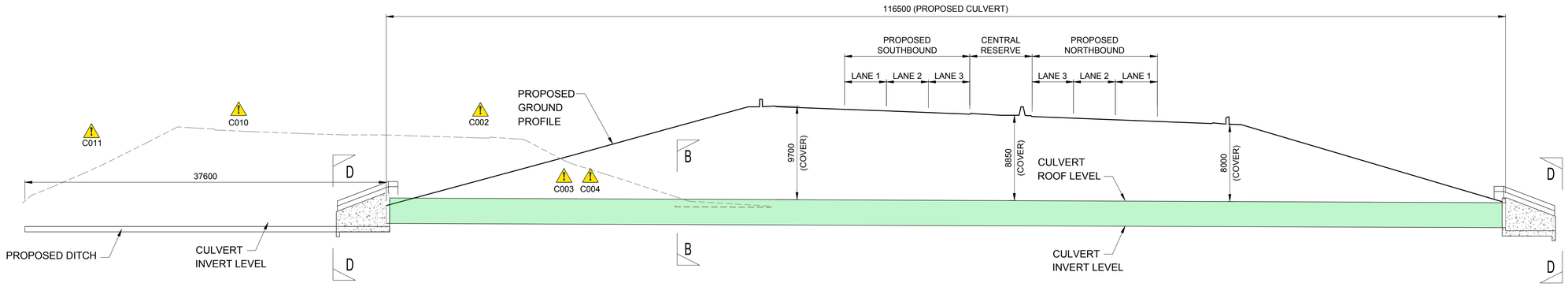
SCALE 1:20

	CROSS SECTIONAL AREA (m²)
EXISTING CULVERT	3.532
PROPOSED CULVERT	6.221



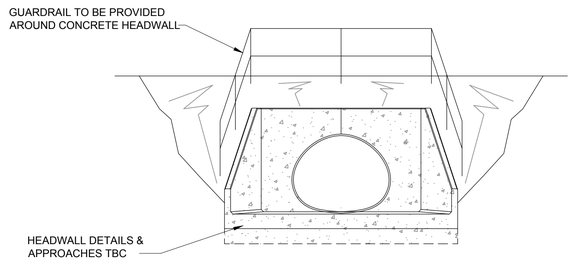
EXISTING LONGITUDINAL SECTION A-A

SCALE 1:250



PROPOSED LONGITUDINAL SECTION A-A

SCALE 1:250



SECTION D-D

SCALE 1:100

GENERAL NOTES

1) STRUCTURAL DETAILS PROVIDED ON THIS DRAWING IS INDICATIVE ONLY BASED ON LIMITED INFORMATION AVAILABLE TO DATE.
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   - SITE INVESTIGATION INFORMATION - CONFIRM FOUNDATION PARAMETERS
   - LIAISON WITH HIGHWAY ENGLAND - CONFIRM STRUCTURAL REQUIREMENTS
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8) FOR CONSTRUCTION SEQUENCE SEE DRAWING: HE551462-WSP-SBR-CL001-DR-S-00004

KEY

- EXISTING STRUCTURE
- PROPOSED STRUCTURE
- PROPOSED RETAINING WALL
- PROPOSED HIGHWAYS FENCE LINE
- RETAINED EXISTING HIGHWAYS FENCE LINE (WHERE AVAILABLE)
- REMOVED EXISTING HIGHWAYS FENCE LINE
- NEW CARRIAGEWAY CONSTRUCTION
- EXISTING CARRIAGEWAY TO BE RETAINED WHERE VERTICAL ALIGNMENT PERMITS
- PROPOSED DRAINAGE DITCH
- NETWORK RAIL LAND BOUNDARY

SAFETY, HEALTH AND ENVIRONMENTAL SYMBOL LEGEND

⚠ INDICATES A RESIDUAL RISK AS A WARNING

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 C002 - EXPOSURE TO LIVE TRAFFIC DURING CONSTRUCTION
REF C003- COLLAPSE OF EXISTING PIPE CULVERT DURING CONSTRUCTION
REF C004- COLLAPSE OF TEMPORARY WORKS
REF C009- WORKING ADJACENT TO A WATER COURSE DURING CONSTRUCTION
REF C010- ENVIRONMENTAL RISK ON SITE.
REF C011- DEMOLITION OF EXISTING PIPE CULVERT DURING CONSTRUCTION

REV	DATE	BY	DESCRIPTION	CHK	APP

DRAWING STATUS: FOR INFORMATION

Three White Rose Office Park, Millshaw Park Lane, Leeds, LS11 0DL
Tel: +44 (0)113 395 6200, Fax: +44 (0)113 395 6201
http://www.wspgroup.com

CLIENT: Working on behalf of highways england

PROJECT: A1 BIRTLEY TO COALHOUSE

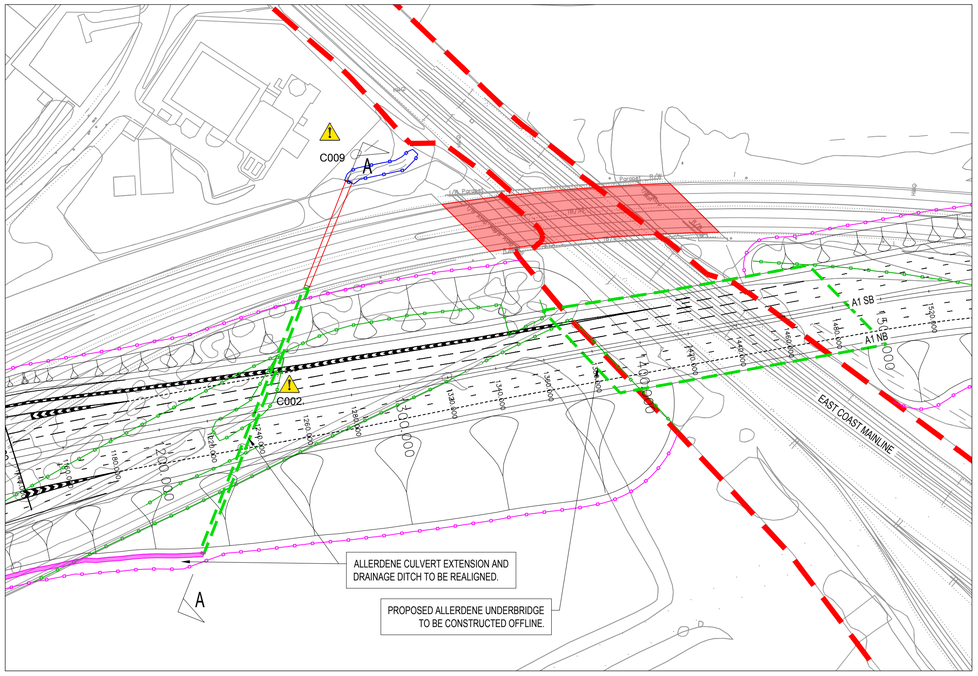
TITLE: ALLERDENE CULVERT OPTION B STEEL CORRUGATED PIPE

SCALE @ A1:	CHECKED:	APPROVED:
AS SHOWN	HM	HM
CAD FILE:	DESIGN-DRAWN:	DATE:
	MT- RA	JUNE 2018
PROJECT No:	DRAWING No:	REV:
70015226	HE551462-WSP-SBR-CL001-DR-S-00002	P02

highways england

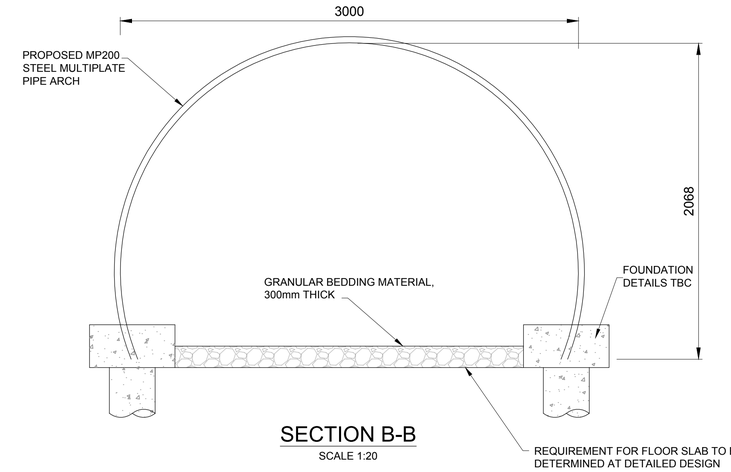
APPENDIX E-3

OPTION C: STEEL CORRUGATED ARCH



PROPOSED HIGHWAY ALIGNMENT PLAN

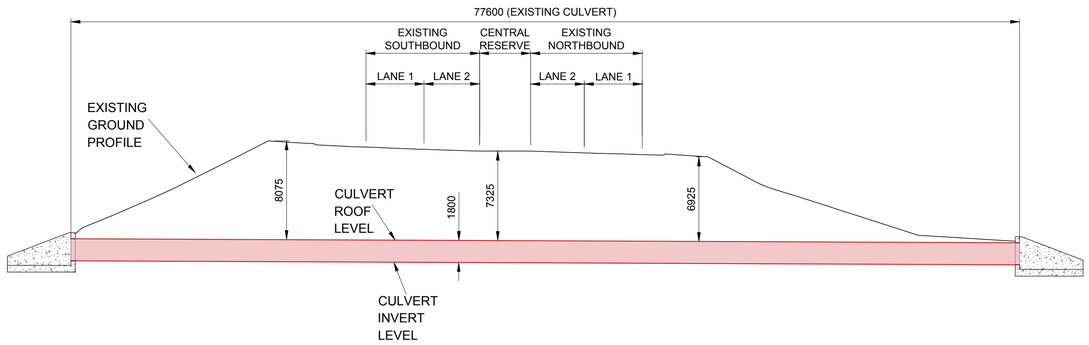
SCALE 1:1250



SECTION B-B

SCALE 1:20

	CROSS SECTIONAL AREA (m²)
EXISTING CULVERT	3.532
PROPOSED CULVERT	5.184



EXISTING LONGITUDINAL SECTION A-A

SCALE 1:250

SECTION D-D

SCALE 1:100

PROPOSED LONGITUDINAL SECTION A-A

SCALE 1:250

GENERAL NOTES

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8) FOR CONSTRUCTION SEQUENCE SEE DRAWING: HE551462-WSP-SBR-CL001-DR-S-00004

KEY

- EXISTING STRUCTURE
- PROPOSED STRUCTURE
- PROPOSED RETAINING WALL
- PROPOSED HIGHWAYS FENCE LINE
- RETAINED EXISTING HIGHWAYS FENCE LINE (WHERE AVAILABLE)
- REMOVED EXISTING HIGHWAYS FENCE LINE
- NEW CARRIAGEWAY CONSTRUCTION
- EXISTING CARRIAGEWAY TO BE RETAINED WHERE VERTICAL ALIGNMENT PERMITS
- PROPOSED DRAINAGE DITCH
- NETWORK RAIL LAND BOUNDARY

SAFETY, HEALTH AND ENVIRONMENTAL SYMBOL LEGEND

⚠ INDICATES A RESIDUAL RISK AS A WARNING

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 C002- EXPOSURE TO LIVE TRAFFIC DURING CONSTRUCTION
REF C003- COLLAPSE OF EXISTING PIPE CULVERT DURING CONSTRUCTION
REF C004- COLLAPSE OF TEMPORARY WORKS
REF C009- WORKING ADJACENT TO A WATER COURSE DURING CONSTRUCTION
REF C010- ENVIRONMENTAL RISK ON SITE
REF C011- DEMOLITION OF EXISTING PIPE CULVERT DURING CONSTRUCTION

REV	DATE	BY	DESCRIPTION	CHK	APP

DRAWING STATUS: FOR INFORMATION

Three White Rose Office Park, Millshaw Park Lane, Leeds, LS11 0DL
Tel: +44 (0)113 395 6200, Fax: +44 (0)113 395 6201
http://www.wspgroup.com

CLIENT: Working on behalf of highways england

PROJECT: A1 BIRTLEY TO COALHOUSE

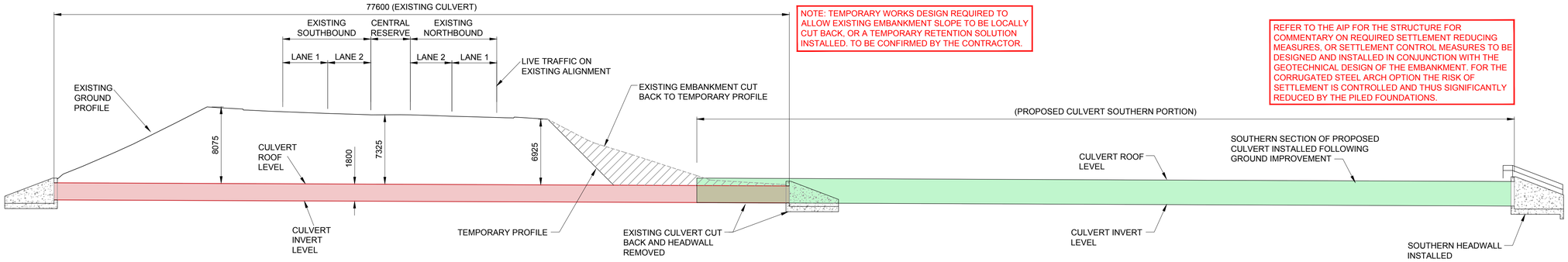
TITLE: ALLERDENE CULVERT OPTION C STEEL CORRUGATED ARCH

SCALE @ A1:	CHECKED:	APPROVED:
AS SHOWN	HM	HM
CAD FILE:	DESIGN-DRAWN:	DATE:
	MT- RA	JUNE 2018

PROJECT No:	DRAWING No:	REV:
70015226	HE551462-WSP-SBR-CL001-DR-S-00003	P02

APPENDIX E-4

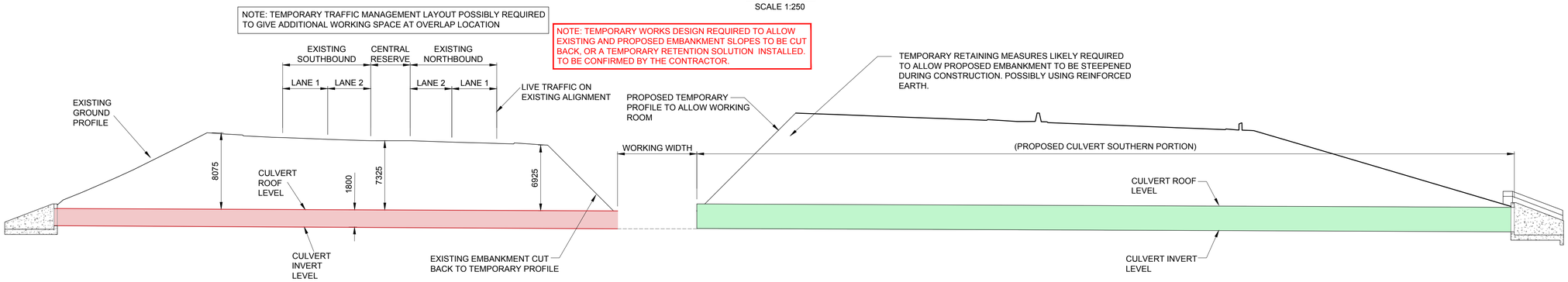
ALLERDENE CULVERT CONSTRUCTION SEQUENCE



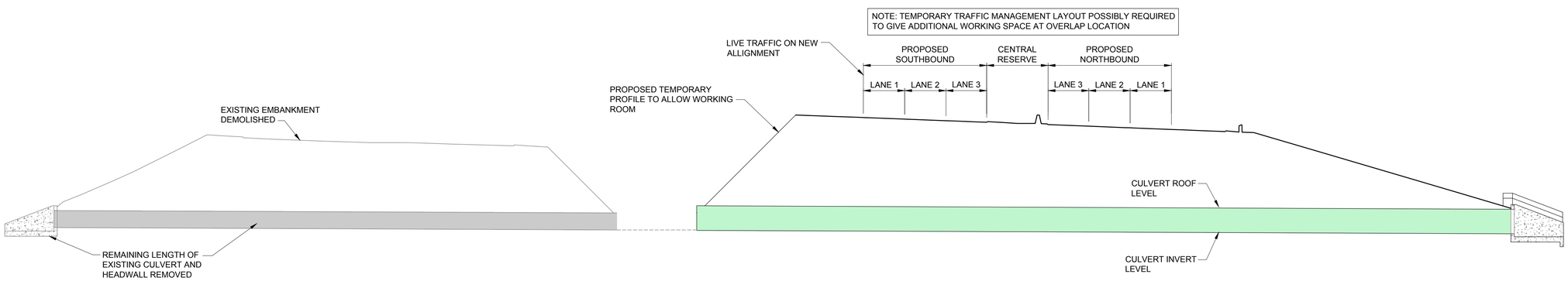
NOTE: TEMPORARY WORKS DESIGN REQUIRED TO ALLOW EXISTING EMBANKMENT SLOPE TO BE LOCALLY CUT BACK, OR A TEMPORARY RETENTION SOLUTION INSTALLED. TO BE CONFIRMED BY THE CONTRACTOR.

REFER TO THE AIP FOR THE STRUCTURE FOR COMMENTARY ON REQUIRED SETTLEMENT REDUCING MEASURES, OR SETTLEMENT CONTROL MEASURES TO BE DESIGNED AND INSTALLED IN CONJUNCTION WITH THE GEOTECHNICAL DESIGN OF THE EMBANKMENT. FOR THE CORRUGATED STEEL ARCH OPTION THE RISK OF SETTLEMENT IS CONTROLLED AND THUS SIGNIFICANTLY REDUCED BY THE PILED FOUNDATIONS.

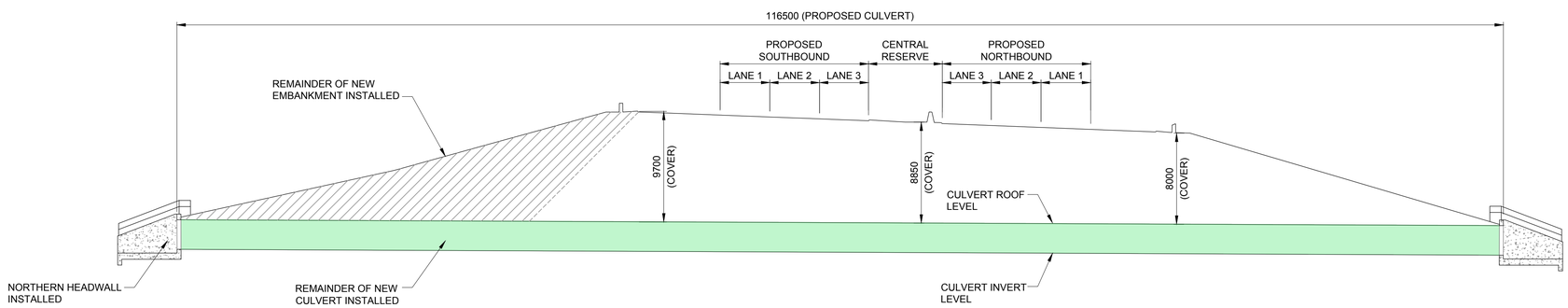
PHASE 1
SCALE 1:250



PHASE 2
SCALE 1:250



PHASE 3
SCALE 1:250



PHASE 4
SCALE 1:250

INDICATIVE CONSTRUCTION SEQUENCE TO BE FURTHER DEVELOPED DURING DETAILED DESIGN:

a. SITE CLEARANCE
b. INSTALL TEMPORARY SHEET PILES INTO EMBANKMENT, BEHIND THE EXISTING CULVERT HEADWALL ON THE SOUTH ELEVATION
c. EXCAVATE EMBANKMENT MATERIAL TO EXPOSE TOP OF EXISTING CULVERT
d. TEMPORARILY DIVERT EXSITING WATERCOURSE (DAM, INSTALL PUMP AND CONNECT PIPE TO DRAINAGE DITCH DOWNSTREAM)
e. REMOVE EXISTING HEADWALLS/WINGWALLS ON THE SOUTHERN ELEVATION
f. TRIM BACK THE EXISTING CULVERT AS REQUIRED
g. INSTALL SOUTHERN SECTION OF NEW CULVERT
h. INSTALL DOWNSTREAM CONCRETE HEADWALL, WINGWALL & APRON
i. CONNECT RE-ALIGNED DRAINAGE DITCH TO THE NEWLY CONSTRUCTED DOWNSTREAM OPENING
j. BACKFILL OVER THE NEW SOUTHERN CULVERT SECTION
k. ONCE ROAD TRAFFIC IS SWITCHED FROM THE EXISTING A1 TO THE NEWLY ALIGNED A1 CARRIAGEWAY, REMOVE EMBANKMENT MATERIAL TO EXPOSE SECTION OF THE OLD CULVERT UP TO THE BOTTOM OF PROPOSED GROUND PROFILE
l. REMOVE TEMPORARY SHEET PILES
m. REMOVE REMAINING LENGTH OF EXISTING CULVERT AND EXISTING NORTHERN HEADWALL/WINGWALL/APRON
n. INSTALL NORTHERN SECTION OF THE NEW CULVERT
o. INSTALL NEW CONCRETE HEADWALL, WINGWALL & APRON TO NORTH ELEVATION
p. REMOVE WATERCOURSE DIVERSION TO ALLOW WATER THROUGH NEW SOUTHERN CULVERT SECTION
q. BACK FILL TO ACHIEVE THE IN SERVICE EMBANKMENT PROFILE AT THE NORTH FACE

* SETTLEMENT REDUCING MEASURES ARE LIKELY TO BE REQUIRED WITHIN THE FULL FOOTPRINT OF THE PROPOSED EMBANKMENT. METHODOLOGY OF SETTLEMENT REDUCING MEASURES YET TO BE CONFIRMED, AND COULD INCLUDE THE FOLLOWING:

- INSTALLATION OF CONTROLLED MODULUS COLUMNS
- USE OF LIGHT WEIGHT FILL EMBANKMENT FILL
- INSTALLATION OF BAND DRAINS AND CUT OFF WALL

SAFETY, HEALTH AND ENVIRONMENTAL SYMBOL LEGEND

INDICATES A RESIDUAL RISK AS A WARNING

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 C002 - EXPOSURE TO LIVE TRAFFIC DURING CONSTRUCTION
REF C003- COLLAPSE OF EXISTING PIPE CULVERT DURING CONSTRUCTION
REF C004- COLLAPSE OF TEMPORARY WORKS
REF C005- WORKING ADJACENT TO A WATER COURSE DURING CONSTRUCTION
REF C010- ENVIRONMENTAL RISK ON SITE
REF C011- DEMOLITION OF EXISTING PIPE CULVERT DURING CONSTRUCTION

REV	DATE	BY	DESCRIPTION	CHK	APP

DRAWING STATUS: FOR INFORMATION

Three White Rose Office Park, Millshaw Park Lane, Leeds, LS11 0DL
Tel: +44 (0)113 395 6200, Fax: +44 (0)113 395 6201
http://www.wspgroup.com

CLIENT: Working on behalf of highways england

PROJECT: A1 BIRTLEY TO COALHOUSE

TITLE: TYPICAL ALLERDENE CULVERT CONSTRUCTION SEQUENCE

SCALE @ A1:	CHECKED:	APPROVED:
AS SHOWN	IM	HM
CAD FILE:	DESIGN DRAWN:	DATE:
	JT- RA	JUNE 2018
PROJECT No:	DRAWING No:	REV:
70015226	HE551462-WSP-SBR-CL001-DR-S-00004	P02

Appendix F

DESIGNERS RISK ASSESSMENT

highways england

APPENDIX F-1

DESIGNERS RISK ASSESSMENT

Way of Working: ***Project Delivery***

T446: Design H&S Risk Register

Project No **70015226**

Project Name **A1 Birtley to Coal House Improvement Scheme - Allerdene Culvert**

Provide Feedback

WSP

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 register 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/installability, operability (normal/emergency), maintainability (inc. routine cleaning, replacement, etc.), and alteration/decommissioning/dismantling/demolition, and should be categorised against those headings,*

CIRIA guidance documents C662, C663, C611, 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* (and 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$ (Y/N)	Date Logged/ Reviewed	Raised By
001	Construction	Allerdene Culvert (Proposed Works)	Working from height during the construction stage around the openings at either end of the structure	Contractor	New fencing will be provided around the culvert openings at both ends.	Fencing to be installed as part of the works. Contractor to protect exposed edge before undertaking any inspection during construction.	Contractor and asset maintainer to implement safe systems of working.	N	31/01/2018	Imtiaz Mulla
002	Construction	Allerdene Culvert (Proposed Works)	Exposure to risks associated with working directly adjacent to live traffic.	Contractor	The culvert extension options results in most of the construction activities being undertaken below existing carriageway level. This limits conflict with live traffic on the A1.	Use of temporary traffic management in form of contra flow needed to create safe work areas.	Risk not completely eliminated as some works will be required at the A1 carriageway level to widened the carriageway. Define contraflow requirements within TM plan.	Y	31/01/2018	Imtiaz Mulla
003	Construction	Allerdene Culvert (Proposed Works)	Collapse of the existing structure during culvert extension works.	Designer	Designer to check capacity of existing structure to take any additional surcharge loading as part of the temporary works including construction traffic.	Where required, propose temporary propping or strengthening to existing arch culvert.	Designer to check existing arch structure capacity and confirm limitations to contractor.	Y	31/01/2018	Imtiaz Mulla
004	Construction	Allerdene Culvert (Proposed Works)	Collapse of temporary works.	Contractor	Temporary works design to be carried out by a competent contractor including independent design check. Designer to confirm proposed methods of working and adequacy of temporary works design especially in relation to the effect on the permanent structure.	Temporary sheet piles to be installed to retain existing earthworks during culvert construction. All earthwork slopes to be benched back minimum 1:2 gradient. Geotech engineer to confirm contractor proposals acceptable. The Contracor shall determine the requirements for Type P and S temporary works in accordacne with BD2/12 and ensure the TAA reqwuirements are satisfied accordingly.	Contractor to set up a safe system of work to enable construction of extension to be carried out.	Y	19/02/2019	Imtiaz Mulla
005	Construction	Allerdene Culvert (Proposed Works)	Founding structure on old coal seams, potential undermining of foundation leading to collapse.	Designer	Grouting shallow coal mining may be required for improved stability of the structure.	Information from the Geotechnical Investigation to be used to confirm if grouting will be required.	Note on drawing.	N	31/01/2018	Imtiaz Mulla
006	Construction	Allerdene Culvert (Proposed Works)	Damage to existing statutory undertaker services.	Contractor	Statutory undertaker's searches/consultation to be undertaken prior to detailed design (on-going). This is to enable requirements for diversion/protection to be determined. This should be reviewed by contractor prior to undertaking works.	Area to be scanned by trained and competent contractor. Contractor to locate all services using hand tools before mechanical excavation can commence. Contractor to also liaise with statutory undertakers/LHA and the HE maintenance service providers to locate all services prior to undertaking piling or any excavation works. Contractor to implement safe system. All excavation to be examined prior to use.	Appropriate note/reference to be put on drawings relating to service location at detailed design	N	31/01/2018	Imtiaz Mulla
007	Maintenance	Allerdene Culvert (Proposed Works)	Inspection/Maintenance Access	Contractor	Size of the proposed culvert extension is bigger than the existing and will allow man entry for inspection/maintenance purposes. A significant portion of the existing culvert is to be 'opened' up upon construction of the new alignment to minimise overall length of structure.	Only trained personnel (confined spaces) to be allowed entry inside culvert with correct PPE and apparatus.	Maintaining contractor to establish a safe system of working. Where possible, consideration should be give to inspection via CCTV methods to eliminate man access altogether.	N	31/01/2018	Imtiaz Mulla
008	Construction	Allerdene Culvert (Proposed Works)	Collapse of Structure Extension	Contractor	Backfill to proposed structure extension to be carried out evenly and in a staged method in accordance with manufacturer guidelines. Construction method to be detailed on drawings.	Work to be carried out by a trained and competent contractor. Contractor to implement safe system of working.	Contractor to set up a safe system of work to enable construction of extension to be carried out. Risk to be highlighted on drawings.	N	31/01/2018	Imtiaz Mulla
009	Construction	Allerdene Culvert (Proposed Works)	Working adjacent to watercourse	Contractor	Watercourse to be temporarily diverted to the existing ditch during construction works by means of water pumped through pipes placed in the existing culvert. Construction method to be detailed on drawings.	Watercourse to be temporarily diverted to the existing ditch during construction works. Work to be carried out by a trained and competent contractor. Contractor to implement safe system of working.	Contractor to set up a safe system of work to enable construction of extension to be carried out. Risk to be highlighted on drawings.	Y	31/01/2018	Imtiaz Mulla
010	Construction	Allerdene Culvert (Proposed Works)	Working adjacent to environmentally sensitive areas	Designer	Environmental risks to be highlighted in the environmental constraints plan/risk register.	Contractor to review environmental constraints plan/risk register and plan work accordingly together with establishing a safe system of working.	Contractor to set up a safe system of work to enable construction of extension to be carried out. Risk to be highlighted on drawings.	Y	19/02/2019	Imtiaz Mulla
011	Construction	Allerdene Culvert (Proposed Works)	Demolition of existing culvert	Contractor	Demolition works to be carried out by a competent contractor. Designer to confirm proposed methods of working.	Work to be carried out by a trained and competent contractor. Contractor to implement safe system of working.	Contractor to set up a safe system of work to enable construction of extension to be carried out. Risk to be highlighted on drawings.	Y	26/07/2018	Imtiaz Mulla/ Michail Tziolas

Appendix G

WSP/HE KEY CORRESPONDENCES

highways england

APPENDIX G-1

WSP/HE KEY CORRESPONDENCES

APPROVAL IN PRINCIPLE	Name of Project:	A1 Birtley to Coalhouse
(Bridges and other Highway Structures)	Name of Bridge/Structure:	Allerdene Culvert
	Structure Ref No:	/A1//443.00/Q

Safety Engineering & Standards (SES) Record Sheet

		Comments Sheet Document Control			
		Comment sheet version	**Date HA comment sheet**	**Date Designer's reply sent**	**Notes**
Document Ref	HA551462-WSP-SBR-MN001-RP-CB-0001	**A**	05/03/2018	16.03.2018	
		B	20/03/2018		
SOR version	Structure Option Report Allerdene Culvert	**C**	04/10/2018	21/11/2018 Further responses 19-02-19	
		D			
AIP Date	-	**E**			

No	**Section**	**Initial comment (HE response) and further comments on Designer's reply**	**Designer's reply**	**Accepted by HE**
1	General	Why such shallow slope is proposed at this stage? This slope gradient would result in large land take and costly earthworks. Is the drawing showing 1:3 or 1:4 slope?	Current proposed slopes are 1:3 in line with the rest of the proposed embankment. Without a known source of material for the embankment, it has been deemed to be too restrictive to steepen up the embankment as a whole. Localised steepening could be included, although the benefits are limited. The culvert is not perpendicular to the embankment, so slope gradients appear	20/03/2018

			shallower on the longitudinal section.	
2	General	Existing culvert - SOR (3.1.4) states that the retained section will be subject to extra 2m surcharge load from the new embankment's fill. The drawings seem to suggest that this is only the case over the section of the culvert that is currently located within the footprint of the existing embankment's slope and that the total as-built fill depth should not exceed the maximum depth over the existing structure. If this is correct, please consider incorporating into the report.	Noted, and will consider rewording. However, this statement is leading up to 3.1.5, providing explanation as to why 9.5m of culvert is proposed to be trimmed back. The additional load on the existing embankment slopes couldcause additional settlement of that section of the existing culvert being retained. If it is to be removed completely then this comment would no longer apply.	20/03/2018 Complete removal of existing culvert is now proposed, please amend SOR.
		Please provide amended version of the SOR so this comment can be closed.	SOR now updated to close comment.	04/10/2018
3	General	It appears that the assumption of 1:3 slope provision results in the need to retain section of the existing culvert. SOR states that it would be beneficial to consider replacement of the whole structure but does not state that the need to retain part of the existing structure is directly associated with the assumed slope gradient. From the drawings included in the SOR it would appear that re-profiling locally to 1:2.5 gradient combined with say 15-20m of trimming back of the existing culvert and slightly larger headwall would allow for complete reconstruction of the existing culvert. Please consider incorporating into the report.	Following our meeting on 13/03/2018, it was agreed that steepening the embankment slopes alone would not allow full removal of the existing culvert. However, we will review the temporary works that would be required to remove it entirely and assess whether these can be built into the permanent works of the proposed embankment. In combination with an extended headwall and temporary sheet piling of the existing embankment, this may be feasible.	20/03/2018 Complete removal of existing culvert is now proposed, please amend SOR.
		Please provide amended version of the SOR so this comment can be closed.	SOR now updated to close comment.	04/10/2018
4	General	The connection details between old and new sections	This has been included on the basis that ground	20/03/2018 Complete

		– is this achievable giving different settlement rates between the existing and proposed structure, lack of structural connection (grout only) and maintenance issues? Please include information about anticipated settlements between existing and proposed structures.	improvement (or measures to limit settlements) are required as part of the widerembankment, and including the culvert location. To be reworded following discussions in our meeting on 13/03/2018. If the existing culvert can be removed completely then this comment would no longer apply.	removal of existing culvert is now proposed, please amend SOR.
		Please provide amended version of the SOR so this comment can be closed.	SOR now updated to close comment.	04/10/2018
5	General	For proposed structure and piled foundation, was consideration given to forces caused by settlement of the new embankment (negative skin friction, extra pressure etc)?	This has been included on the basis that ground improvement (or measures to limit settlements) are required as part of the wider embankment, reducing the down drag from settling ground. To be reworded following discussions in our meeting on 13/03/2018.	See below
		The option selection seems inconsistent in the sense that for option A and B any necessary ground improvement is not included and therefore assumed to form part of embankment works and for option C the piles are assumed to provide mitigation against settlement. For Option C, no consideration is given to the extra soil pressure on arch, negative skin friction on piles etc. or heave of ground inside the arch (no RC slab	Shall be reworded to state necessary ground improvement will be provided as part of the embankment work and options assessed assuming settlements are taken care of as part of the approach embankment design. 19-02-19 The above statement has been repeated within various sections of the report.	

		provided) due to adjacent settlement suggesting that the ground improvement to mitigate settlement is also assumed over the embankment area therefore removing the need for pilled foundation. The scoring is the skewed towards showing benefits of piles for Option 3 mitigating settlements and reducing the need to resurfacing where in fact the settlement will most likely be mitigated by soil improvement under the embankment. Why no general assumption has been made that the necessary ground improvement will be provided as part of the embankment work and the options assessed assuming settlements are taken care of as part of the approach embankment's design?		
6	General	Was consideration given to the integrity of the culvert (including gradient) when subject to ongoing settlement?	Refer to response to comment 4.	20/03/2018
7	2.3.1	Please update PI/ GI list. Most recent GI is dated 21/06/2016. Where the references past 08/11/2004 are taken from as there are not on SMIS.	Notedand shall be updated accordingly. References for inspection dates prior to 2004 were taken from the 2014 GI report (though it is acknowledged these are currently not on SMIS and have been provided for information purposes only).	Please see comment below
		PI/GI list not updated	Noted and shall be updated accordingly. 19-02-19 Inspection schedule updated	

8	2.5	Please refer to the most recent GI here.	Noted and shall be updated accordingly.	Please see comment below
		It has not been updated. Amend to reflect current proposal. Para. 2.5.2 seems to be from the previous revision of SOR. Please amend.	Noted and shall be updated accordingly. 19-02-19 paragraph revised on the basis existing culvert not being retained	
9	3.1.4	Is the extra 2m surcharge an issue for this type of construction? At this depth, it's mostly static load and the surcharge would increase radial stress but the steel plate is usually quite robust. Other sections of the same culvert performed well under similar load. Where necessary for structure to be retained, an assessment should be carried out to determine the type of the existing culvert (including thickness) and capacity. Please consider including into the report.	The additional load on the existing embankment slopes will cause additional settlement of that section of the existing culvert being retained. If it is to be removed completely then this comment would no longer apply. Noted, and shall be updated accordingly to state requirement for a structural assessment.	20/03/2018 Complete removal of existing culvert is now proposed, please amend SOR.
		Please provide amended version of the SOR so this comment can be closed.	SOR now updated to close comment.	04/10/2018
10	3.2.1	Please add information that this is closed box. Are the pre-cast segments mechanically connected? How wold it respond to the differential settlement caused by the new embankment?	Noted and shall be updated accordingly to state closed box construction. The precast segments shall not be mechanically connected. Step joints shall be used with a suitable sealant in between as per manufacturer guidelines. Refer to response to comment 4.	04/10/2018 Clause not amended however drawings shown closed box so accepted.

11	3.4 & 4.4.2	Please explain why preliminary proposal for Option C requires pilled foundation and for option A does not? See also comment to Option C drawing – floor slab is required there that is currently missing.	Piles were selected for Option C (corrugated arch) to minimise settlement of the pilecapand also sustain the horizontal thrust imposed by the arch superstructure. Floor slab shall be shown on the drawing for option C. 19-02-19 Reference to the requirement for a floor slab (subject to detailed design) provided on the Option C GA	20/03/2018 Please see further comment to 17
		Floor slab not shown. The granular bedding material will not perform well in case of settlement or heave caused by adjacent abutment's settlement. Horizontal thrust form arch will result in laterally loaded piles i.e. large diameter required.	19-02-19 Reference to the requirement for a floor slab (subject to detailed design) provided on the Option C GA	
12	4.2.1	Error! Reference source not found… - please amend.	Noted, cross-reference to be amended.	04/10/2018
13	4.3.1	Table 4-1 indicates high risk of instability caused by shallow mine workings however the workings are probably -50m bgl in the Pennine Middle Coal Measures bedrock. What is the extent of the proposed SI from the c/c of the proposed culvert and is such significant investigations really necessary for a culvert foundation? Why can't Allerdene Bridge SI be used for this structure (due to proximity)?	Noted, this should be a medium risk. However, worked coal seams are anticipated within 10x seam thickness of rockhead. As such, the benefit gained from the overlying cohesive superficial deposits needs to be assessed as part of the Coal Mining Risk Assessment. The SI is for the embankment as a whole, rather than the culvert specifically.	Please respond to comment below so it can be closed.

		Please add note to clarify the SI covers the entire embankment area.	19-02-19 Reference made to the SI covering the wider extent of the embankment. Note the ground investigation section of the report has been updated to reflect the additional SI information	
		(new numbering 3.2.1) - risk rating not updated since last revision. Please amend to reflect your response above.	19-02-19 Risk rating table updated to align with the latest SI information	
14	5.2.2	In the second part of Buildability paragraph: "..and simple foundations in comparison with Option B" – should this be Option C?	Noted, and shall be updated accordingly. 19-02-19 Note the comparison section of the report has been reviewed and updated to reflect the HE SES comments and SI information. The preferred option is now Option B – Corrugated Pipe with ground improvement to the wider embankment	04/10/2018

15	5.2.3	It would be worth adding in this document which option is considered best from differential settlement point of view as this is a significant risk. Are the settlements considered when recommending preferred option? Is the likely magnitude of settlement known at this stage? Currently there is nothing in this document to that effect.	Noted, however this has been written on the basis that ground improvement (or measures to limit settlements) are required as part of the wider embankment, including the culvert location. As such, differential settlement would be managed as part of these works. To be reworded following discussions in our meeting on 13/03/2018.	Please respond to comment below so it can be closed.
		Please include statement that this document has been written on the basis that suitable ground improvements (or measures to limit settlements) are required as part of the wider embankment design.	19-02-19 Noted similar statement has been repeated at various sections of the report	
16	Appendix E	Options A-C - general Note 1 refers to bridge – is this correct?	Typo – shall be amended accordingly.	Please respond to comment below so it can be closed.
		Typo not amended.	Typo now amended.	.
		Option B –construction sequence should be removed from the drawing as it's now shown separately.	Construction sequence now removed.	
		Option C – slab not shown hence piles loaded horizontally due to thrust from the arch.	Floor slab shall be shown on the drawing for option C. 19-02-19 Reference to the requirement for a floor slab (subject to detailed design) provided on the Option C GA	

		All options – some residual risk not shown on the drawings for example: buried services, lack of GDR, potential soil stabilisation works (DAR 6-8).	All residual risks shall be identified and stated on GA drawings. 19-02-19 DRA has been reviewed and updated, All outstanding residual risk have been referenced on the option GAs and typical construction sequence drawing.	
17	Appendix E	Option C – section B-B - the arch is supported on piled foundations but there should be slab forming floor of the proposed culvert extension as well. This will in essence provide similar floor footprint to Option A which raises question why piles are selected for this option?	Floor slab shall be shown on the drawing for option C. Refer to response to comment 11. 19-02-19 Reference to the requirement for a floor slab (subject to detailed design) provided on the Option C GA	Please respond to comment below so it can be closed.
		With the floor slab now proposed and acting as restraint to the horizontal thrust from the arch and with the ground improvement (or measures to limit settlements) required as part of the wider embankment design are the piles still considered necessary?	19-02-19 SOR has been updated based on the latest SI and the preferred option inclines towards close Option B Corrugated pipe structure no piled foundations. The corrugated arch structure with pile foundation remains as another option for comparison purposes	

		Floor slab not shown – see further comment 11 above.	Refer to comment 11 response. 19-02-19 Reference to the requirement for a floor slab (subject to detailed design) provided on the Option C GA	
18	Designer's Risk Assessment	004 – this should be either type S or P temporary works (please state which type) and in both cases the PW Designer needs to endorse the TW design with regards to the permanent structure. Contractor appears not to be the owner here. Please consider amending.	Noted, shall be amended/reworded.	See below.
		Not amended/ reworded.	DRA shall be amended to address comment. 19-02-19 Reference to the requirement for type P and S temp work design in accordance with BD2/12 has been highlighted on the DRA	
19	Designer's Risk Assessment	005 – the weight of the structure itself is of little relevance to the overall settlement. It's rather the combined weight of the proposed embankment over the area that was not subject to surcharge load that might cause the problem, especially giving the alluvium deposits. When recommending design action (piled foundation) – was consideration given to the negative skin friction and extra load imposed onto the structure and foundation due to settlement of the	Noted, to be amended/reworded. Refer to response to comments 4 & 5.	See below.

		embankment (as caused by consolidation of the soil below) vs. the relatively rigid piles?		
		Not amended/ reworded.	DRA shall be amended to address comment. 19-02-19 DRA has been reviewed and updated, All outstanding residual risk have been referenced on the option GAs and typical construction sequence drawing. Some of the risk previously referred have been removed as not considered applicable	
20	Designer's Risk Assessment	006 – was geotechnical engineer consulted regarding this risk? Is such deep SI and potential grouting really required to secure foundation for a culvert?	Refer to response to comment 13. 19-02-19 DRA has been reviewed and updated, All outstanding residual risk have been referenced on the option GAs and typical construction sequence drawing. Some of the risk previously referred have been removed as not considered applicable	20/03/2018
21	Designer's Risk Assessment	008 – where are these pipes shown on the drawings? Are these drainage pipes part of a larger system or simply weep holes?	Correct, these are simply weep holes which alleviate pore water pressures behind the headwalls. Existing drawings shall be updated to show locations of the weep holes.	See below.

		Drawings and DRA not updated.	Drawings and DRA shall be amended to address comment. 19-02-19 DRA has been reviewed and this include the removal of risk 008, therefore updates to drawings not required.	
22	Designer's Risk Assessment	011 – how is the water proposed to be diverted during the works? Both this register and the drawings refer to 'diverting' the water - is it done by means of pumping water through pipes placed into existing culvert?	Correct, the water shall be diverted by means of water pumped through pipes placed in the existing culvert. This shall be amended/reworded to provide clarity.	04/10/2018 Accepted – shown on construction sequence on separate drawing.
23	Designer's Risk Assessment	012 – Should this not be part of designer's responsibility? How safe system of work is supposed to help mitigate this? What risks are to be shown on the drawings? Consider rewording.	Noted, to be amended/reworded to provide clarity – the Environmental constraints plan/risk register shall be made available to the contractor and relevant risks identified on the drawing SHE box.	See below.
		DRA not amended.	DRA shall be amended to address comment. 19-02-19 DRA has been updated accordingly	
24	Designer's Risk Assessment	007 - the risk refers to HA – it should be HE.	Noted, to be amended/reworded.	See below.
		DRA not amended.	DRA shall be amended to address comment. 19-02-19 DRA has been updated accordingly	
25	Designer's Risk Assessment	008 – Design action – should this not be referring to permanent as well as temporary solution?	Noted, to be amended/reworded.	See below.
		DRA not amended.	DRA shall be amended to address comment.	

			19-02-19 DRA has been reviewed and this include the removal of risk 008, therefore updates to drawings not required.	
26	General	For information - section 3 and 4 now reversed so the previous comments made to section 3 now refers to section 4 and vice versa. Where (new numbering) suffix is added it refers to numbering on this SOR revision.	Noted.	04/10/2018
27	1.3	Is the planned consultation date and planned start of work on site still valid?	19-02-19 Section 1 introduction updated to reflect latest the latest development of the scheme	
28	3.1 (new numbering)	Is this preliminary ground model still current or is there more up to date SI information? HE is aware that there has been some recent development in terms of Geotechnical Risk Register for this area. Should this not be incorporated into this submission?	Section shall be updated following recent developments in the SI works. 19-02-19 Reference to the SI coving extent of embankment provided. Note the ground investigation section of the report has been updated to reflect the additional SI information	
29	3.4.1, 3.4.3, 3.4.4, 3.4.6, 3.4.7 etc. (new numbering)	Please review section 3.4. The wording refers to section of existing culvert to be left in situ and resulting differential settlements yet clause 3.4.7 seems to suggest that new culvert is proposed to de-risk it. Please reword to avoid confusion.	Noted. Shall be reworded to remove reference. 19-02-19 Section 3.4 re-drafted for clairty	
30	4.4.5 (new numbering)	Given lack of GDR and the issue of interaction with proposed earthworks it appears that all the options should share the same assumptions about foundation design.	Indicative cost of piled foundation shall be included.	

		As a minimum, please show the cost of pilled foundation (Option C) separately to demonstrate the potential cost implications. Otherwise it's difficult to compare between these three options with this SOR biased towards Option C.	19-02-19 SOR has been updated (including section 4) based on the latest SI and the preferred option inclines towards close Option B Corrugated pipe structure no piled foundations.	
31	General	This document still refers to 'culvert extension' and 'existing culvert' throughout. This is confusing as new culvert is proposed over the existing culvert section. Fee for example 4.3.1 (new numbering). Please reword.	Noted. This shall be reworded. 19-02-19 SOR has been updated (including section 4) based on the latest SI and the preferred option inclines towards close Option B Corrugated pipe structure no piled foundations.	
32	4.3.3 (new numbering)	This paragraph refers to underside of an arch, does it mean pipe? Is the back and bedding surround included in pricing?	Shall be updated with correct reference to pipe. 19-02-19 SOR has been updated (including section 4) based on the latest SI and the preferred option inclines towards close Option B Corrugated pipe structure no piled foundations.	
33	4.4.2	Lack of slab means piles are loaded horizontally due to thrust form the arch. Why slab is not provided as already discussed above?	GA drawing will be amended to show floor slab. 19-02-19 Reference to the requirement for a floor slab (subject to detailed design) provided on the Option C GA	

34	5.2	Risk and scoring: WLC – scoring only valid assuming the piles mitigate settlement and the arch performs satisfactorily but if ground improvement is required under the embankment anyway then the piles might be designed-out resulting in cost savings. Construction programme – ditto. Disruption to traffic – without improvement to soil under the embankment Option C creates '*hard spot*' and would probably result in severe deformation to the structure due to the anticipated circa 1.0 m settlement. Such settlement would cause the need to resurface the entire new section of the road simply because of the ongoing consolidation.	Noted. Scoring shall be updated to reflect comments. 19-02-19 Note the comparison section of the report (section 5) has been reviewed and updated to reflect the HE SES comments and SI information. The preferred option is now Option B – Corrugated Pipe with ground improvement to the wider embankment	
35	General	Please consider removing piles for option C and include assumption that ground improvement is required over the entire footprint area of the approach embankment as already stated in 5.2.4 and 6.2.2.	Noted and section to be updated accordingly. Refer to comment 5 response. 19-02-19 Note the comparison section of the report has been reviewed and updated to reflect the HE SES comments and SI information. The preferred option is now Option B – Corrugated Pipe with ground improvement to the wider embankment	

36	6.2.3	Please consider including information that subject to further geotechnical analysis and potential ground improvements under the embankment area, the piles in option C might become obsolete. The reduction in slope gradient from 1:3 to 1:2 (and resulting reduction in culvert length) is possible if the settlements can be controlled and reduced and that in turn is possible if either a) the assumptions about the existing ground model is overly conservative b) some remedial work to the soil beneath is proposed.	Noted and section to be updated accordingly. Refer to comment 5 response. 19-02-19 Note the comparison section of the report has been reviewed and updated to reflect the HE SES comments and SI information. The preferred option is now Option B – Corrugated Pipe with ground improvement to the wider embankment	
37	Construction sequence	Step g&o – this refers to corrugated steel pipe unit but it should be generic. Please amend. Step j - water allowed through the culvert before new section to the north is reconstructed – is this correct? Step l - should this not be after step 'm'? Last step should be to backfill to achieve the 'in service embankment profile (from reduced to the north face).	Construction sequence to be updated to address comments. 19-02-19 Construction sequence has been amended to align with the comments	
38	General	The recent Geotechnical Risk Register Item 8 suggests that in addition to soil improvement under the embankment pilled foundations for the culvert with transition zones either side should be considered. This SOR only considers pilled foundations for Option C causing inconsistency in option selection and pricing. As per comments above, please consider separating these two issues and either a) include any potential pilled foundations	Noted and section to be updated accordingly. Refer to comment 5 response. 19-02-19 SOR has been updated based on the latest SI and the preferred option inclines towards close Option B Corrugated pipe structure no piled foundations.	

		and transition zones within the overall ground improvement under the embankment with note added to cover this. b) or show indicative cost of pilled foundations for each option including breakdown between structure and foundations cost and note that it's dependant on the whole embankment stabilisation scheme.		

The pertinent HE SES queries appear to relate to the risks associated with settlement and in particular differential settlement between the existing and new culvert section.

Upon reflection, to minimise these concerns it is proposed that the existing culvert be replaced it its entirety. This will require a phased construction sequence, which could take the form of the outline sketches that includes.
Phase 1: Ground Improvement (suitable system) and construction of the new CSBS culvert extent beneath the new A1 embankment, traffic to be maintained on the existing A1 alignment during this period. The method, depth and extent of ground improvement is to be assessed in more detail as part of the embankment design, taking into account the potential impact on the surrounding infrastructure (including the East Coast Mainline). The decision on ground improvement will be governed by whether the settlements are to be accelerated (e.g. with band drains) or limited (e.g. with CMCs) will have an impact on the design of the culvert.
Phase 2: Period of surcharging to the new embankment (period TBC, depending on the type of ground improvement) to limit the extent of the post-construction settlement prior to pavement construction and switching of traffic onto the new alignment.
Phase 3: Removal of the existing A1 embankment and construction of the final section of the culvert. It is considered the risk of settlement for this section of the culvert construction is reduced as it will be constructed on the footprint of the existing embankment which has already consolidated.

In principal the structural form of the culvert (CSBS) could then be agreed to allow the SOR to be closed. However the SOR would state that further investigation/analysis is required with the support contractor/HE SES to confirm the following prior to detailed design:

- Ground improvement to be applied – Will require contractor input to confirm cost/programme implication
- Suitable construction sequence taking account of the ground improvement/surcharging required to limit the impact of settlement
- Review of the construction programme and traffic management taking account of the above.

19-02-19 In general the report has been reviewed to incorporate the previous HE SES comments and also include reference to the latest SI. Based on the further review of the information available to date and the additional assessment undertaken since the previous report issue, the preferred structural form for the replacement culvert inclines towards a buried corrugated pipe structure (no piled foundations).

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