DATED 2022

BIRMINGHAM CITY COUNCIL

- and -

CANAL & RIVER TRUST
ACTING AS TRUSTEE OF THE WATERWAYS INFRASTRUCTURE TRUST

DEED OF AGREEMENT in respect of Lee Bridge, Birmingham

INDEX

THE DEED is made on day of 2022

BETWEEN:-

(1) **BIRMINGHAM CITY COUNCIL** of the Council House, Birmingham, B1 1BB ("the Council")

(2) **CANAL & RIVER TRUST** a charity registered with the Charity Commission no. 1146792-2 and a company limited by guarantee registered in England and Wales no. 7807276 ACTING AS TRUSTEE OF THE WATERWAYS INFRASTRUCTURE TRUST whose registered office is at National Waterways Museum Ellesmere Port, South Pier Road, Ellesmere Port, Cheshire, England, CH65 4FW ("the Trust")

WHEREAS

(A) The Council is the highway authority for Birmingham and proposes to carry out the Improvement Scheme and in doing so is an undertaker for the purposes of the New Roads and Street Works Act 1991

(B) The Trust is the national body responsible for inland waterways.

(C) The Trust enter into this agreement insofar as they have the rights and interests required to do so and the Trust do not warrant or claim that they have any registered title right and registered interest in the Bridge

(D) The Bridge passes over the inland waterway known as Birmingham Mainline Canal and the public highway known as A457 Dudley Road runs over the Bridge

(E) The Trust is agreeable to the Council carrying out the Improvement Scheme subject to the parties entering into this Deed in order to clarify the extent of their respective liabilities in relation to the maintenance of the Bridge

(F) For the avoidance of doubt, the Council shall comply with the Trust's Code of Practice for Works Affecting the Canal & River Trust save for the requirement to enter into a deed of indemnity

NOW THIS DEED WITNESSES as follows:-

1. **STATUTORY PROVISIONS**

This Deed is made pursuant to the provisions of the Localism Act 2011, the Transport Act 1968, the New Roads and Street Works Act 1991, the Highways Act 1980 and all other powers enabling which may be relevant for the purpose of giving validity hereto or facilitating the provisions herein contained

2. **INTERPRETATION**

2.1 In this Deed in addition to the parties hereinbefore referred to the following words and expressions shall where the context so requires or admits have the following meanings:-

"Act"	the Transport Act 1968 (as amended)
"AECOM Report"	the Lee Canal and Aberdeen St and Dudley Road A457 (RBS2 10) Bridges Strengthening Options Report dated 13 July 2022 annexed hereto as Appendix 2
"Bridge"	the bridge known as Lee bridge including the bridge's arch, backing, spandrels, abutment and wingwalls as shown edged red on the Location Plan
"Improvement Scheme"	the works to be carried out by the Council as part of the Dudley Road Highway Improvement Scheme as set out in the AECOM Report
"Location Plan"	the plan annexed hereto as "Appendix 1"

2.2 In this Deed where the context so requires:-

2.2.1 the singular includes the plural and vice versa

2.2.2 references to clauses schedules and paragraphs are references to clauses schedules and paragraphs in this Deed except where otherwise specified

2.2.3 title headings to the clauses schedules and paragraphs are for convenience only and shall not affect the interpretation of this Deed

2.2.4 references to any statute or statutory instrument shall except where otherwise specifically provided include reference to any statutory modification or re-enactment thereof for the time being in force

2.2.5 the expression the "Trust" shall include successors in title to the Trust and its assigns

3. **<u>COMMENCEMENT</u>**

The provisions of this Deed shall have immediate effect upon the completion of this Deed

4. **<u>DECLARATION</u>**

4.1 The Council and the Trust agree that:

4.2 The Trust are a “Board” as defined for the purposes of section 159 and section 117(1) of the Act.

4.3 Section 117 of the Act sets out the statutory duty in respect of the maintenance, improvement or strengthening of bridges carrying highways over inland waterways and is applicable to the Bridge.

4.4 Section 117(2) of the Act places a duty on the Trust to maintain and if necessary, to improve or strengthen the Bridge so that it has the required load-bearing capacity.

4.5 Section 117(3) of the Act confirms (in part) that a bridge has the required load-bearing capacity if it is capable of bearing the weight of the traffic which ordinarily uses, or may reasonably be expected to use, the highway carried by a bridge on or about the day on which section 117 came into force in relation to bridges of the Board concerned or, if a bridge was constructed subsequently, when it was opened for traffic.

4.6 Section 117(3) came into force on 1 January 1971 and the parties agree that the Bridge was in existence prior to this date.

4.7 The parties agree that the required load-bearing capacity for which the Trust is responsible for the purposes of Section 117 of the Act is set out in the Department of Transport (DfT) Circular 2-91, which confirms that (apart from bridges built or reconstructed since the Act came into force) the Trust have to maintain highway bridges vested in them to the Department’s former standard known as BE4. The parties agree that the Trust’s responsibility is to maintain the Bridge to a standard suitable for the traffic which ordinarily uses the Bridge or may reasonably be expected to use the Bridge on or about 1 January 1971, through the application of the BE4 standard.

4.8 The parties agree that it shall wholly be the responsibility of the Council to maintain and if necessary, to improve or strengthen the Bridge over and above the required load-bearing capacity set out in the BE4 standard, so as to bear the weight of the traffic which shall ordinarily use the Bridge following the completion of the Improvement Scheme.

4.9 The Council has consulted the Trust before giving notice in accordance with section 55 and section 88 of the New Roads and Street Works Act 1991 in relation to the commencement of the Improvement Scheme.

4.10 The parties agree that the Council shall comply with the Trust's "Code of Practice for Works Affecting the Canal & River Trust" dated April 2022 as updated from time to time and the Approval in Principle for the strengthening of the Bridge when undertaking the Improvement Scheme

5. ARBITRATION

In the event of any dispute or difference arising out of this Deed between the parties (other than a dispute or difference relating to a matter of law or concerning the meaning or construction of this Deed) such dispute or difference shall be referred to a sole arbitrator to be agreed between the parties and being a member of the Royal Institution of Chartered Surveyors or in the absence of agreement on the application of any party by the President of the Royal Institution of Chartered Surveyors and in these respects these presents shall be construed as a submission to arbitration within the meaning of the Arbitration Act 1996

6. CONTRACTS (RIGHTS OF THIRD PARTIES) ACT 1999

It is hereby agreed and declared that unless specifically agreed the Contracts (Rights of Third Parties) Act 1999 shall not apply to this Deed

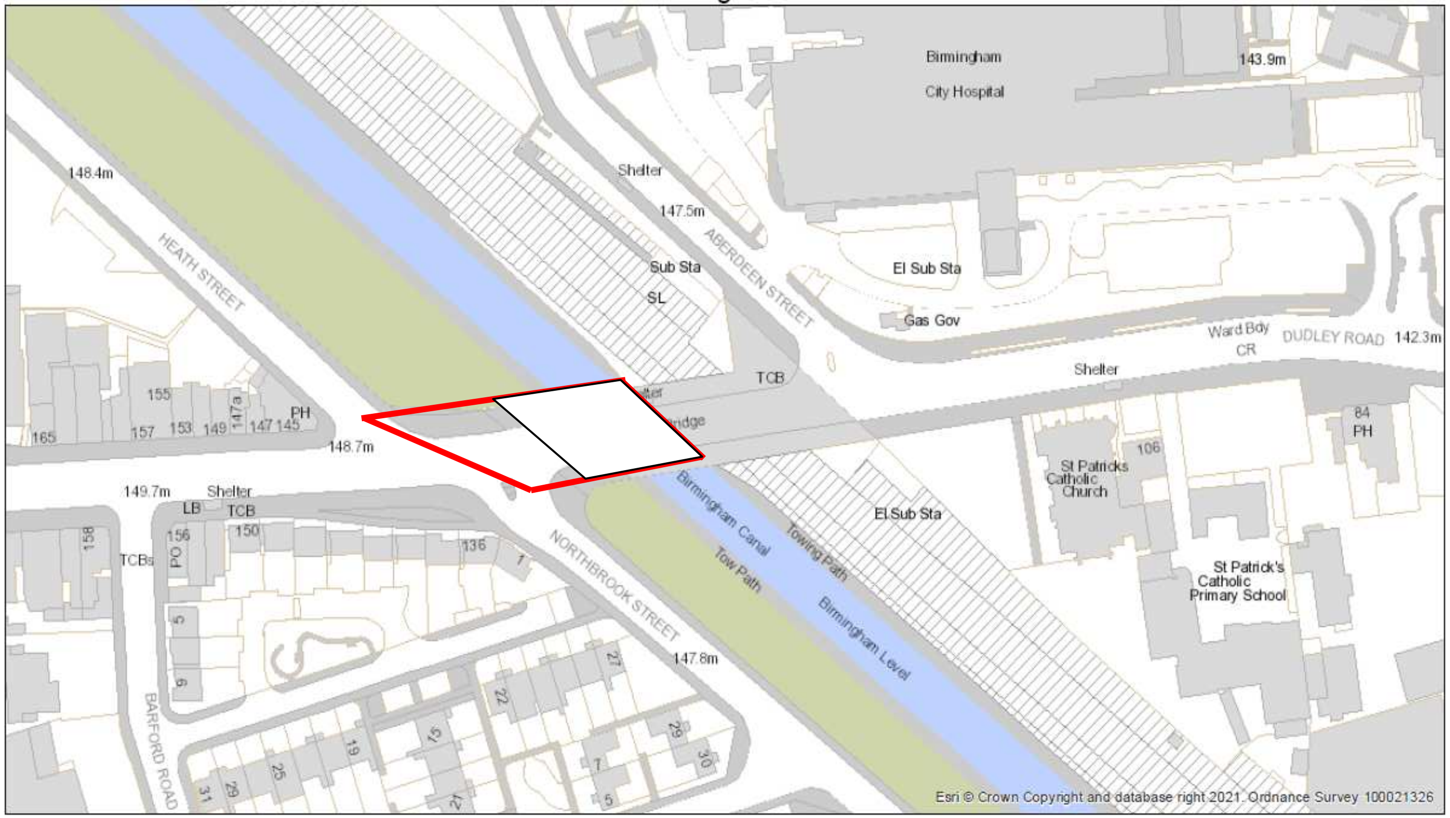
7. JURISDICTION

This Deed is governed by and interpreted in accordance with the Law of England.

APPENDIX 1

Location Plan

Lee Bridge



Birmingham City Council

Date of Map Creation: 10/11/2021

Map Created By:

Scale: 1:1,250

N

APPENDIX 2

AECOM Report

A457 Dudley Road Improvement Scheme

Lee Canal and Aberdeen St and Dudley Road A457 (RBS2 10) Bridges
Strengthening Options Report

Birmingham City Council

Project number: 60680804
60680804-REP-OPTION-0001

13 July 2022

1 Lancaster Circus,
Queensway,
Birmingham
B4 7DJ

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Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
A	13/07/2022	For Comment		Nick Coxhill	Project Manager

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1. Introduction

1.1 Background

Birmingham City Council (BCC) intends to widen the carriageway on the A457 Dudley Road to reduce congestion and provide improvements for public transport together with improved pedestrian and cycling facilities. This will assist the wider growth taking place along the corridor along with development sites in Sandwell.

As part of the scheme development, the affected structures were subject to assessment by AECOM (under previous, separate commission) to determine their capacity to withstand the load effects from the revised highway alignment. Spring Hill bridge and the Northbrook Street footpath supporting structure were found to be adequate for the revised carriageway alignment. However, assessment of the Lee Canal Bridge and Aberdeen St and Dudley Road A457/RBS2 10 bridge (to be referred to as 'RBS2 10' hereafter) identified that whilst the arch barrels of both structures were adequate to accommodate the effects of 40/44t ALL/AV, the reduced footpath width resulted in increased load effects on the spandrel walls of up to 14% and 10% for the Lee Canal Bridge and RBS2 10 respectively. Whilst the latter was deemed acceptable subject to the implementation of repointing and subsequent monitoring of the spandrel walls prior to, during and following construction of the widening scheme, the increase in load effects to Lee Canal Bridge was deemed unacceptable and therefore necessitated mitigation.

An Initial Optioneering Report was produced by AECOM (Ref 1) which undertook a high-level optioneering study. Three options were identified as suitable for further consideration. These were:

- Replacement of the backfill adjacent to the spandrel walls with lightweight fill or concrete
- Extension of the existing slab beneath the carriageway
- Installation of pattress plates with discrete ground anchors

This initial optioneering report was limited to the Lee Canal Bridge only. However, owing to the requirement to implement strengthening of the Lee Canal Bridge, BCC have requested that consideration be given to extending the scheme to include RBS2 10 as an alternative to the aforementioned repairs and monitoring. Accordingly, this report shall consider options for strengthening of both bridges.

1.2 Structure Description

1.2.1 Lee Canal Bridge (Bridge No. BC-003-002)

Lee Canal Bridge is owned and maintained by The Canal & River Trust (referred to as 'the Trust' hereafter) and is a single span structure, carrying the A457 Dudley Road over the Birmingham Canal Main Line and towpaths. The structure is a brick multi-ring masonry arch with a skew span of 21.2m and skew angle of 41°. The arch barrel has a constant width with an abutment length of 31m. The plaque on the structure indicates it was constructed in 1826, consistent with the date of construction of the canal. The skew elevations of the arch are approximately elliptical with a rise from the springings to the crown of 5.05m. The arch is supported by brick abutments. The barrel, face rings and spandrels are all brick. The keystone, quarter points of the ring face and the skewback on the abutments are stone. The arch barrel is 580mm thick on both elevations and the combined thickness of fill and surfacing over the crown of the arch is circa 700mm. The thickness of the spandrel walls varies with depth between circa 500mm and 1250mm thick. They are capped with concrete copers, which are locally widened at the positions of the metallic parapet posts. The metal vertical infill parapet is a minimum 1.62m high from finished footway level.

A concrete slab is present beneath the surfacing of circa 260mm thickness. This slab extends laterally between the kerb lines. Investigations undertaken to inform pavement design (Ref 2) indicate that the slab extends for circa 200m and 900m to the east and west of the structure respectively. Accordingly, this concrete slab is considered part of the pavement construction and not intended as a ‘saddle’ or similar bridge strengthening measure.

1.2.2 Aberdeen St and Dudley Road A457 (RBS2 10)

RBS2 10 is a three-span structure, carrying the A457 Dudley Road over the Birmingham Bushbury Junction Rail Line. The structure is owned and maintained by Network Rail (NWR). The structure is a three-span brick arch bridge supported by brick and abutments founded on pad foundations. The total width between parapets is approximately 21.0m. Span 1, which crosses 2No. electrified tracks is skewed at 40 degrees and has a square span of 8.52m. Spans 2 and 3 supports are extended beyond those of Span 1 to enable the arches to span square whilst carrying a skewed carriageway. Spans 2 and 3 cross redundant ground and each have spans of 4.44m. The angle between the carriageway and span is approximately 40 degrees. The track span comprises a skewed arch barrel and the two adjacent disused track spans are square arch barrels.

Span 1 arch barrel is 560mm thick whilst Span 2 and Span 3 arch barrels are 450mm thick. The approximate fill depth (including surfacing) over Span 1 is 1.0m.

The parapets are brick with stone copings.

Span 1 was constructed as a widening to the Lee Canal Bridge at an unknown date. Given the available archive drawings it is likely that Spans 2 and 3 were constructed as a further widening circa 1888.

The concrete pavement slab discussed in Section 1.2.1 above is also present to RBS2 10.

2. Consultations and Requirements

2.1 Planning Requirements

Consultation associated with the wider scheme is being undertaken by BCC. Discussion within this report will be limited to that associated with the bridge strengthening only.

Neither Lee Canal Bridge nor RBS2 10 are listed structures. Strengthening options associated with extension of the existing pavement slab or replacement of backfill adjacent to the spandrel walls will not change the aesthetics of the structure. With the exception of the Technical Approval Authority acceptance discussed in Section 2.2 below, it is not expected that consultation with the public or third parties will be necessary. Should strengthening change the aesthetic of the structures, the structure owners may wish to seek advice from their respective heritage advisors and Birmingham City Council (BCC) should consider whether separate planning requirements become necessary.

It is noted that the Church of St Patrick, located approximately 40m to the east of RBS2 10 is a Grade II listed building. However, it is not envisaged that the proposed strengthening works will affect this structure.

2.2 Technical Approval Authority Acceptance

Lee Canal Bridge and RBS2 10 are owned and maintained by the Trust and NWR respectively. Accordingly, the strengthening proposals will be subject to acceptance by the respective Technical Approval Authorities. For Lee Canal Bridge, this is expected to comprise submission of an *Approval in Principle* (AiP) in accordance with CG 300 and associated design and check certificate, as well as a construction compliance certificate following the construction works. For RBS2 10, this is this is expected to comprise submission of a *Form A: Certificate of Approval in Principle*, followed by Form B*: Certificate of Design and Check for Permanent Works.*

3. Geology

Owing to the number of marked lanes remaining as two in each direction as part of the proposed realignment and the lightweight fill there is no significant increase in the total action effects. Additionally, the proposed strengthening measures do not significantly reduce vertical loading. Accordingly, the sub-structures were qualitatively assessed as adequate to accommodate the revised highway alignment as per CS 459.

Nonetheless, the loading of the spandrel walls and associated strengthening proposals will be considerably influenced by the geotechnical properties of the arch backfill material. Accordingly, a Geotechnical Investigation (GI) has been undertaken to inform this options study. The GI briefly comprised inspecting and sampling eight hand excavated trial pits and sinking five hand auger boreholes within selected trial pits. The associated report (Ref 3) provides detailed descriptions of the materials identified within the trial pits and boreholes. In summary, the backfill was found to comprise clayey, gravelly sand and sandy, gravelly clay.

4. Loading

4.1 Design Approach

To mitigate the additional load effects resulting from the narrowed footpaths, measures may be implemented which reduce or mitigate the additional load effects resulting from the carriageway widening relative to those in the existing alignment, for which the spandrel walls have been qualitatively assessed as adequate. Alternatively, the spandrel walls may be strengthened to accommodate the additional load effects.

Load mitigation options are generally considered to be preferable owing to the practical difficulties associated with the strengthening of spandrel walls and associated compliance with current standards, given the materials used in their construction and workmanship being non-compliant with current standards. Accordingly, where measures can be implemented which can be demonstrated to reduce the load effects on the spandrel walls in the proposed carriageway alignment to an acceptable level relative to those currently experienced, it is proposed that the spandrel walls be considered to remain adequate as per the previous qualitative assessment. The acceptable change in load effects on the spandrel walls shall be subject to agreement with the respective Technical Approval Authorities.

Should strengthening options be developed, it is proposed that these would be on the basis that the existing spandrel walls are adequate to withstand the applied load effects in the current road alignment and that strengthening be designed to withstand as a minimum, the additional load effects resulting from the changes to the road alignment.

4.2 Design Standards

Notwithstanding the intention to implement a consistent approach to Lee Canal Bridge and RBS2 10, separate design submissions will be made to the respective Technical Approval Authorities.

Works to Lee Canal Bridge and RBS2 10 will be designed in order to fully comply with DMRB and NWR standards respectively. Whilst detailed design criteria will be determined at AiP stage, it is noted that in order to fully comply with both CD 350 and NR/L2/CIV/020 strengthening or modification works would need to be undertaken in accordance with Eurocodes.

However, as discussed in Sections 7.1 and 7.2, outline calculations undertaken as part of this initial design development have identified that the use of Eurocode loading results in a significant increase in the necessary depth of excavations such that load mitigation options become impracticable. Accordingly, it is proposed that Departures from Standard be submitted as part of the AiP process, further discussion of which is given in Sections 7.1.8 and 7.2.8.

4.3 Abnormal Traffic Loading

In the absence of an existing assessment for SO or STGO vehicles being included within the archive information relating to Lee Canal Bridge and RBS2 10, it is presumed that such vehicles do not need to pass over the structure.

Should it be decided that there is a need for abnormal traffic passage in the future, then owing to the closer proximity of the traffic lanes to the spandrel and wing walls, load effects due to SO or STGO vehicles in Lane 1 would be increased in the proposed carriageway alignment. However, it may still be possible for the structure to carry abnormal traffic in the future by requiring such vehicles to straddle Lanes 1 and 2 or utilise Lane 2. In the absence of previous abnormal traffic passage, the passing of such vehicles would be subject to additional assessment. It is expected that this assessment would be based on comparing their effects in the revised configuration against the existing load effects.

4.4 Accidental Vehicle Loading

Accidental loading scenarios represent the most onerous loading applied to the spandrel walls, owing to the potential immediate proximity of the load to the traffic face of the spandrel wall.

Consistent with the recommendations of the previously undertaken IAN 97/01 risk assessments (Ref 4 and Ref 5) N1 containment trief kerbs will be provided (the design of which is being undertaken by others).

In accordance with CS 454, Clause 5.27.5 where there is a barrier in place that does not provide a higher containment or very high containment level in accordance with CD 377, such as the aforementioned trief kerb, the characteristic accidental vehicle loading is reduced to that from a single vehicle from ALL model 1, with an impact factor of 1.0 and assuming low traffic flow.

Accordingly, by inspection, accidental vehicle loading will be reduced as a result of the carriageway realignment scheme. It is for this reason that accidental vehicle loading was omitted from the assessments of both RBS2 10 and Lee Canal Bridge.

5. Environment

A review of important ecological or geological sites has been undertaken, which identified that none of the following are present local to the proposed works:

- Sites of Special Scientific Interest
- Site of Local Importance for Nature Conservation
- Site of Importance for Nature Conservation
- National Nature Reserve
- Local Nature Reserve
- Potential Site of Importance Area

However, as shown in Figure 1 overleaf, those trees adjacent to the north footpath local to Birmingham City Hospital to the east of Aberdeen Street and an area containing trees adjacent to Aberdeen Street are subject to a Tree Preservation Order. However, it is not envisaged that the proposed bridge strengthening works will affect these.

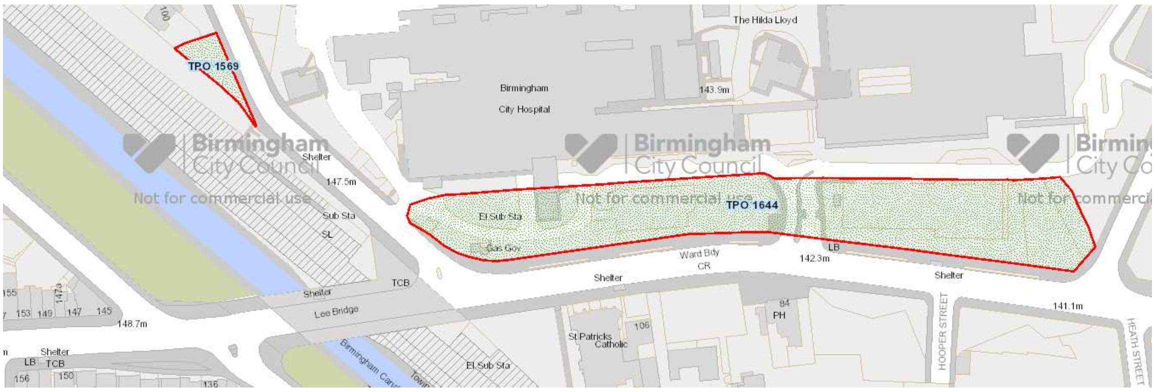


Figure 1: Extent of Tree Preservation Orders Local to Lee Canal Bridge and RBS2 10

Japanese Knotweed has been identified in the area adjacent to the western canal towpath to the north of Dudley Road. However, as the area is segregated via hoardings from the footpath, it is not envisaged that works will encroach into this area.

5.1 Land and Property

As the highway realignment remains within the overall highway corridor it is not expected that the proposals will require land take. There are no properties immediately adjacent to the bridges which will be affected by the proposed works.

6. Buried Infrastructure

6.1 Statutory Undertaker's Equipment and Buried Services

C2 service searches indicate that buried infrastructure is present within the footpaths and carriageway over Lee Canal Bridge and RBS2 10, which has the potential to significantly influence the option selected as well as construction methodology, programme and capital cost.

Accordingly, non-destructive investigation using ground penetrating radar (GPR) and Electromagnetic Cable Location (ECL) techniques was undertaken by Fugro on 15th July, 8th August, and 17th - 18th August 2021. To permit ECL tracing, slit trenches were excavated at various locations within the footpaths and Lane 1. An associated report (Ref 6) was produced, the associated drawings from which are contained in Appendix A.

6.1.1 North Footpath

The buried infrastructure identified within the north footpath is discussed in Table 1 below:

Table 1: North Footpath Buried Infrastructure

Utility	Findings
Electricity	2 No. ducts circa 0.6m from the parapet face (2No. ducts identified in TT02, with 1No. in remainder of trenches. Assumed that ducts were on top of each other where second duct not identified). This is generally consistent with the C2 return, which shows 2No. 11kV supplies in close proximity to the parapet across both bridges.

	1No. duct circa 2.0m from the parapet face and 2 No. ducts circa 2.5m from the parapet face. This is generally consistent with the C2 return, which shows 3No. 11kV supplies approximately in the middle of the footpath across both bridges. 1 No. duct circa 3.9m from the parapet face (not identified in TT01 nor TT04), which incorporates a spur towards the parapet between the two bridges. The presence of the spur towards the parapet is generally consistent with the C2 return, which shows 33kV and 11kV cables spurring towards the parapet at this location, assuming that separation was not possible as a result of their close proximity. However, the continuation of the cable onto the Lee Canal Bridge is inconsistent with the C2 return. This spur is consistent with the presence of steel ducting passing through the spandrel wall which is believed to carry the cables to ground level, as seen in Figure 2 overleaf. 1 No. cable circa 4.1m from the parapet face (not identified in TT02). Owing to this cable not being housed within ducting, it is likely to be low voltage. This is consistent with the C2 return, which shows a low voltage cable across both bridges, albeit it is shown circa 1m from the parapet face. There are several low voltage cables shown on the C2 return which were not explicitly identified within the survey.
Water	1 No. 610mm diameter main circa 1.5m from the parapet face. This is consistent with the C2 return, which shows a 24” diameter clay/steel water main in the footpath. Additionally, the C2 return shows the water main diverting into the carriageway at an approximately 45-degree angle above the Lee Canal Bridge west abutment. The traced alignment of the main matches this alignment.
Virgin Media	2No. ducts circa 0.7m from the parapet face. This is consistent with the C2 return, which shows a duct run across both bridges.
Gas	Gas was not identified within the north footpath and is not shown in the C2 return.
Unidentified	Several ducts/cables were identified as being of unknown ownership. At the time of writing, further investigation is being undertaken by BCC to determine the ownership of these ducts/cables.

Figure 2: Ducting Believed to be Carrying 11kV and 33kV Cables

6.1.2 Eastbound Lane 1

The buried infrastructure identified within the eastbound Lane 1 is discussed in Table 2 below:

Table 2: Eastbound Lane 1 Buried Infrastructure

Utility	Comments
Water	No evidence of water supply or wastewater apparatus was identified within the trial trenches which extended into Lane 1. However, a water main was traced along a portion of its length within the carriageway. This is generally consistent with the C2 return, which shows a 6” clay water main within the eastbound carriageway.
Gas	No evidence of a gas main was identified within the trial trenches which extended into Lane 1. However, a gas main was traced along a portion of its length within the carriageway. This is generally consistent with the C2 return, which shows a low pressure main in the eastbound carriageway.

6.1.3 South Footpath

The buried infrastructure identified within the south footpath is discussed in Table 3 below:

Table 3: South Footpath Buried Infrastructure

Utility	Comments
Electricity	1 No. duct circa 0.6m from the parapet face and 1 No. duct circa 0.9m from the parapet face. This is generally consistent with the C2 return, which shows 4No. 11kV supplies in the footpath across both bridges. 1 No. armoured cable between 0.8m and 1.2m from the parapet face. Whilst this is generally consistent with the C2 return in that low voltage cables are

	shown to cross both bridges in the footpath the C2 shows 5No. low voltage cables.
Water	1 No. duct circa 2.5m from the parapet face. This is generally consistent with the C2 return, which shows a 6” diameter clay water main in the footpath.
BT Openreach	4No. ducts circa 1.9m from the parapet face. This is generally consistent with the C2 return, which shows ducts in the footpath.
Gas	1 No. main circa 1.9m from the parapet face. This is consistent with the C2 return, which shows a low pressure main in the footpath.
Unidentified	Several ducts/cables were identified as being of unknown ownership. At the time of writing, further investigation is being undertaken to determine the ownership of these ducts/cables.

6.1.4 Westbound Lane 1

The buried infrastructure identified within the westbound Lane 1 is discussed in Table 4 below:

Table 4: Westbound Lane 1 Buried Infrastructure

Utility	Comments
BT Openreach	Signal traced in close proximity to kerb. This is generally consistent with the C2 return, which shows ducts running in close proximity to the kerb. BCC have confirmed that the telecoms ducts which run approximately parallel to the westbound kerb line are programmed to be abandoned and therefore redundant prior to the construction phase of the strengthening scheme.

6.1.5 Winson Green Feeder Culvert

Winson Green Feeder Culvert runs from Edgbaston Reservoir to the Birmingham Canal Feeder Arm. There are two lengths of culvert with a section of open channel in-between. Local to the A457 Dudley Road, the culvert is a brick lined arch supported by vertical side walls with a dished invert. Below the A457 Dudley Road the culvert cross section is 2.06m high and 1.72m wide.

Attempts to determine the alignment and depth of the culvert were made during the aforementioned buried service investigation using GPR. The GPR data collected within the footpaths and Lane 1 did not resolve the position of the culvert. The culvert was only resolved in the GPR data collected in the grassed area to the north-west of the site. The soffit of the culvert was detected to be at a depth of 1.95m from the surveyed surface and is therefore not envisaged as being affected by the proposed works.

7. Proposed Structure Options

Three options were identified as suitable for further consideration within the Initial Optioneering Report (Ref 1). These were:

- Replacement of the backfill adjacent to the spandrel walls with lightweight fill or concrete
- Extension of the existing slab beneath the carriageway
- Installation of pattress plates with discrete ground anchors

Following further review, it is proposed that ‘installation of pattress plates with discrete ground anchors’ be discounted. This is due to the inherent difficulties associated with drilling ground anchors through the spandrel walls, given the density of buried infrastructure within the footpaths. Additionally, the requirement to access the external faces of the structures to facilitate installation render the programme and costs associated with this option to be onerous, particularly given the presents of overhead line equipment below RBS2 10 and associated limited access availability.

7.1 Option 1 - Replacement of Backfill Adjacent to Spandrel Walls

The results of the existing assessment (Ref 7) indicate that over the portion of spandrel/wing walls affected by vehicular loading, up to 88% of the load effects are associated with lateral earth pressure resulting from the backfill material i.e. permanent loading. Accordingly, excavation of the existing backfill and replacement with a fill material of lower density would facilitate a reduction in load effects due to permanent loading, allowing more live load effects from vehicle surcharge loading to be sustained, whilst maintaining the net load effects on the walls. A detail of this proposal is seen in Figure 3 below:

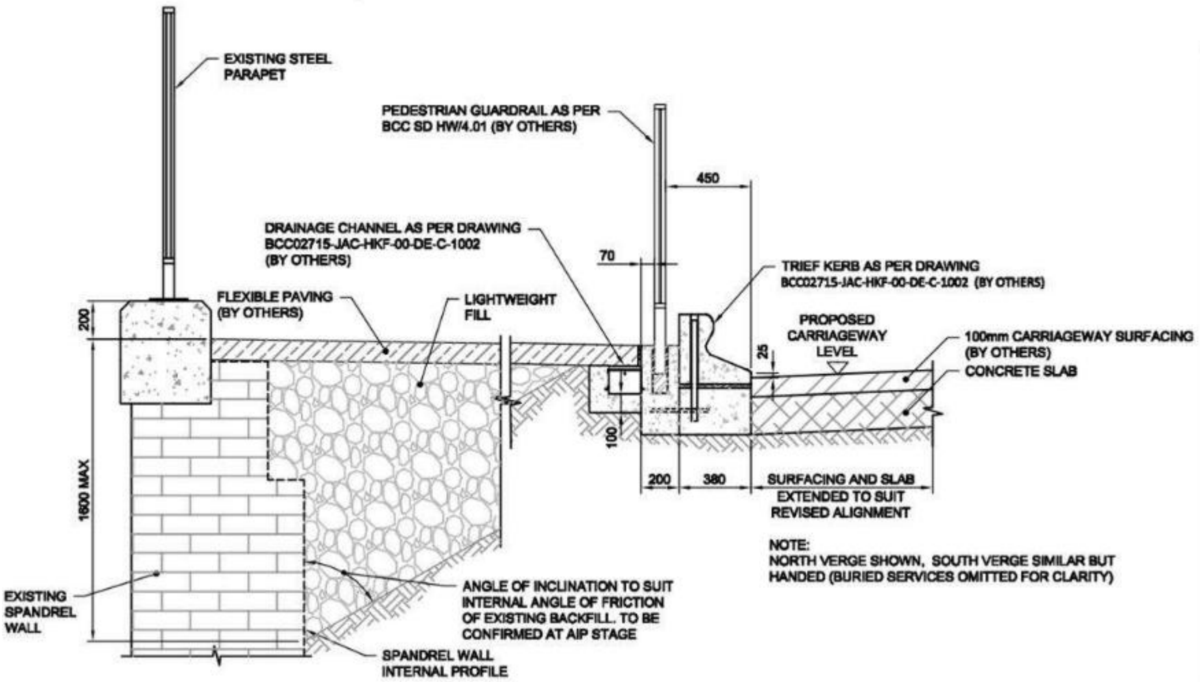


Figure 3: Section Through Footpath Showing Option 1 (Lee Canal Bridge Shown, RBS2 10 Similar)

Indicative calculations have been undertaken to estimate the necessary depth of material replacement (measured from existing footpath level) and are summarised in Table 5 overleaf to effectively mitigate the additional load effects associated with the revised highway alignment. Calculations have been undertaken considering load groups gr1a, gr1b and gr2 as per BS EN 1992-1 and ALL Model 1 as per CS 454 ALL i.e. normal traffic excluding STGO and SO vehicles. It is noted that whilst maximum and minimum have been provided at this stage, the necessary depth of lightweight fill replacement varies with depth of spandrel/wing wall.

The interface between the existing and replacement backfill would be sloped at an angle to match the internal angle of friction of the existing backfill, such that the permanent lateral earth pressures applied to the spandrel/wing walls over the height of the replacement material may be based on the properties of the replacement material only. The associated width of material replacement is based on an initial estimate of 30 degrees and stepped profile of the traffic face of the spandrel wall.

Table 5: Approximate Replacement of Backfill Depths Necessary to Induce 0% Additional Load Effects

Minimum/ Maximum	Approximate Depth (m) Of Lightweight Fill Required to Achieve 0% Load Effects Increase	
	BS EN 1991-2 Loading	**CS 454 Loading**
RBS2 10		
Minimum	≈ 0.4 (0.9)	≈ 0.4 (0.9)
Maximum	≈ 2.1 (3.7)	≈ 1.3 (2.5)
Lee Canal Bridge		
Minimum	≈ 0.4 (0.9)	≈ 0.4 (0.9)
Maximum	≈ 2.4 (4.2)	≈ 1.6 (3.0)

*Associated width of replacement material from traffic face of parapet coping stone shown in brackets

As seen in Table 5 above, loading in accordance with CS 454 permits a significant reduction in necessary maximum excavation depths. This is a result of the maximum 113kN characteristic axle weight within the CS 454 ALL model 1 relative to 300kN and 400kN as part of BS EN 1992-1 Load Models 1 and 2 respectively. The proportionate increase in load effects is maintained irrespective of the code applied. However, the absolute change in load effects on the spandrel/wing walls requiring mitigation is significantly increased through consideration of BS EN 1992-1 with associated increased depth of lightweight replacement fill required.

Outline calculations indicate that where load distribution is idealised in accordance with PD 6694 (which both CS 454 and BS EN 1991-2 refer to), vehicular loading does not significantly affect the spandrel walls where their height is less than 2.0m in the proposed highway alignment. Accordingly, the spandrel walls over the central circa 12m and 6m of the Lee Canal Bridge and RBS2 10 respectively are not subject to vehicular loading. However, unlike BS EN 1991-2, CS 454 stipulates an increase in the intensity of footpath loading with reduced width, resulting in an increase (albeit small) in load effects to the spandrel walls over the central portions of the bridges. Infill replacement over a minimum of circa 400mm depth would therefore be required over these extents to maintain load effects.

It would be necessary to extend the existing pavement slab over the widened portion of the carriageway. The slab extension would be connected to the original along the line of the existing kerb alignment through dowels or similar to provide continuity and avoid an otherwise abrupt change in pavement stiffness.

Outline drawings of the proposal are included in Appendix C.

7.1.1 Proposed Design Method

The derivation of loads on the spandrels would be based on soil mechanics principles, using geotechnical parameters determined from interpretation of the aforementioned GI. Wheel loads would be dispersed to the traffic face of the spandrel walls through the fill material in accordance with PD 6694.

The load effects on the spandrel walls would be derived for the existing highway alignment and fill materials. A similar process would be undertaken for the proposed highway alignment, considering the reduction in permanent lateral earth pressures as a result of the reduced fill density over the applicable height.

At detailed design stage, consideration of the relative density of services and the fill material will need to be given.

7.1.2 Construction Issues

7.1.2.1 Interface with Buried Infrastructure

Whilst the below considers the impacts of the load mitigation option on existing buried infrastructure it is noted that liaison with buried infrastructure owners and associated design of diversions is to be undertaken by others.

7.1.2.1.1 North Footpath/Eastbound Lane 1

As per the drawings in Appendix C, in the north footpath, the extents of the proposed replacement backfill coincide with water, telecoms, electricity and unknown buried infrastructure. Owing to the significant cost and programme implications associated with diversions, it is instead proposed that the buried infrastructure be left in-situ during construction. However, this should be subject to agreement with the buried infrastructure owners. Should this be unacceptable, the buried infrastructure would require temporary diversion during construction works or permanent diversion into the carriageway.

Whilst the alignment of the 24” water main is generally such that it runs below the proposed lightweight infill, its alignment diverts to below the carriageway towards the west of Lee Canal Bridge. At the time of writing, the depth of the water main at the point whereby it diverts into the carriageway is unknown and further investigations are being undertaken by BCC to ascertain its depth at this location such that consideration may be given to how it may interface with the trief kerb, pedestrian handrail and drainage channel, the design of which is to be undertaken by others. This may also influence the design of the slab extension.

The carriageway widening and associated extension of the pavement slab, trief kerb, pedestrian handrail and drainage channel coincide with electricity and unknown buried infrastructure which are located within the footpath in the existing carriageway alignment. It is considered unlikely that the infrastructure owners would accept leaving this buried infrastructure in-situ as the services would be located beneath the pavement slab, trief kerb, pedestrian handrail and drainage channel with associated difficulties accessing for future maintenance. Accordingly, it is proposed that these services be diverted into the footpath.

7.1.2.1.2 South Footpath/Westbound Lane 1

As per the drawings in Appendix C, in the south footpath, the extents of the proposed replacement backfill coincide with telecoms, electricity, gas and unknown buried infrastructure. Consistent with the north footpath, it is proposed that this buried infrastructure remain in-situ, subject to agreement with the buried infrastructure owners.

The carriageway widening and associated extension of the pavement slab, trief kerb, pedestrian handrail and drainage channel coincide with telecoms, electricity and unknown buried infrastructure which are located within the footpath in the existing alignment, albeit telecoms and electricity are limited to the west end of Lee Canal bridge. Consistent with the north footpath, it is proposed that these services be diverted into the footpath.

BCC have confirmed that the telecoms ducts which run approximately parallel to the westbound kerb line are programmed to be abandoned and therefore redundant prior to the construction phase of the strengthening scheme.

7.1.2.2 Excavations and Backfilling

Removal of the existing backfill material is not considered to be unusually onerous for a competent Contractor and may be undertaken using hand tools. Given the density of services and potential for mechanical plant loading to introduce excessive surcharge adjacent to the spandrel walls use of mechanical plant is considered unlikely to be suitable. Vacuum excavation may be utilised, albeit given the presence of cohesive materials within the backfill identified as part of the GI, its effectiveness may be limited, but this may still be used to supplement hand excavations.

Should mechanical plant be located closer to the spandrel walls than the existing kerbline, this would introduce potential for the mechanical plant loading to introduce additional load effects on the spandrel walls relative to those experienced in the existing carriageway alignment. Accordingly, such plant should be located within the footprint of the existing carriageway alignment, or an assessment undertaken to determine the acceptable proximity of the mechanical plant from the parapet such that the existing load effects on the spandrel walls are not exceeded.

Where excavations are necessary around buried services, it is common practice to undertake such excavations in bays via a ‘hit and miss’ methodology to limit the lengths over which the service ducts/cables are required to span. Typically, at the end of each bay, material would be battered/benched or retained using trench sheets or similar. Given the density of services in the footpaths, such retention is considered unlikely to be viable. Similarly, the need to allow for battering/benching is expected to be impracticable owing to the necessary lengths of the bays. It is therefore expected for the buried services to require temporary support whilst excavations are undertaken.

7.1.2.3 Sequencing of Works and Associated Traffic and Pedestrian Management

The sequencing of the work will be subject to the Contractor’s preferred methodology. However, the following is considered suitable in principle:

1. Close southern footpath to pedestrians, utilising pedestrian crossings circa 86m to the east and circa 160m to the west to provide crossing points to the north footpath,
2. Close Lane 1 westbound (to accommodate mechanical plant to remove excavated backfill and deliver replacement backfill),
3. Excavate backfill and install lightweight fill,
4. Divert services which clash with proposed slab extension trief kerb, pedestrian handrail, drainage channel etc.,
5. Extend westbound pavement slab,
6. Install trief kerb, pedestrian handrail, drainage channel etc.,
7. Re-surface carriageway and reinstate paving slabs to footpath,
8. Open southern footpath and Lane 1 westbound,
9. Repeat Steps 1-8 in north footpath and eastbound carriageway.

Step 3 may be undertaken concurrent with Steps 4-6. Alternatively, should Step 3 be undertaken prior to or following Steps 4-6, the requirement for a Lane 1 closure may be avoided through removal of excavated material and delivery of replacement backfill material by hand along the south footpath to Northbrook Street, where it may be loaded into/out of wagons.

7.1.3 Appearance

This option would not affect the appearance of the structure.

7.1.4 Sustainability and Use of Natural Resources

The low volume of backfill material removal and replacement means this option has low demand for natural resources. The backfill material to be removed generally comprises naturally occurring materials and is not expected to contain hazardous materials. The existing paving slabs may be stored and re-utilised where suitable.

Proprietary lightweight aggregates such as those expected to be utilised for backfill replacement are typically made from fly ash, a by-product of coal fired power stations. Being a wholly manufactured aggregate, made from a waste stream, means that the quantity of fly ash being tipped is reduced and virgin aggregate extraction is reduced.

7.1.5 Durability/Design Life

There are no foreseen issues with the infill achieving a design life of 120 years in accordance with Table 7.1 of CD 350 Rev 0. The remaining service life of the existing structure would be unaffected by the proposal.

7.1.6 Residual Health and Safety Risks

This option avoids the requirement for deep excavations and associated risks to operatives. The residual health and safety risks are predominately associated with excavations local to buried infrastructure.

A designer's residual hazard register for this option is contained within Appendix D.

7.1.7 Potential Risks and Constraints to the Project

7.1.7.1 Impact on Integrity of Existing Structure

Consideration is required with regard to the impact of the proposed works on the behaviour and integrity of the structure. Owing to the small proportion of backfill material proposed to be replaced, it is not considered to have a significant effect upon the existing structure.

Nonetheless, whilst the design intent is to not increase the overall load effects on the spandrel walls under loading, the proportion of permanent and live loads acting on the spandrel walls will be modified. Accordingly, owing to the existing assessment (Ref 7) being qualitative in nature and the limited ductility within masonry structures, it is recommended that monitoring be undertaken during and following the construction phase. Additionally, a baseline condition survey should be undertaken prior to works commencing.

Such monitoring shall be subject to separate specification, albeit this is envisaged as installation of retro reflective EDM targets to quantitatively monitor the positions of the spandrel walls. Associated control point(s) would require establishment, preferably in locations which would not require possession of the railway line to undertake monitoring. This may be supplemented by regular visual examinations from ground level with associated photographic records, potentially using long lens photography to provide improved resolution. Trigger points and associated actions would be established in a monitoring plan.

7.1.7.2 Diversion of Buried Infrastructure to Accommodate Carriageway Widening

Whilst the carriageway widening design and associated trief kerb, pedestrian handrail and drainage channel are subject to separate design by others, as per Section 7.1.2.1 these are expected to require diversion of existing buried infrastructure, for which the design and liaison with owners and associated design of diversions is to be undertaken by others. The current unknown nature of several services, absence of a known alignment of the 24" water main where it diverts towards the carriageway at the west end of Lee Canal Bridge and programme requirements for diversions has the potential to significantly influence the overall programme.

It is recommended that BCC undertake further investigation to identify the owners of the buried infrastructure which is currently unknown and obtain C3 and C4 estimates for the necessary diversions in order to provide more accurate costs and programmes for these diversionary works.

7.1.7.3 Retention of Existing Buried Infrastructure In-Situ

Retention of the buried infrastructure affected by replacement of the backfill material in-situ shall be subject to agreement with the respective owners and will require liaison and agreement by BCC. Should this be acceptable, it is expected that the respective owners would dictate the means of temporarily supporting the ducts/cables during the works. Should retention of the existing buried infrastructure in-situ be unfeasible, consideration should be given to temporary diversion. The requirements for temporarily supporting and/or diverting buried infrastructure is expected to significantly influence the Contractor’s methodology and programme.

It is noted that permanent access to the buried infrastructure would remain unchanged, albeit being surrounded in lightweight fill material. It is recommended that BCC undertake further investigation to identify the owners of the buried infrastructure which is currently unknown and liaise with the affected buried infrastructure owners to confirm the acceptability of this proposal prior to further design development.

7.1.7.4 Future Excavations

Where future excavations are undertaken to expose buried infrastructure, it is imperative that the backfill material be replaced in a ‘like for like’ manner to maintain the load effects on the spandrel walls. It is expected that this would be managed through the requirement for statutory undertakers to give prior notification of proposed works to the asset owners in accordance with the New Roads and Street Works Act 1991 (NRSWA). It is typical practice for excavations in footpaths to be reinstated with the spoil removed during excavation. However, it is recommended that the asset owners (the Trust and NWR) provide supervision of the excavations and reinstatement to ensure that the backfill is reinstated ‘like for like’. The Health and Safety File for the project will be required to highlight this ongoing requirement.

7.1.7.5 Consistency of Approach Across Structures Owned and Maintained by Differing Parties

It is proposed that a consistent strengthening approach be applied to both Lee Canal Bridge and RBS2 10. As per Section 2.2, the design should be submitted for acceptance to the Trust and NWR. Accordingly, there remains the potential for differing requirements of the respective Technical Approval Authorities. Collaboration between BCC, the Trust and NWR would be required to facilitate a consistent approach throughout.

7.1.8 Departures from Standards

As per Section 7.1 above, the absolute increase in load effects when considering loading in accordance with BS EN 1992-1 would lead to the depth of lightweight infill replacement being impracticable with regard to buildability. Additionally, the associated width of the excavation would require the introduction of lightweight fill beneath the carriageway, the acceptability of which with regard to pavement stiffness is unknown.

Accordingly, a Departure from Clause 2 of CD 350 and Clause 15 of NR/L2/CIV/020 to permit use of CS 454 live loading would be included within the AiP submissions to the Trust and NWR respectively.

7.1.9 Capital and Whole Life Cost

An initial capital cost estimate has been provided by BCC, and is summarised in Table 6 below:

Table 6: Capital Cost Estimate for Replacement of Backfill Adjacent to Spandrel Walls

Item	Capital Cost Estimate
Civils works – replacement fill	£104,950
Civils works – slab	£199,500
Service diversions	£555,000
Total	**£859,450**

Owing to there being no foreseen maintenance or inspection requirements, whole life costing is not considered applicable.

7.1.10 Operation and Maintenance

This option is not considered to affect the operation of the structure in the permanent arrangement, nor require maintenance.

7.2 Option 2 – Reinforced Concrete Strip

Through introduction of a reinforced concrete 'strip' below the nearside portion of the carriageway, the level at which the vehicular surcharge loading is applied to the backfill material and therefore acts on the spandrel/wing walls is reduced, with associated reduction in load effects. A detail of this proposal is shown in Figure 4 below:

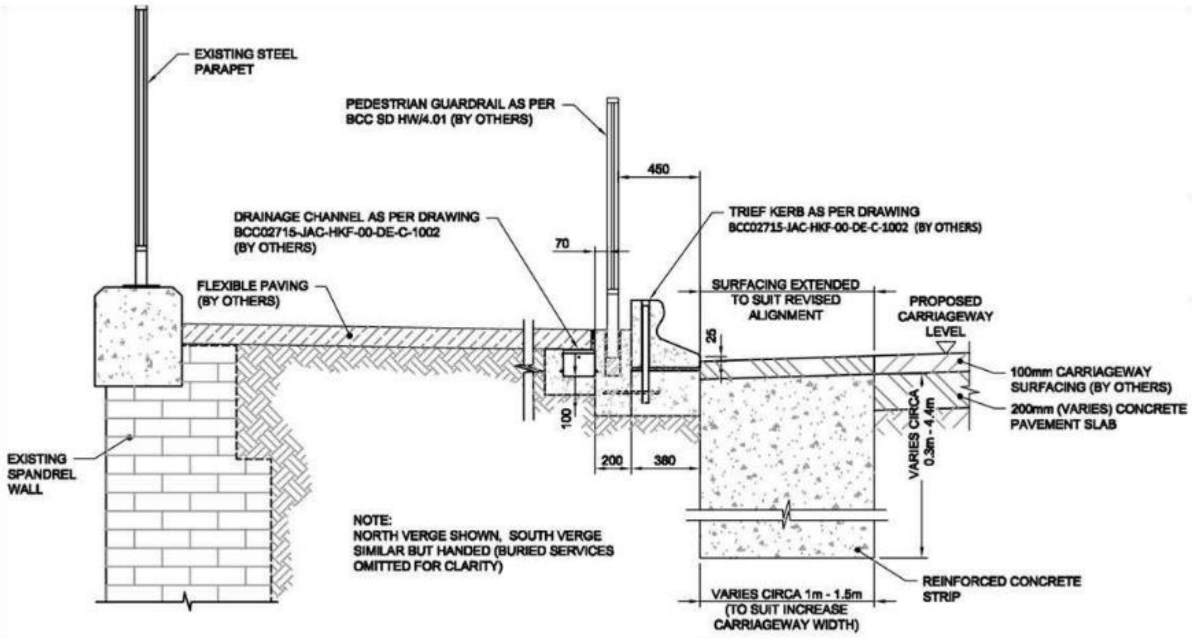


Figure 4: Section Through Footpath Showing Option 2 (Lee Canal Bridge Shown, RBS2 10 Similar)

However, since up to 88% of the load effects on the spandrel walls and wing walls are associated with lateral earth pressure resulting from the backfill material, a proportionately large reduction in the load effects due to vehicular loading is required to mitigate the increase resulting from carriageway realignment.

Indicative calculations considering loading in accordance with CS 454 have been undertaken to estimate the necessary depth to the underside of the reinforced concrete strip (measured from existing surfacing level) and are summarised in Table 7 below. Owing to the significant depth required to limit additional loading on the wing walls of Lee Canal Bridge to 0%, consideration has also been given to limiting additional loading to 1%.

Table 7: Approximate Reinforced Concrete Strip Depths Necessary to Induce 0% and 1% Increase in Load Effects

Minimum/Maximum	Approximate Depth (m) to Achieve 0% Load Effects Increase	Approximate Depth (m) to Achieve 1% Load Effects Increase
RBS2 10		
Minimum	≈ 0.5 at circa 3m from crown, tapering to circa 0.3m towards crown to match existing slab	≈ 0.5 at circa 3m from crown, tapering to circa 0.3m towards crown to match existing slab
Maximum	≈ 4.4	≈ 3.3
Lee Canal Bridge		
Minimum	≈ 0.5 at circa 6m from crown, tapering to circa 0.3m to match existing slab towards crown	≈ 0.5 at circa 6m from crown, tapering to circa 0.3m to match existing slab towards crown
Maximum	≈ 4.4	≈ 3.3

Owing to the depths of concrete strip identified when considering loading in accordance with CS 454 being prohibitive, similar calculations have not been undertaken considering loading in accordance with BS EN 1992-1 as this would require even greater depths, which are considered impractical.

The nearside edge of the concrete strip would align with the proposed kerb line and be required to extend towards the offside to the existing kerb line alignment as a minimum to ensure that the additional load associated with the revised carriageway alignment is distributed through the slab. The concrete strip would be connected to the existing concrete pavement slab through dowels or similar to provide continuity and avoid an otherwise abrupt change in pavement stiffness.

As discussed in Section 7.1, outline calculations indicate that vehicular loading does not significantly affect the spandrel walls over the central circa 12m and 6m of the Lee Canal Bridge and RBS2 10 respectively, where load distribution is idealised in accordance with PD 6694. However, owing to the concrete strip mitigating load effects due to vehicles only, lightweight infill replacement over circa 400mm depth would be required over these extents to maintain load effects due to CS 454 stipulating an increase in the intensity of footpath loading with reduced width.

Outline drawings of the proposal are included in Appendix E.

7.2.1 Proposed Design Method

The design method would be consistent with that for Option 1, albeit the traffic loading would be considered as being transmitted to the underlying backfill via the reinforced concrete strip.

Should in-situ concrete be utilised and formed by propping against the existing wall either directly or via backfill, consideration would need to be given to hydrostatic loading from the wet concrete and associated potential for ‘built in’ loading and associated stresses to be induced to the spandrel/wing walls. This may require the concrete strip to be poured in a series of separate lifts; each lift curing before the next lift is poured. However, if tied formwork were used or lateral wet concrete pressures otherwise prevented from loading the wall then this would not be an issue.

At detailed design stage, consideration of the relative density of services and the fill material will need to be given.

7.2.2 Construction Issues

7.2.2.1 Interface with Buried Infrastructure

Whilst the below considers the impacts of the strengthening option on existing buried infrastructure it is noted that liaison with buried infrastructure owners and associated design of diversions is to be undertaken by others.

7.2.2.1.1 North Footpath/Eastbound Lane 1

As the concrete strip would be limited to within the carriageway, there would be no impact to those services in the north footpath.

However, as per the drawings in Appendix E the concrete strip coincides with electricity and unknown buried infrastructure, the latter of which was identified within TT01 only. As for Option 1, the carriageway widening and associated extension of the pavement slab, trief kerb, pedestrian handrail and drainage channel coincide with electricity and unknown buried infrastructure which are located within the footpath in the existing carriageway alignment. It is considered unlikely that the infrastructure owners would accept leaving this buried infrastructure in-situ, due to difficulties accessing for future maintenance. Additionally, such maintenance would require traffic management with associated disruption to the traffic network. Accordingly, diversion of these services into the footpath would be preferrable. However, it is acknowledged that the existing footpath is significantly congested, with associated potential for this to be unfeasible. Where necessary, the affected services may be left in-situ (albeit lowered where necessary to accommodate the trief kerb and associated footing) or relocated to within the carriageway, utilising ducts encased within the concrete strip.

7.2.2.1.2 South Footpath/Westbound Lane 1

As the concrete strip would be limited to within the carriageway, there would be no impact to those services in the south footpath.

However, as per the drawings in Appendix E the concrete strip coincides with unknown buried infrastructure and a ceramic drainage pipe, the latter of which was identified within TT08.
BCC have confirmed that the telecoms ducts which run approximately parallel to the westbound kerb line are programmed to be abandoned and therefore redundant prior to the construction phase of the strengthening scheme. As for Option 1, the carriageway widening and associated extension of the pavement slab, trief kerb, pedestrian handrail and drainage channel coincide with telecoms, electricity and unknown buried infrastructure which are located within the footpath in the existing alignment, albeit telecoms and electricity are limited to the west end of Lee Canal bridge. Consistent with the north footpath, it is proposed that these services be diverted into the footpath, or where this is unfeasible, relocated to within the carriageway, utilising ducts encased within the concrete strip. Alternatively, the ducts may be left in-situ albeit lowered to accommodate the trief kerb and associated footing.

7.2.2.2 Excavations and Backfilling

The significant excavation depths would require use of temporary shoring as the lack of available road space whilst maintaining traffic flows is considered to make for battering transverse to the carriageway alignment unfeasible. Accordingly, it is envisaged that shoring would be installed progressively with increasing excavation depth using trench sheets or similar.

Owing to the excavation depths, mechanical plant shall be necessary. It is envisaged that such mechanical plant would be located within the carriageway to mitigate against additional loading to the spandrel/wing walls. Accordingly, it is expected that the works would be phased such that the concrete strips are installed to the east and westbound carriageways in series to retain traffic flows along Dudley Road. Nonetheless, as a minimum, Lane 1 of the carriageway being excavated would require closure during the works with Lane 2 also potentially requiring closure subject to positioning of mechanical plant. Additionally, owing to the significant depth of excavation, temporary VRS may be necessary to mitigate risks associated with an errant vehicle falling into the excavation which again may necessitate closure of Lane 2.

7.2.2.3 Sequencing of Works and Associated Traffic and Pedestrian Management

The sequencing of the work would be subject to the Contractor's preferred methodology. However, the following is considered suitable in principle:

1. Close southern footpath to pedestrians, utilising pedestrian crossings circa 86m to the east and circa 160m to the west to provide crossing points to the north footpath,
2. Close westbound lane(s),
3. Divert services which clash with proposed concrete strip, trief kerb, pedestrian handrail, drainage channel etc.,
4. Excavate backfill and install concrete strip,
5. Install trief kerb, pedestrian handrail, drainage channel etc.,
6. Re-surface carriageway and reinstate paving slabs to footpath as necessary,
7. Open southern footpath and Lane 1 westbound,
8. Repeat Steps 1-7 in north footpath and eastbound carriageway.

Should services be unable to be diverted into the footpath, stage 3 would be undertaken as part of Stage 4.

7.2.3 Appearance

Consistent with Option 1, this option would not affect the appearance of the structure.

7.2.4 Sustainability and Use of Natural Resources

Relative to Option 1, the volume of backfill material requiring removal and replacement with reinforced concrete means this option has high demand for natural resources. Whilst the concrete mix design for the concrete strip may incorporate cement replacement materials which are by-products from industry to reduce embodied carbon, this would be expected to remain significantly higher than that for Option 1.

The backfill material to be removed generally comprises naturally occurring materials and is not expected to contain hazardous materials. The existing paving slabs may be stored and re-utilised where suitable.

7.2.5 Durability/Design Life

Consistent with Option 1, there are no foreseen issues with achieving a design life of 120 years in accordance with Table 7.1 of CD 350 Rev 0. The remaining service life of the existing structure would be unaffected by the proposal.

7.2.6 Residual Health and Safety Risks

A Designer's Residual Hazard and Risk Log for this option is contained within Appendix F. The most significant residual risk is associated with the requirement for deep excavations and associated risk to operatives and the public. To mitigate the risk associated with an errant vehicle falling into the excavation, it is recommended that consideration be given to provision of a temporary VRS.

7.2.7 Potential Risks and Constraints to the Project

7.2.7.1 Impact on Integrity of Existing Structure

Given the absence of any connection between the concrete strip and the arch barrel, this option would not be considered to have a significant effect upon the existing structure in the permanent condition. However, whilst the width of the backfill material proposed to be excavated is small, excavations at such depth introduce the potential for changes in local load distribution. Additionally, the introduction of a significant concrete element within the backfill has the potential to introduce an interface along which sub-surface water may penetrate the arch backfill at an increased rate.

Whilst the design intent should be such that the overall load effects on the spandrel walls due to combined permanent and live loads is maintained, the distribution of loads on the spandrel wall would be modified. Accordingly, monitoring is proposed consistent with that discussed for Option 1.

7.2.7.2 Diversion of Buried Infrastructure to Accommodate Carriageway Widening

As for Option 1 whilst the carriageway widening design and associated trief kerb, pedestrian handrail and drainage channel are subject to separate design by others, as per Section 7.1.2.1 both these and the concrete strip are expected to require diversion of existing buried infrastructure, for which liaison with owners and associated design of diversions is to be undertaken by others.

The current unknown nature of several services, absence of a known alignment of the 24” water main where it diverts towards the carriageway at the west end of Lee Canal Bridge and programme requirements for diversions has the potential to significantly influence the overall programme. It is recommended that BCC undertake further investigation to identify the owners of the buried infrastructure which is currently unknown and obtain C3 and C4 estimates for the necessary diversions to provide more accurate costs and programmes for these diversionary works.

7.2.7.3 Future Access to Services Buried Within/Below Concrete Slab/Strip

Where diversion of buried services is necessary, it is preferrable for these to be within the footpath. However, where this is not practicable, these may be relocated to within or below the concrete strip or below the adjacent pavement slab, subject to acceptance from infrastructure owners. Should this be necessary, it is proposed that this be limited to those services which are not likely to require direct access to buried portions (i.e. gas or water) and that chambers be installed local to the bridges to enable access. Consistent with Option 1, should future excavations be necessary to expose infrastructure below or within the concrete strip or pavement slab, it is important that they be replaced in a 'like for like' manner to avoid increasing load effects on the spandrel walls. It is expected that this would be managed through the requirement for statutory undertakers to give prior notification of proposed works to the asset owners in accordance with NRSWA. However, it is recommended that the asset owners (the Trust and NWR) provide supervision of the excavations and reinstatement to ensure that the backfill is reinstated ‘like for like’. The Health and Safety File for the project will be required to highlight this ongoing requirement.

7.2.7.4 Extent of Traffic Management to Facilitate Excavations

Whilst an indicative estimate of excavation requirements is given within Section 7.2.2.2., details of mechanical plant and temporary works arrangements would be subject to the Contractor’s methodology. Mechanical plant and temporary works requirements would dictate the traffic management requirements, which would have a significant impact on the local traffic network, owing to Dudley Road being a significant route into and out of Birmingham city centre.

7.2.7.5 Introduction of Buried / Hidden Structural Element

Whilst the concrete strip would be designed with a 120-year design life and the concrete mix design specified accordingly, it is undesirable for a structural element which is required to mitigate potentially excessive load effects on the spandrel walls to be inaccessible for inspection and where necessary, maintenance.

7.2.7.6 Consistency of Approach Across Structures Owned and Maintained by Differing Parties

As for Option 1, it is proposed that a consistent strengthening approach be applied to both Lee Canal Bridge and RBS2 10 and there remains the potential for differing requirements of the respective Technical Approval Authorities. Collaboration between BCC, the Trust and NWR shall be required to facilitate a consistent approach throughout.

7.2.8 Departures from Standards

As per Section 7.2 above, the absolute increase in load effects when considering loading in accordance with BS EN 1992-1 would lead to the depth of concrete strip being significantly greater than that when considering loading in accordance with CS 454.

Accordingly, a Departure from Clause 2 of CD 350 and Clause 15 of NR/L2/CIV/020 would be included within the AiP submissions to the Trust and NWR respectively.

7.2.9 Capital and Whole Life Cost

An initial capital cost estimate has been provided by BCC, and is summarised in Table 8 below:

Table 8: Capital Cost Estimate for Reinforced Concrete Strip

Item	Capital Cost Estimate
Civils works	£1,436,650
Service diversions	£505,000
Total	**£1,941,650**

Owing to there being no foreseen maintenance or inspection requirements, whole life costing is not considered applicable.

7.2.10 Operation and Maintenance

This option is not considered to affect the operation of the structure in the permanent arrangement, nor require maintenance.

8. Preferred Option

8.1 Proposed Preferred Option

Based on the approximately 50% lower capital cost, avoidance of the need for deep excavations, absence of the introduction of a buried structural element and associated more onerous traffic management and lower environmental impact, *Option 1 – Replacement with Backfill Adjacent to Spandrel Walls* is considered preferrable and is therefore recommended for AiP Design.

However, it is noted that this option carries a residual risk associated with future excavation of the replacement backfill. This is mitigated through the requirement for statutory undertakers to give prior notification of proposed works to the asset owners in accordance with NRSWA, enabling the asset owners (the Trust and NWR) to highlight this requirement. Nonetheless, it is recommended that the asset owners provide supervision of the excavations and reinstatement to ensure that the backfill is reinstated ‘like for like’. The Health and Safety File for the project will be required to highlight this ongoing requirement.

It is noted that to facilitate practicable excavation depths, a Departure from Standards to permit the use of loading derived in accordance with CS 454 to determine the increase in load effects to the spandrel/wing walls which are necessary to be mitigated.

Table 9 below summarises those recommendations made to reduce residual project risks associated with this option:

Table 9: Key Recommendations

Recommendation	Owner
Investigate unknown buried infrastructure to identify owners	BCC
Liaise with buried infrastructure owners to determine acceptability of and any conditions on leaving apparatus in-situ whilst excavating surrounding material	BCC
Investigate alignment of 24” diameter water main where it diverts into the carriageway from the north footpath	BCC

8.2 Proposed Category of Check

It is proposed that the design is subject to Category 2 check in accordance with the requirements of CG 300 and NR/L2/CIV/003.

8.3 Role of the Works Examiner Supervising the Works

It is proposed that the role of the works examiner by consistent with Option 1 within Appendix N of CG 300 i.e. examining the execution to certify that it has been constructed, commissioned and tested in accordance with the AiP.

9. The Above is Submitted for Acceptance

Signed: ______________________

Name: Benn Schofield
Design Team Leader

Engineering Qualifications: MEng CEng, MICE

Name of Organisation: AECOM

Date: 13/07/2022

10. Preferred Option Agreed

Signed: ______________________________

Name: ______________________________

Position Held: ______________________________

Engineering Qualifications: ______________________________

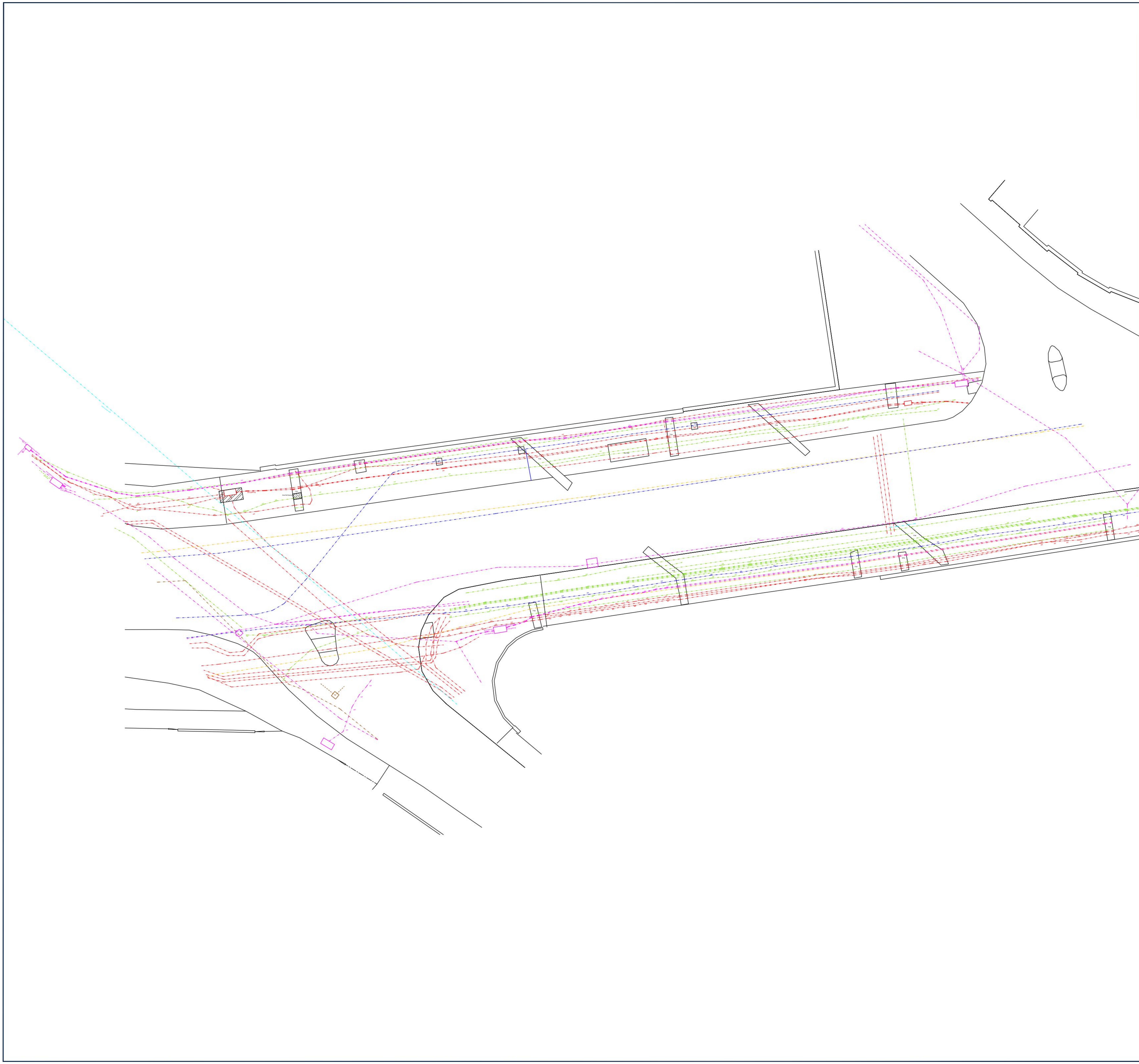
TAA: ______________________________

Date: ______________________________

11. References

1. Spandrel Wall Strengthening – Initial Optioneering Report, Lee Canal Bridge (CRT No. BC003-002), Report Reference 60603650-M200-REP-00014 Rev B, AECOM (March 2021)
2. Dudley Road Improvement Scheme - Pavement Design Report), Report Reference BCC02715-JAC-HPV-00-RP-C-0001 | P01, Jacobs (December 2020)
3. Geotechnical Investigation for Dudley Road Widening Scheme at Lee Canal Bridge Birmingham, Report Reference 2114C, Ground Investigation Specialists (May 2022)
4. Parapet Risk Assessment, Lee Canal Bridge (CRT No. BC003-002), Report Reference 60603650-M200-REP-0005-Rev A, AECOM (March 2020)
5. Parapet Risk Assessment, Lee Rail Bridge (NR No. RBS2-10), Report Reference 60603650-M200-REP-0006-Rev A, AECOM (March 2020)
6. Lee Canal Bridge Survey, Report Reference 190694REP_003, Fugro (April 2022)
7. Structural Assessment Report, Lee Canal Bridge (CRT No. BC003-002), Report Reference 60603650-M200-REP-0008 Rev 3, AECOM (June 2022)

Appendix A



NOTES:

1)The data presented in this drawing have been collected using a combination of the following: consultation of utility asset information, visual survey & inspection of manholes and inspection chambers; electromagnetic location techniques; ground penetrating radar, and, where applicable, trial hole excavations. These techniques have been deployed in accordance with the BSI PAS128 Specification for Underground Utility Detection, Verification and Location using the search methodologies indicated below and described in the accompanying report.

2)This drawing should be used in conjunction with the accompanying report which details the limitations of these techniques and any hindering factors encountered during this survey.

3)Unless otherwise stated, all utilities shown on this plan have been surveyed using approved detectors and the connections between inspection chambers, if unable to be detected, are generally assumed to be direct unless there are indications to the contrary. The detection confidence for each utility segment is depicted in line with the PAS128 scheme outlined below. Information depicted as QL-C or QL-D cannot be guaranteed as it is based on historic utility records which can be inaccurate and incomplete.

4)While we undertake to perform our services to industry best practice guidance and with reasonable skill and care, the nature of non-destructive and geophysical testing techniques mean that no guarantee can be given that all utilities have been located or that all reported features represent utilities. This could be due to a number of factors including but not limited to those below:

- the local ground conditions and soil/material types
- the size, depth and material of the utility
- multiple utilities within the survey area which have masked other utilities around and below
- inability to locate or open an inspection cover within or around the survey area
- the utility may have been 'missed' between survey lines or the surface may have been obstructed

No utility mapping survey can be considered a 100% accurate depiction of the sub-surface environment, and the use of these drawings does not remove the requirement for the use of safe digging techniques at all times, in line with the requirements of HSG47 and current CDM regulations.

5)The utility routes depicted may reflect the routes of multiple cables or pipes. It is not always possible to differentiate between buried construction features, utilities and other subsurface linear features therefore it is possible that some features shown are not utility related, and due to the limitations of electromagnetic techniques all utility identifications should be treated with caution and verified prior to use during design/building works.

6) It should not be assumed that utilities which are shown to be discontinuous are abandoned.

7) Utilities which appear to be terminated or not running to any obvious surface apparatus should be considered to be live.

8) In the absence of evidence to the contrary the routes of confirmed inspection chamber connections are assumed to be direct and straight.

9) All results should be viewed in conjunction with the statutory undertakers records.

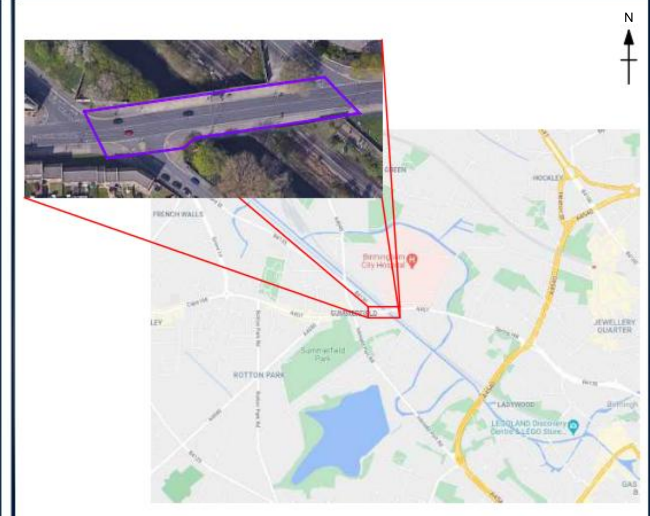
10) If excavations are to take place safe digging practices should be employed.

11) Survey information was collected within AUG 2021.

INTRUSIVE INFORMATION:

CORE & REFERENCE NO.	XX
WINDOW SAMPLE & REFERENCE NO.	XX

LOCATION PLAN (NTS):



SUB-SURFACE KEY:

DRAINAGE SLOT	
DRAINAGE COMBINED *	DC-B2P >
DRAINAGE FOUL*	DF-B2P >
DRAINAGE SURFACE*	DS-B2P >
DRAINAGE UNIDENTIFIED*	DU-B2P >
[* FLOW DIRECTION DENOTED BY ARROW (>) or (<) IF KNOWN]	
ELECTRIC	ELE-B2P
ELECTRIC LV	ELELV-B2P
ELECTRIC HV	ELEHV-B2P ELEHV-B2P
ELECTRIC STREET LIGHTING	SL-B2P
GAS	GAS-B2P
OIL/FUEL PIPELINE	OIL-B2P
STREET FURNITURE CABLES	SF-B2P
TELECOMS	TEL-B2P
TELECOMS - FIBRE OPTIC	FO-B2P
TELECOMS - BT	BT-B2P
TELECOMS - VIRGIN MEDIA	VM-B2P
TRAFFIC SIGNALS	TS-B2P
WATER	WTR-B2P
UNIDENTIFIED UTILITY	U K-B2P
UNIDENTIFIED EMPTY DUCT	ED-B2P
GPR LINEAR FEATURE	GPR-B2P
GPR AREA ANOMALY	
GPR AREA ANOMALY - REBAR	
MANHOLE NUMBER	MHXX
GULLY NUMBER	GXX
MANHOLE UNOPENED	MH UN
INVERT LEVEL OF INSPECTION CHAMBER BGL	IL XX.XX
INVERT LEVEL NOT SURVEYABLE DUE TO DEBRIS/WATER FILLED CHAMBER	IL NS
MANHOLE & CHAMBER EXTENTS	
DIAMETER OF PIPE/DUCT (mm) & MEASURED DEPTH BGL TO PIPE/CABLE/DUCT [BGL - BELOW GROUND LEVEL]	ØXXX@XXXbgl
MEASURED DEPTH (mm) BGL PIPE/CABLE/DUCT - TOP	650
STOP COCK	SC
FIRE HYDRANT	FH
LAMP POST	
ELECTRIC CABINET	
AREA UNABLE TO BE SURVEYED DUE TO SURFACE OBSTRUCTIONS, VEGETATION OR LACK OF ACCESS	
SERVICE MARKER	
EXTENT OF SURVEY - BOUNDARY	

WITH EXAMPLE CONFIDENCE LEVELS

UTILITY CONFIDENCE LEVELS

(A) HORIZONTAL AND VERTICAL POSITION VERIFIED VISUALLY (Accuracy: Horizontal (±25mm) Vertical(±50mm)

(B1P) HORIZONTAL AND VERTICAL POSITION DETECTED BY MULTIPLE METHODS WITH POST PROCESSING OF GPR DATA (Estimated Accuracy: ±150mm OR ±15% of detected depth)

(B1) HORIZONTAL AND VERTICAL POSITION DETECTED BY MULTIPLE METHODS (Estimated Accuracy: ±150mm OR ±15% of detected depth)

(B2P) HORIZONTAL AND VERTICAL POSITION DETECTED VIA POST-PROCESSED GPR (Estimated Accuracy: ±250mm OR ±40% of detected depth)

(B2) HORIZONTAL AND VERTICAL POSITION DETECTED BY A SINGLE METHOD (Estimated Accuracy: ±250mm OR ±40% of detected depth)

(B3P) HORIZONTAL POSITION DETECTED VIA POST-PROCESSED GPR (Estimated Accuracy: ±500mm in the Horizontal - Depth is undefined)

(B3) HORIZONTAL POSITION DETECTED BY A SINGLE METHOD (Estimated Accuracy: ±500mm in the Horizontal - Depth is undefined)

(B4) A UTILITY SEGMENT WHICH IS SUSPECTED TO EXIST BUT HAS NOT BEEN DETECTED AND IS THEREFORE SHOWN AS ASSUMED ROUTE

(C) ROUTE TRANSCRIBED FROM UTILITY ASSET PLANS AND CORRELATED TO VISUAL INDICATORS AND SURFACE FEATURES (Accuracy Undefined)

(D) ROUTE TRANSCRIBED FROM UTILITY ASSET PLANS (Accuracy Undefined)

DUCT INFORMATION:

1W:	1 WAY SINGLE DUCT
2W:	2 WAY FLAT
2W:1/2	2 WAY: 1 WIDE, 2 DEEP
4W:2/2	4 WAY: 2 WIDE, 2 DEEP
6W:3/2	6 WAY: 3 WIDE, 2 DEEP
12W:4/3	12 WAY: 4 WIDE, 3 DEEP

CLIENT:

MCPHILLIPS

LEE CANAL BRIDGE SURVEY

TITLE:

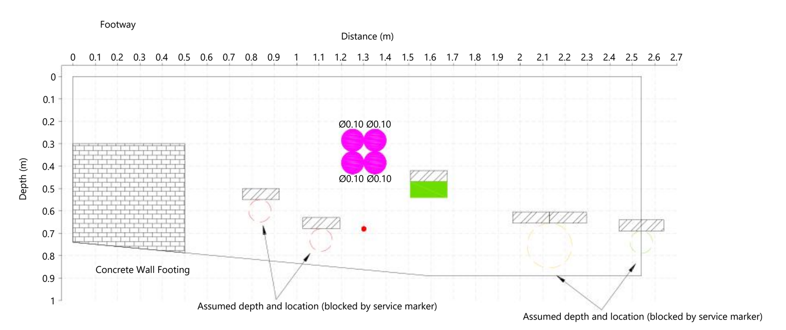
LEE CANAL BRIDGE UTILITY SURVEY

PROJECT NO.:	190694			DRAWING NO.:	001		
ISSUE REFERENCE:	C			DATE:	April 2022		
INTERP. BY:	RF	DATE:	SEP 2021	DRAWN BY:	RF	DATE:	SEP 2021
CHECKED BY:	DG	DATE:	APR 2022	APPROVED BY:	SB	DATE:	APR 2022
DRAWING SCALE:	1:200						
PLOTTED DRAWING SIZE:	A1 (841 x 594)						

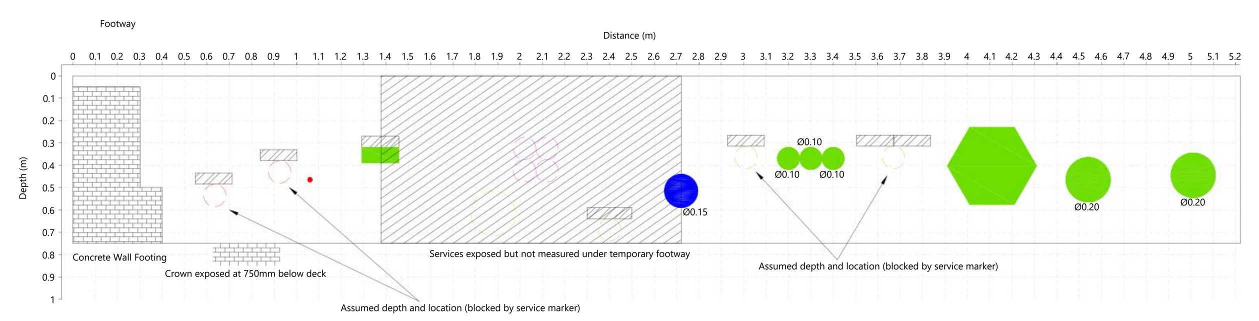
FUGRO GEOSERVICES LIMITED
Focal Point, Newmarket Carriageway
Bottisham, Cambridge, CB25 9BD
Tel: +44 (0)870 600 80 50

Bridge South Side Footway Excavations

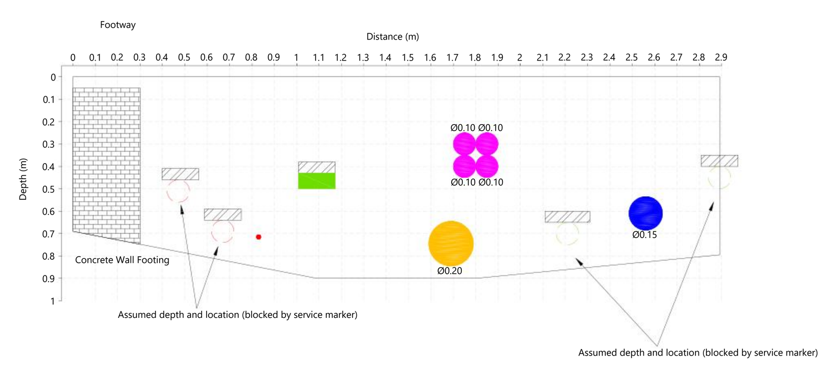
Slit Trench 05 (TT05)



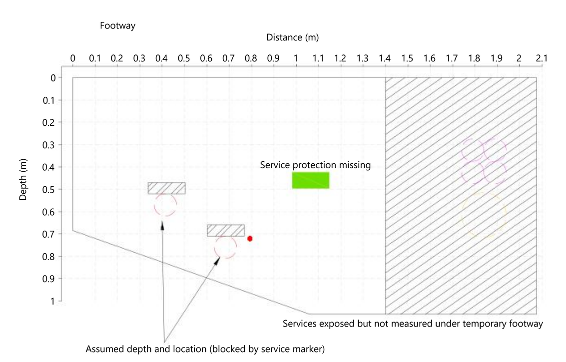
Slit Trench 06 (TT06)



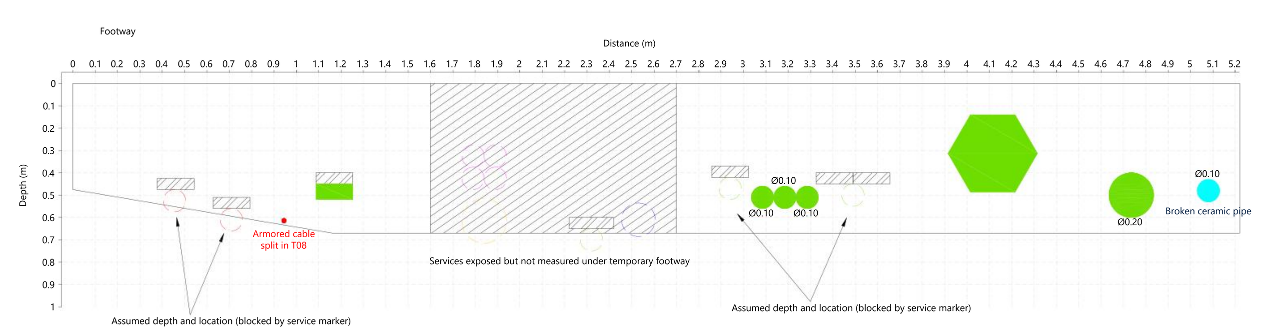
Slit Trench (TT07)



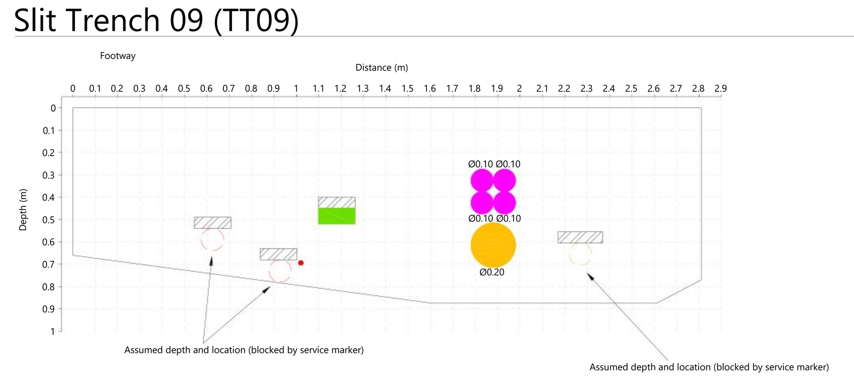
Service Pit 02 (SP02)



Slit Trench 08 (TT08)

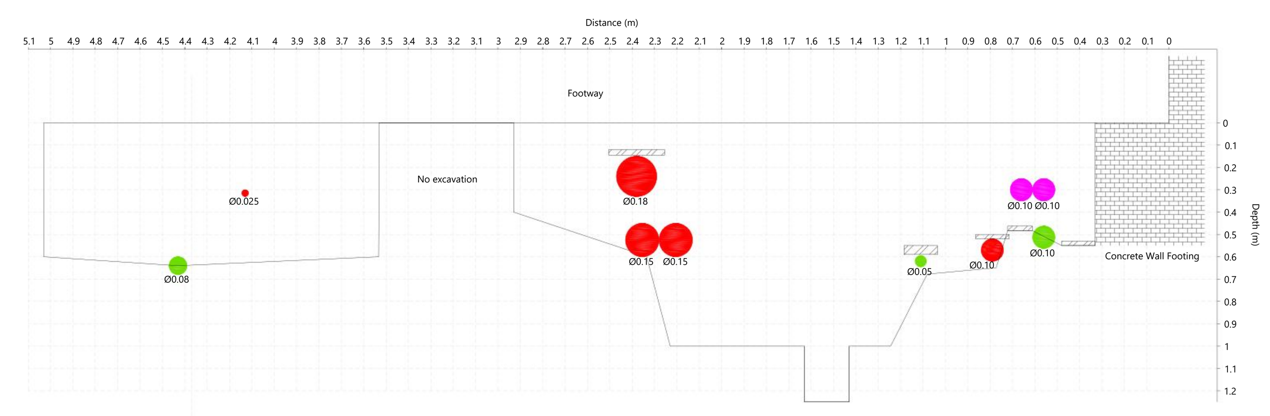


Slit Trench 09 (TT09)

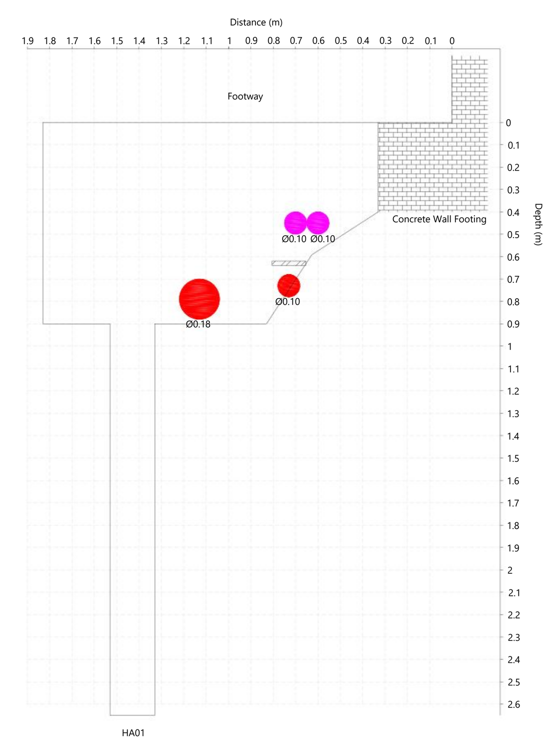


Bridge North Side Footway and Carriageway Excavations

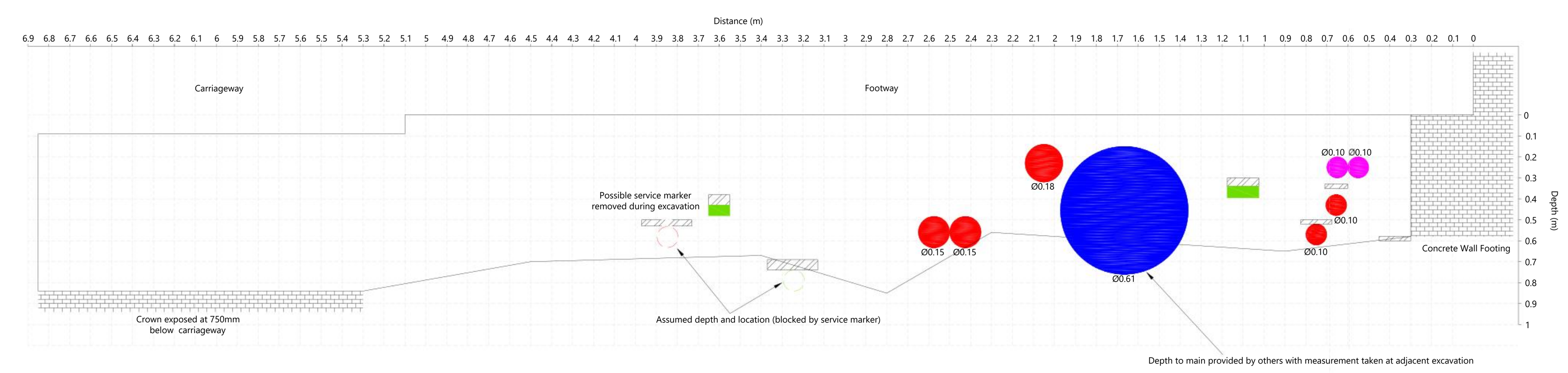
Slit Trench 01 (TT01)



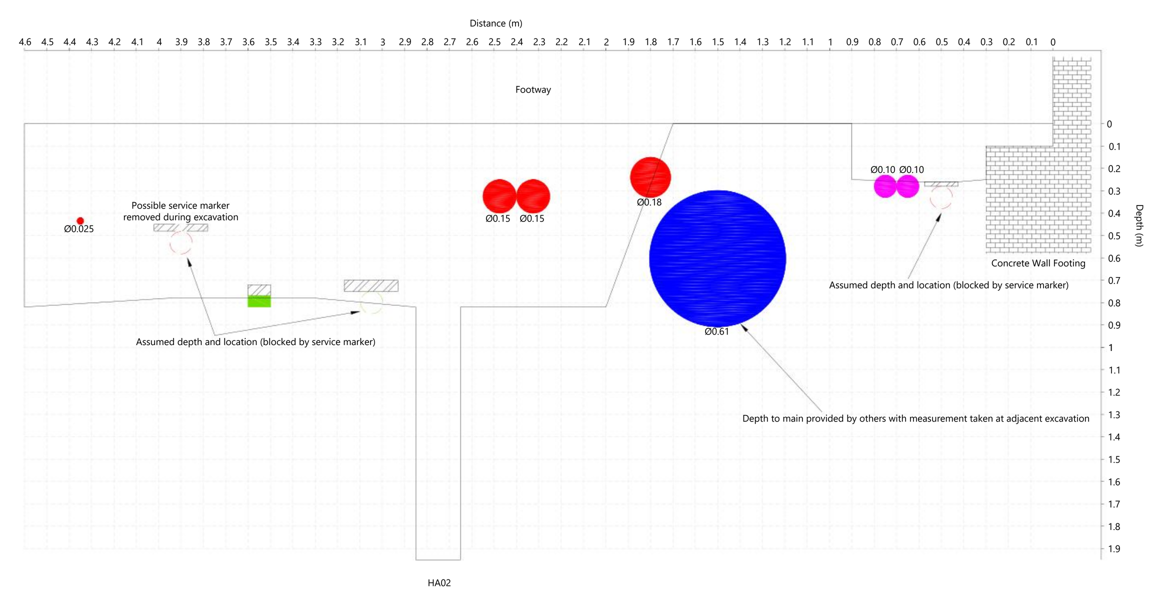
Service Pit 01 (SP01)



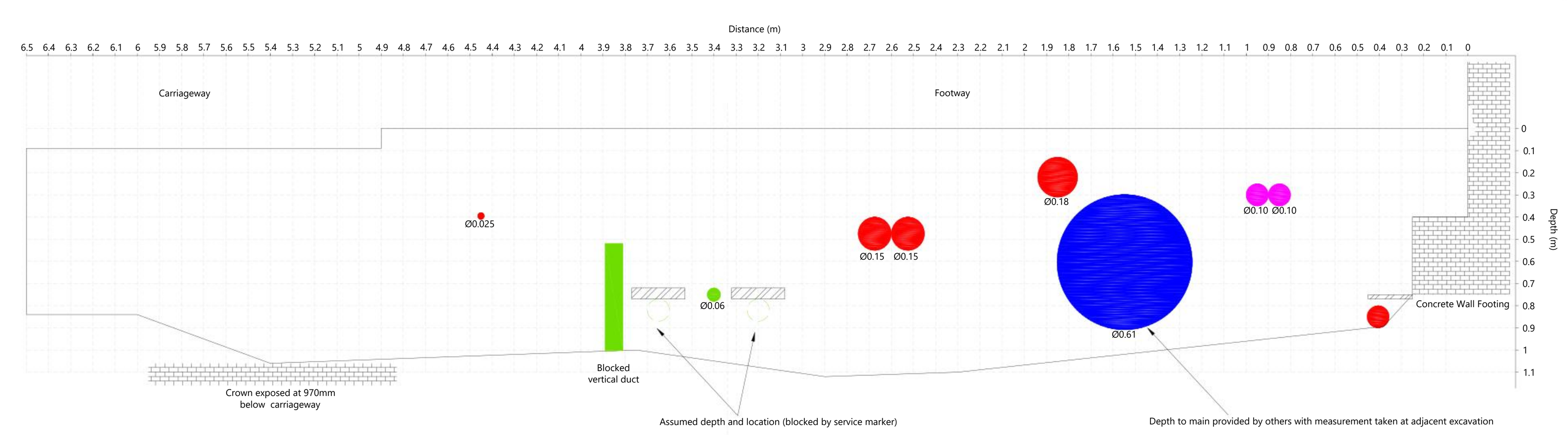
Slit Trench 02 (TT02)



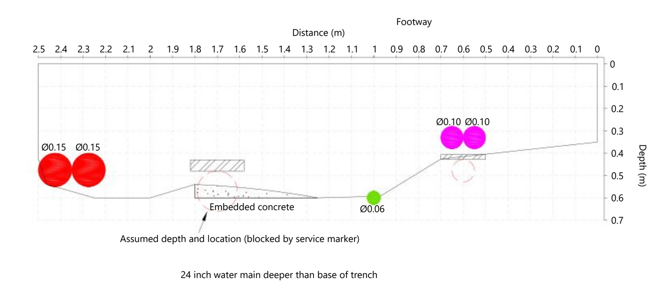
Slit Trench 03 (TT03)



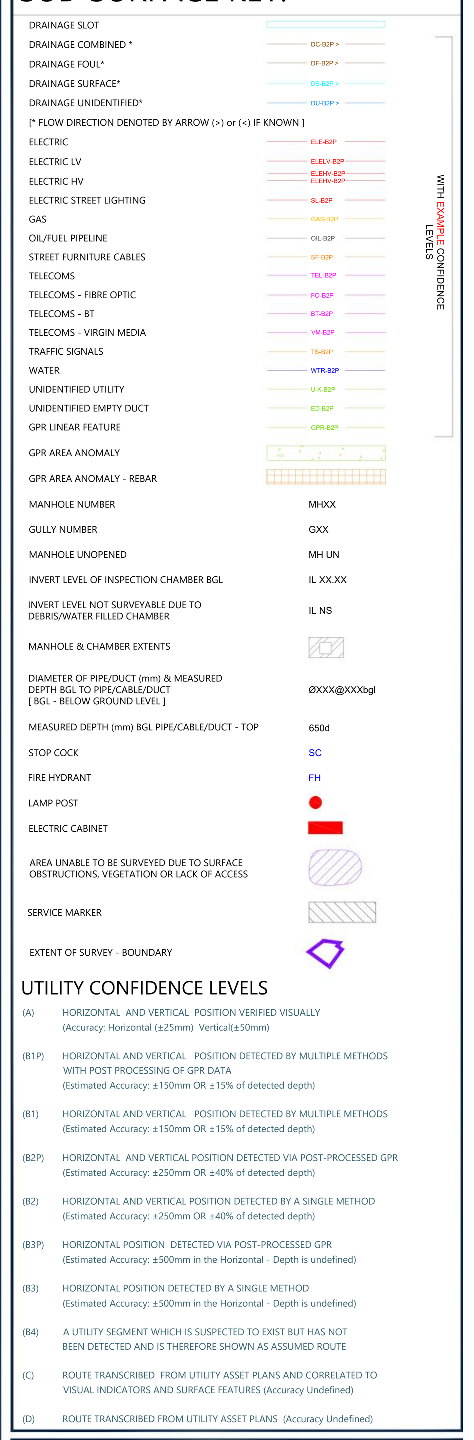
Slit Trench 04 (TT04)



Slit Trench 04 (TT04A)

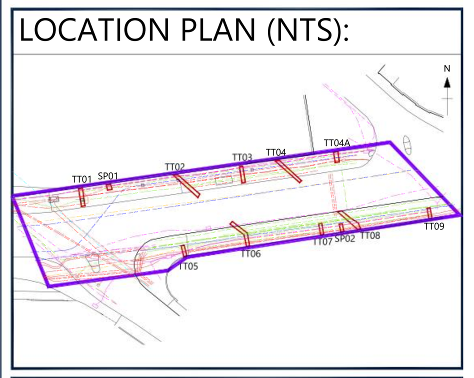


SUB-SURFACE KEY:



DUCT INFORMATION:

LOCATION PLAN (NTS):



NOTES:

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7) Utilities which appear to be terminated or not running to any obvious surface apparatus should be considered to be live.

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9) All results should be viewed in conjunction with the statutory undertakers records.

10) If excavations are to take place safe digging practices should be employed.

11) Survey information was collected within AUG 2021.

12) Offset of any utilities exposed in trial pits were measured perpendicular to the nearest wall.

CLIENT:

MCPHILLIPS

PROJECT:

LEE CANAL BRIDGE SURVEY

TITLE:

LEE CANAL BRIDGE SLIT TRENCHES

PROJECT NO.: 190694		DRAWING NO.: 002	
ISSUE REFERENCE: C		DATE: April 2022	
INTERP. BY: JB	DATE: SEP 2021	DRAWN BY: JB	DATE: SEP 2021
CHECKED BY: DG	DATE: APR 2022	APPROVED BY: SB	DATE: APR 2022
DRAWING SCALE: 1:20			
PLOTTED DRAWING SIZE: A0 (1189 x 841)			

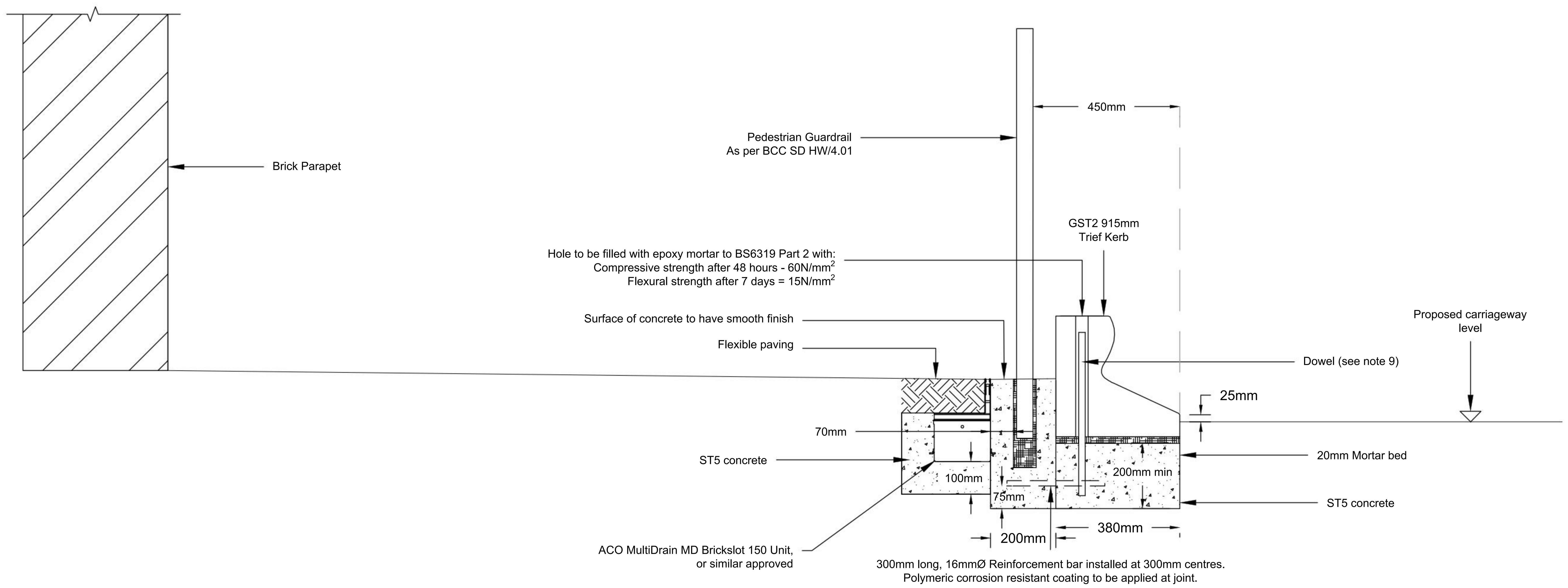
FUGRO GEOSERVICES LIMITED
Focal Point, Newmarket Carriageway
Bottisham, Cambridge, CB25 9BD
Tel: +44 (0)870 600 80 50

Appendix B

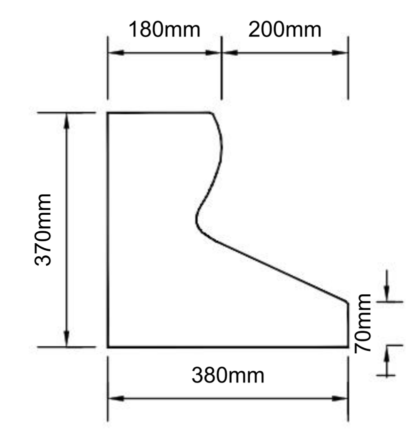
Notes:

1. Do not scale.
2. This drawing is to be read in conjunction with the relevant Dudley Road contract drawings and documents.
3. The Contractor shall verify the presence and location of all services before undertaking any work in any area of the site by carrying out a full non-intrusive survey of the entire site before commencing the works.
4. Drawing to be read in conjunction with Birmingham City Council Volume H Works Information.
5. Cycle demarcation blocks as per Marshalls CYCLEWAY BLOCK PV9002550.
6. Cycle demarcation end blocks as per Marshalls CYCLEWAY STOP END BLOCK PV9005500.
7. Demarcation drainage detail to be placed at 5m intervals along demarcation strip.
8. Dowels to be 16mm Ø (H16). High yield grade B5008 ribbed complying with 8S4449:2005 (min. length 500mm with 150mm min. embedment). Dowels to be cast insitu with ST5 concrete foundation or set in pre-drilled holes with epoxy resin anchor grout to 8S6319 parts 2, 3 & 7 with strengths after 24 hours respectively:

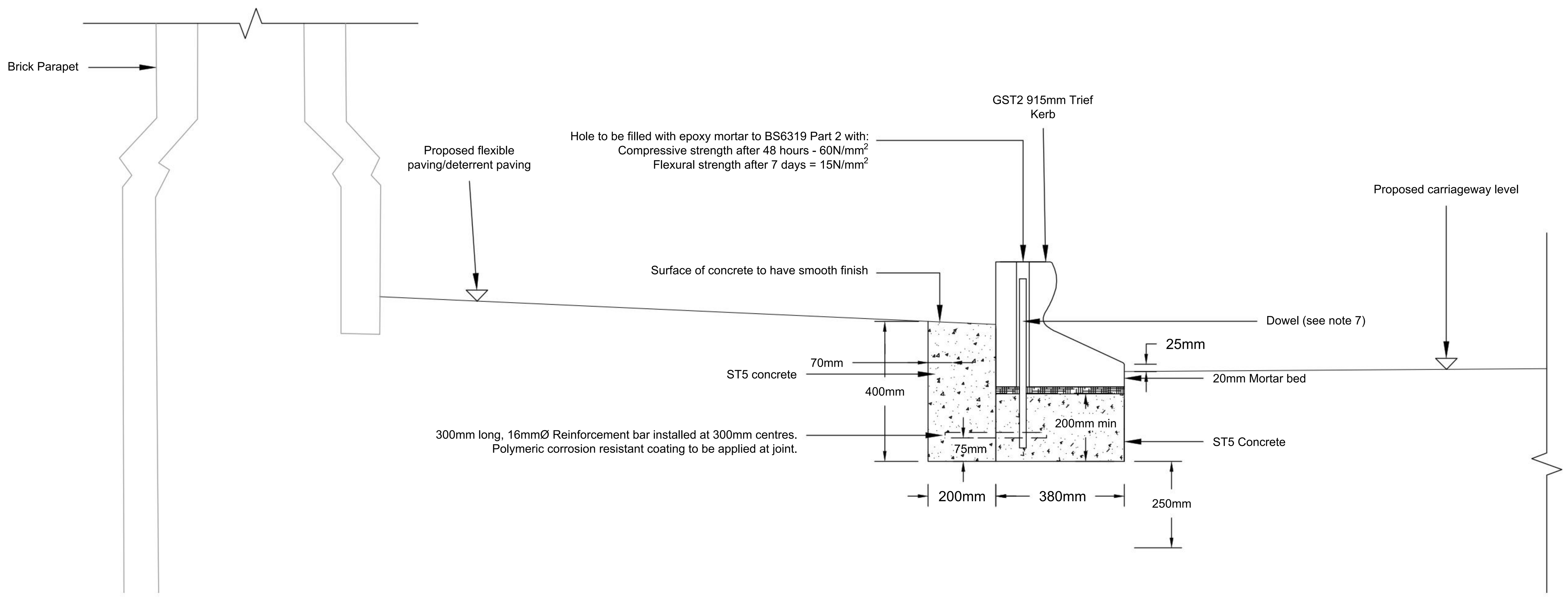
   Compressive = 110N/mm2
   Flexural= 28N/mm2
   Tensile= 12N/mm2



TYPICAL TRIEF KERB CROSS SECTION ACROSS LEE BRIDGE
SCALE 1:10



STANDARD GST2 TRIEF KERB PROFILE
SCALE 1:10



TYPICAL TRIEF KERB CROSS SECTION ACROSS SPRING HILL BRIDGE
SCALE 1:10

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	17/11/20	SUITABLE FOR REVIEW AND COMMENT	KG	DM	MP	CM
P02	29/04/21	WORK IN PROGRESS - SUITABLE FOR REVIEW AND COMMENT	KG	DG	MP	CM
P03	11/11/21	CHANGES INCORPORATING BCC COMMENTS	KG	MP	MP	CM

Designer:
Jacobs
7th Floor, 2 Colmore Square, 38 Colmore Circus
Queensway, Birmingham, B4 6BN
Tel:+44(0)121 237 4000 www.jacobs.com

Client
McPHILLIPS
FOR
Birmingham City Council

Project
A457 DUDLEY ROAD IMPROVEMENT SCHEME

Drawing title
KERBS, FOOTWAYS & PAVED AREAS STANDARD DETAILS SHEET 2

Drawing status
S3 - SUITABLE FOR REVIEW AND COMMENT

Scale	AS SHOWN@A1	DO NOT SCALE
Jacobs No.	B2376400	Rev
Client no.	BCC02715	P03

Drawing number
BCC02715-JAC-HKF-00-DE-C-1002

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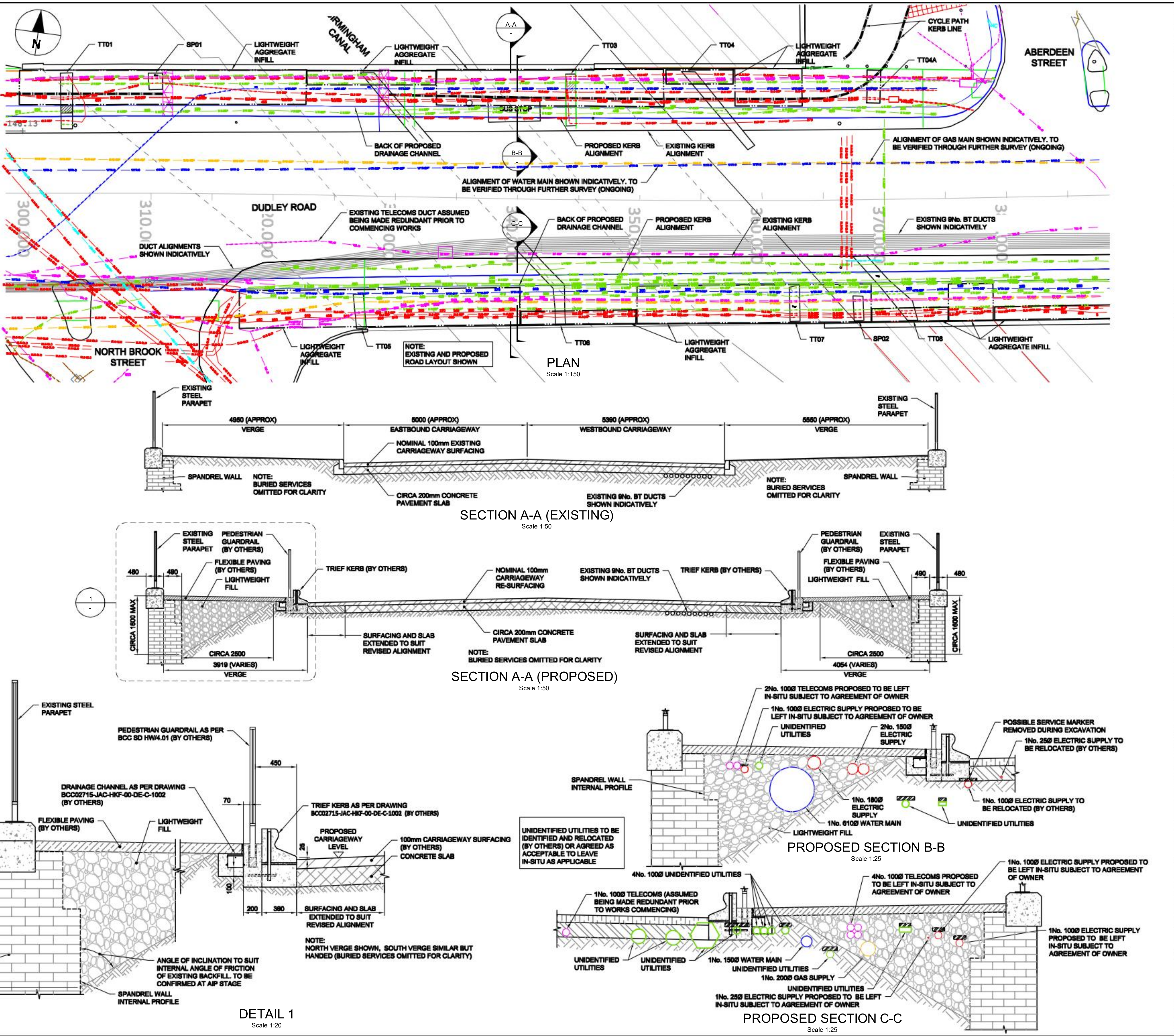
Appendix C



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AECOM

NOTES

1. DO NOT SCALE FROM THIS DRAWING.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
3. HIGHWAYS DESIGN IN ACCORDANCE WITH DRAWINGS BCC02715-JAC-HML-00-M2-C-1000, BCC02715-JAC-HML-00-M2-C-1002 AND BCC02715-JAC-HML-00-M2-C-1003 BY JACOBS.
4. TRIEF KERB, PEDESTRIAN GUARDRAIL AND DRAINAGE IN ACCORDANCE WITH DRAWING BCC02715-JAC-HKF-00-DE-C-1002 BY JACOBS.
5. DETAILS OF BURIED SERVICES (INCLUDING LOCATIONS) IN ACCORDANCE WITH REPORT REFERENCE 190694REP_003 BY FUGRO.

KEY

- GPR LINEAR FEATURE
- VIRGIN MEDIA
- WATER SUPPLY
- WATER SUPPLY
- WATER SUPPLY
- TELECOMS
- TELECOMS
- GAS SUPPLY
- GAS SUPPLY
- GAS SUPPLY
- ELECTRIC SUPPLY
- ELECTRIC SUPPLY
- UNIDENTIFIED UTILITIES
- UNIDENTIFIED UTILITIES
- PROPOSED KERB ALIGNMENT
- CYCLE PATH KERB LINE
- BOUNDARY OF LIGHTWEIGHT AGGREGATE INFILL
- TT0X TRIAL HOLE - REFER TO REPORT REFERENCE 190694REP_003 BY FUGRO

Revision Details	By	Check	Date	Rev
Feasibility	J.M.	B.S.	12/07/22	A

Designed	Drawn	Checked	Approved	Date
B.S.	J.M.			

Internal Project No. 60680804	Design Stage Feasibility
Scale @ A1 As Shown	Discipline Civil - Bridges and Structures

PURPOSE OF ISSUE

PRELIMINARY DRAWING
NOT FOR CONSTRUCTION

PROJECT

A547 DUDLEY ROAD REVISED MAIN SCHEME

Birmingham City Council

CLIENT

BIRMINGHAM CITY COUNCIL

Council House
Victoria Square
Birmingham
United Kingdom
B1 1BB
0121 303 1111 TEL
WWW.BIRMINGHAM.GOV.UK

CONSULTANT

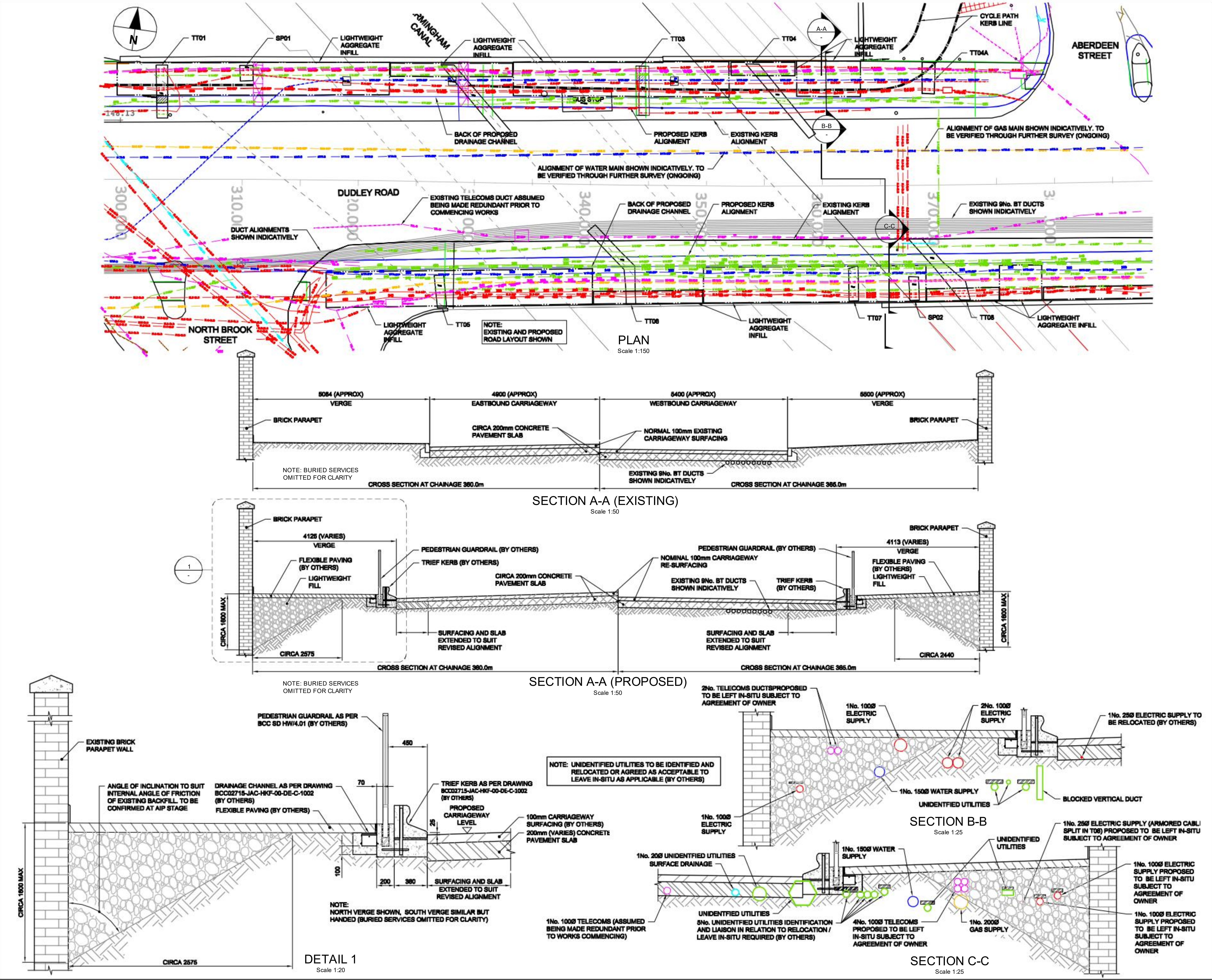
AECOM
THE COLMORE BUILDING
BIRMINGHAM
UNITED KINGDOM
B4 6AT
0121 212 3035 TEL
WWW.AECOM.COM

SHEET TITLE

LEE CANAL BRIDGE
GENERAL ARRANGEMENT
OPTION 1 - LIGHTWEIGHT FILL

SHEET NUMBER

DRAWING NUMBER 60680804-FEAS-DWG-0001 REVISION A



AECOM

NOTES

1. DO NOT SCALE FROM THIS DRAWING.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
3. HIGHWAYS DESIGN IN ACCORDANCE WITH DRAWINGS BCC02715-JAC-HML-00-M2-C-1000, BCC02715-JAC-HML-00-M2-C-1002 AND BCC02715-JAC-HML-00-M2-C-1003 BY JACOBS.
4. TRIEF KERB, PEDESTRIAN GUARDRAIL AND DRAINAGE IN ACCORDANCE WITH DRAWING BCC02715-JAC-HKF-00-DE-C-1002 BY JACOBS.
5. DETAILS OF BURIED SERVICES (INCLUDING LOCATIONS) IN ACCORDANCE WITH REPORT REFERENCE 190694REP_003 BY FUGRO.

KEY

- GPR LINEAR FEATURE
- VIRGIN MEDIA
- WATER SUPPLY
- WATER SUPPLY
- WATER SUPPLY
- TELECOMS
- TELECOMS
- GAS SUPPLY
- GAS SUPPLY
- GAS SUPPLY
- ELECTRIC SUPPLY
- ELECTRIC SUPPLY
- UNIDENTIFIED UTILITIES
- UNIDENTIFIED UTILITIES
- PROPOSED KERB ALIGNMENT
- CYCLE PATH KERB LINE
- BOUNDARY OF LIGHTWEIGHT AGGREGATE INFILL
- TT0X — TRIAL HOLE - REFER TO REPORT REFERENCE 190694REP_003 BY FUGRO

Revision Details	By	Check	Date	Rev.
Feasibility	J.M.	B.S.	12/07/22	A

Designed	Drawn	Checked	Approved	Date
B.S.	J.M.			

Internal Project No. 60680804 — Design Stage: Feasibility
Scale @ A1: As Shown — Discipline: Civil - Bridges and Structures

PURPOSE OF ISSUE

PRELIMINARY DRAWING
NOT FOR CONSTRUCTION

PROJECT

A547 DUDLEY ROAD REVISED MAIN SCHEME

Birmingham City Council

CLIENT

BIRMINGHAM CITY COUNCIL
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Victoria Square
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0121 303 1111 TEL
WWW.BIRMINGHAM.GOV.UK

CONSULTANT

AECOM
THE COLMORE BUILDING
BIRMINGHAM
UNITED KINGDOM
B4 6AT
0121 212 3035 TEL
WWW.AECOM.COM

SHEET TITLE

LEE RAIL BRIDGE
GENERAL ARRANGEMENT
OPTION 1 - LIGHTWEIGHT FILL

SHEET NUMBER

DRAWING NUMBER	REVISION
60680804-FEAS-DWG-0002	A

Last saved by: DANIEL.SIDAWAY(2020-03-05) Last Plotted: 2020-03-05
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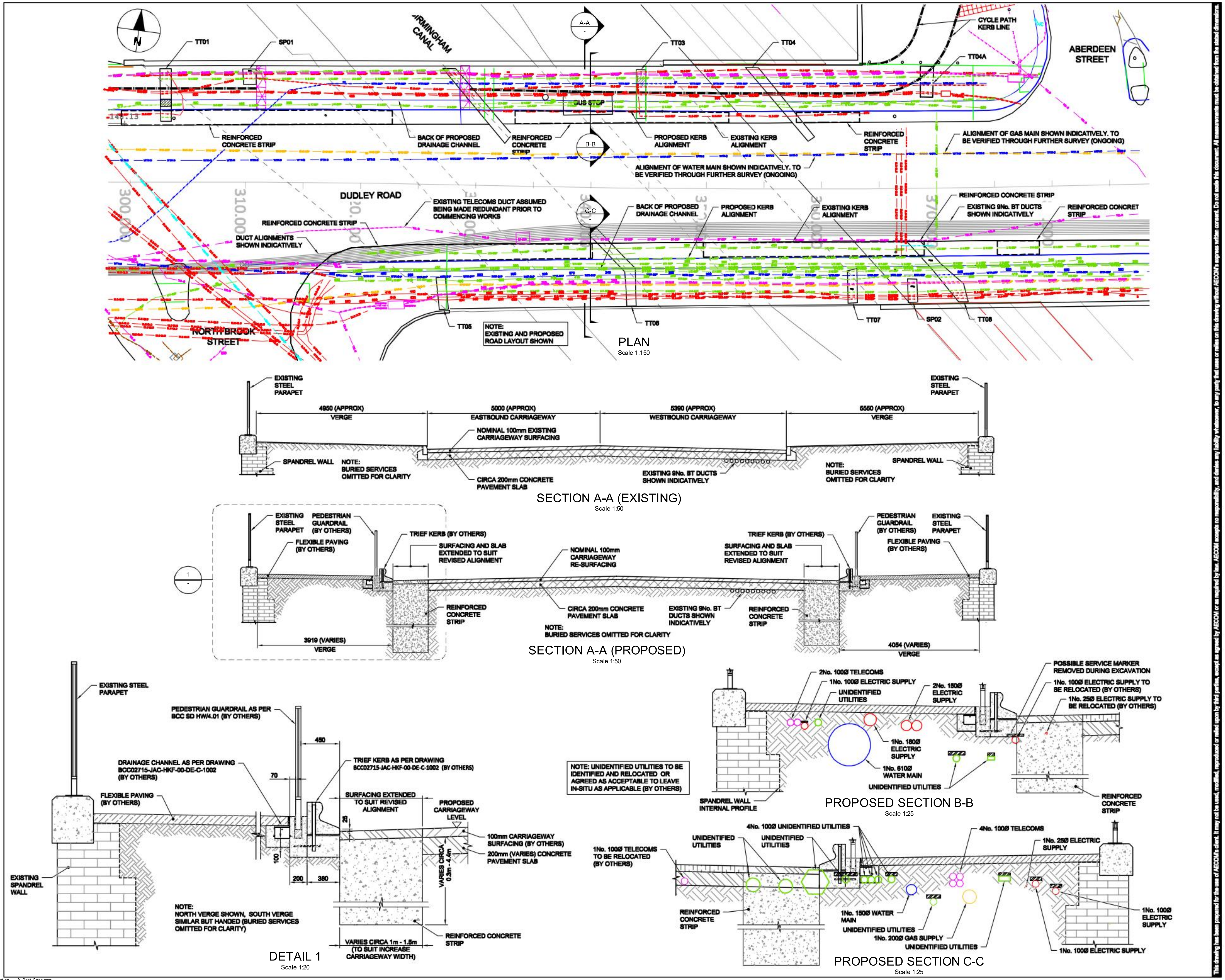
Appendix D

AECOM		Residual Hazard and Risk Log				
		AECOM Project Name:				
Design Stage	Concept	AECOM Project No:	60680804			
Item No.	**Feature, element, structures, process or activity considered**	**Risk Factor**	**Output Residual Hazard to Residual Hazard Log**	**Output Residual Risk to Residual Hazard Log**	**Environment/Persons at Risk?**	**Design input Control to Eliminate or Reduce Hazard and/or Reduce Risk**
D1	Excavation around live services	8	Excavation and fill reinstatement around live services	Service strike	Contractor	Dig depth and extent reduced through proposed consideration of CS 454 loading. Locations of services dervied from survey shown on design drawings.
D3	Change in proportion of load effects due to permanent and transient loads	5	Change in proportion of load effects due to permanent and transient loads	Collapse of spandrel/wing walls	Public	Monitoring proposed post construction works with associated trigger points
D5	Assessment of existing spandrel/wing walls	5	Incorrect capacity calculated	Collapse of spandrel/wing walls	Public	Design principle to maintain existing load effects for which spandrel/wing walls are qualitatively assessed as adequate, consistent with approach specified in CS 454
D7	Internal profile of spandrel/wing walls	5	Design based on internal profile of spandrel/wing walls as identified through coring and subsequent GPR survey. Design may be invalid if internal profile not consistent with findings of existing investigations	Collapse of spandrel/wing walls	Public	Assumed profile and risk to be highlighted on design drawings.
D8	Abnormal vehicle movements	5	Increase in load effects on spandrel/wing walls relative to existing carriageway alignment if vehicles are routed in Lane 1.	Collapse of spandrel/wing walls	Public	Risk to be highlighted on design drawings. Requirement for specific assessment for SO and/or STGO vehicles.
C1	Excessive surcharge loading on spandrel/wing walls due to mechanical plant	10	Load effects on spandrel/wing walls due to plant loading in excess of capacity	Collapse of spandrel/wing walls	Contractor/Public	Risk to be highlighted on design drawings. Assessment to be undertaken to determine permissible proximity to spandrel walls of mechanical plant.
C2	Construction works adjacent to live carriageway	8	Errant vehicles entering work site.	Errant vehicle striking operatives/plant. Errant vehicles striking exposed services. Errant vehicles entering excavation	Contractor/Public	Design suitable to permit phased approach to works. Risk to be highlighted on design drawings.
C3	Conflict with pedestrians	6	Pedestrians entering work site	Injury to public	Public	Risk to be highlighted on design drawings.
M1	Excavation of lightweight fill to access buried infrastructure	10	Lightweight fill not reinstated 'like for like' following removal to access buried infrastructure	Additional loading on spandrel/wing walls leading to collapse	Public	Requirement for statutory undertakers to give prior notification of proposed works to the asset owners in accordance with the New Roads and Street Works Act 1991

Appendix E



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NOTES

1. DO NOT SCALE FROM THIS DRAWING.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
3. HIGHWAYS DESIGN IN ACCORDANCE WITH DRAWINGS BCC02715-JAC-HML-00-M2-C-1000, BCC02715-JAC-HML-00-M2-C-1002 AND BCC02715-JAC-HML-00-M2-C-1003 BY JACOBS.
4. TRIEF KERB, PEDESTRIAN GUARDRAIL AND DRAINAGE IN ACCORDANCE WITH DRAWING BCC02715-JAC-HKF-00-DE-C-1002 BY JACOBS.
5. DETAILS OF BURIED SERVICES (INCLUDING LOCATIONS) IN ACCORDANCE WITH REPORT REFERENCE 190694REP_003 BY FUGRO.

KEY

- GPR LINEAR FEATURE
- VIRGIN MEDIA
- WATER SUPPLY
- WATER SUPPLY
- WATER SUPPLY
- TELECOMS
- TELECOMS
- GAS SUPPLY
- GAS SUPPLY
- GAS SUPPLY
- ELECTRIC SUPPLY
- ELECTRIC SUPPLY
- UNIDENTIFIED UTILITIES
- UNIDENTIFIED UTILITIES
- PROPOSED KERB ALIGNMENT
- CYCLE PATH KERB LINE
- BOUNDARY OF REINFORCED CONCRETE STRIP
- TT0X TRIAL HOLE - REFER TO REPORT REFERENCE 190694REP_003 BY FUGR

Feasibility	J.M. B.S.	12/07/22	A
Revision Details	By Check	Date	Rev.

Designed B.S.	Drawn J.M.	Checked	Approved	Date
Internal Project No. 60680804	Design Stage Feasibility		
Scale @ A1 As Shown	Discipline Civil - Bridges and Structures		

PURPOSE OF ISSUE

PRELIMINARY DRAWING
NOT FOR CONSTRUCTION

PROJECT

A547 DUDLEY ROAD REVISED MAIN SCHEME

Birmingham City Council

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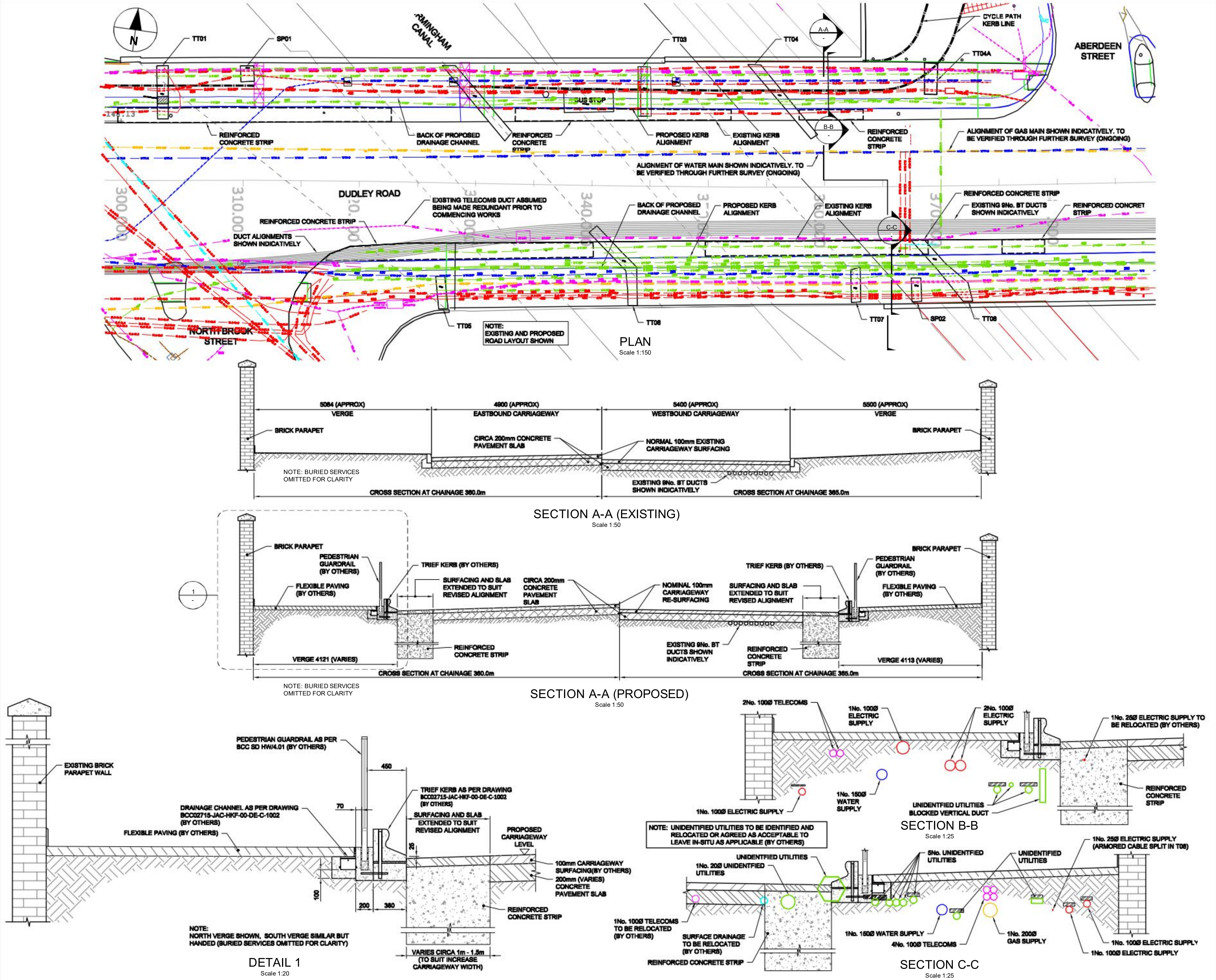
SHEET TITLE

LEE CANAL BRIDGE
GENERAL ARRANGEMENT - OPTION 2
REINFORCED CONCRETE STRIP

SHEET NUMBER

DRAWING NUMBER 60680804-FEAS-DWG-0003
REVISION A



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NOTES

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3. HIGHWAYS DESIGN IN ACCORDANCE WITH DRAWINGS BCC02715-JAC-HML-00-M2-C-1000, BCC02715-JAC-HML-00-M2-C-1002 AND BCC02715-JAC-HML-00-M2-C-1003 BY JACOBS.
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- CYCLE PATH KERB LINE
- BOUNDARY OF LIGHTWEIGHT AGGREGATE INFILL
- TT0X — TRIAL HOLE - REFER TO REPORT REFERENCE 190694REP_003 BY FUGRO

Revision Details	By / Check	Date	Rev.
Feasibility	J.M. / B.S.	12/07/22	A

Designed	Drawn	Checked	Approved	Date
B.S.	J.M.			

Internal Project No: 60680804 — Design Stage: Feasibility
Scale @ A1: As Shown — Discipline: Civil - Bridges and Structures

PURPOSE OF ISSUE

PRELIMINARY DRAWING
NOT FOR CONSTRUCTION

PROJECT

A547 DUDLEY ROAD REVISED MAIN SCHEME

Birmingham City Council

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SHEET TITLE

LEE RAIL BRIDGE
GENERAL ARRANGEMENT - OPTION 2
REINFORCED CONCRETE STRIP

SHEET NUMBER

DRAWING NUMBER	REVISION
60680804-FEAS-DWG-0004	A

Appendix F

AECOM	Residual Hazard and Risk Log					
	AECOM Project Name:					
Design Stage: **Concept**	AECOM Project No:	60680804				

Item No.	Feature, element, structures, process or activity considered	Risk Factor	Output Residual Hazard to Residual Hazard Log	Output Residual Risk to Residual Hazard Log	Environment/Persons at Risk?	Design input Control to Eliminate or Reduce Hazard and/or Reduce Risk
D1	Excavation around live services	8	Excavation and fill reinstatement around live services	Service strike	Contractor	Dig depth and extent reduced through proposed consideration of CS 454 loading. Locations of services dervied from survey shown on design drawings.
D3	Change in proportion of load effects due to permanent and transient loads	5	Change in proportion of load effects due to permanent and transient loads	Collapse of spandrel/wing walls	Public	Monitoring proposed post construction works with associated trigger points
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T: +44 (121) 710 1100
aecom.com

EXECUTED AS A DEEDthe day and year first written

EXECUTED AS A DEED by affixing THE COMMON SEAL of BIRMINGHAM CITY COUNCIL in the presence of:-	))))

Authorised Signatory

EXECUTED AS A DEED by CANAL & RIVER TRUST acting as trustee of the Waterways Infrastructure Trust by affixing the common seal of CANAL & RIVER TRUST in the presence of:-	)))))))

Authorised Signatory