A605 Kings Dyke Level Crossing Replacement

Engineering Options Feasibility Report

June 2014

Cambridgeshire County Council
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## Issue and revision record

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1 Introduction

1.1 Background

Mott MacDonald Ltd has been commissioned by Cambridgeshire County Council (CCC) to appraise the feasibility of seven options for replacing the existing Kings Dyke level crossing. CCC has identified the need to replace the level crossing and have produced seven options to be considered for engineering feasibility. Jackson Civil Engineering Group Limited has been commissioned by Mott MacDonald Ltd to provide early Contractor involvement (ECI) advice with regards to buildability and construction costs, which have been included in this report.

CCC previously commissioned a study to undertake an outline assessment to consider the potential value for money of replacing the existing Kings Dyke Level Crossing and to identify the benefits closing it might bring. The Kings Dyke level crossing, shown on the Figure below, is an at-grade crossing located where the A605 crosses the Peterborough-Ely railway line, between Peterborough and Whittlesey stations.

Operation of the crossing is by means of control from the signal box at Kings Dyke where sighting of the crossing must be maintained. The Signal box controls approximately four miles of the line (including signals and the CCTV crossing at Funthams Lane), bordering Peterborough and Whittlesey signalling areas.

The seven options proposed by CCC that have been brought forwards for further investigation are:

- Option 1 Online within existing highway boundary
- Option 2 On line within the existing highway boundary allowing for temporary working or traffic management on land outside the highway during construction
- Option 3 Part on line contiguous to the existing highway keeping one or more main line traffic flowing under traffic management control during construction
- Option 4 Off line alignment to the north

Figure 1-1 – Existing Level Crossing Location (© Getmapping plc)
Option 5 Off line alignment to the south
Option 6 Tunnel solution
Option 7 Wider area bypass

This report will review the feasibility of these options.

1.2 Scope

This document sets out the seven proposed level crossing replacement options which have been assessed for the following:

- Land take requirements;
- Network Rail (NR) constraints;
- Ground conditions;
- Existing statutory utilities constraints / diversions required;
- Buildability / construction methodology;
- Transport planning and access to existing property requirements;
- Temporary works requirements;
- Traffic Management requirements;
- Works phasing requirements;
- Feasibility level cost estimate.
2 Feasibility Criteria

2.1 Site Constraints / Conditions

There are a number of site constraints that have been taken into account for the options assessment and these are described below.

2.1.1 Land Ownership

Drawing 5040010/HW/LO/001 Rev B Land Ownership Plan and Kings Dyke Land Reference Schedule has been provided by CCC (refer to Appendix A). The existing site is very constrained by existing land use, as shown on Figure 1-1 above.

The area to the north and south of the A605 east of the crossing for the new routes proposed consists of land plots 10 as shown in Appendix A. Land to the west of the crossing and north of the A605 is shown as plot 1. The land to the west of the crossing and south of the A605 are plots 2 and 3. There are a number of businesses located to the south west of the crossing with access directly off the A605. It should be noted that there are areas to the west of the level crossing, both north and south of the A605, where land ownership has not been identified on the drawing provided for this study.

2.1.2 Network Rail

The following Network Rail (NR) criteria have been adhered to:

- The existing signal box at the Kings Dyke level crossing (LC) controls approximately four miles of the line (including signals and the CCTV crossing at Funthams Lane), bordering Peterborough and Whittlesey signalling areas. The signal box is currently continuously manned (i.e. twenty four hours per day, seven days per week) as visibility of the Kings Dyke LC is required for its operation. Following discussions with NR it is anticipated that the signal box would have to stay, unmanned with the signalling fully automated for the length of track controlled by this signal box, once the
crossing closes. Visibility of the Kings Dyke LC from the signal box is to be maintained until the LC is closed.

- Following discussions with NR, temporarily or permanently relocating the signal box during the works is technically possible, and a very high level cost estimate for this is £2m. It should be noted that a new signal box would have to be built and commissioned, using new technology (no major contractors would have the expertise to construct a mechanical signal box anymore), before decommissioning and removing the old one.
- The existing signal box is 5.2m tall above rail level. NR has informed us that they don’t have a standard for clearance over signal boxes, as they view this as a somewhat unusual scenario. However, as long as an over the signal box solution is risk assessed and proved to be acceptable from a signalling perspective, there is nothing in standards to preclude a 600mm clearance. NR strongly recommend that building over the signal box is avoided. However, NR has stated that if this really is the most desirable option, it is likely that some agreement could be reached and that building over the signal box cannot be outright excluded at this stage.
- The proposed bridge should have a minimum soffit height of 5800mm and a minimum clearance from the outer running rails of 4500mm.
- Network Rail land can be used for the permanent works so long as gauging and sighting aren’t compromised.
- Vehicular access must remain to the existing signal box and the track from Kings Dyke LC to Ramsey Road LC, approximately 2.3 km east of the Kings Dyke LC, for the permanent works.
- It has been advised by NR that weekend (54 hours), night (8 – 10 hours), and bank holiday weekend (72 hours) possession lengths would be available.
- All new structures must be built to provide provision for future electrification and to European gauging standards.
- There is no requirement to include for future additional tracks as part of this scheme.
- The existing railway is not electrified; however NR has requested that the options take into account future electrification. The design of a structure carrying or passing over electrified lines must comply with the electrical clearance requirements in GE/RT8025: Electrical protective provisions for electrified lines.

2.1.3 Ground Conditions

The Preliminary Sources Study Report (Atkins ref. GTG 20131584/R001) carried out in January 2014 includes preliminary geotechnical information. The typical ground conditions at the site are 1.2m made ground and 1.0m march gravels overlying oxford clay likely to be encountered from 0.5 to 3m depth with an expected thickness of 40+m. The Preliminary Sources Study Report details a high perched water table between 1.1 and 4.0m below ground level (average of 2.0m) present on the site which will affect the construction of excavations and foundations. The preliminary geotechnical engineering assessment within this Atkins report recommends the use of piled foundations for proposed structures. Mott MacDonald has undertaken a review of the available ground conditions information with respect to the proposed options and produced a geotechnical advice note which is included in Appendix B. Based on the available information, a the Class A material in conjunction with a 1 in 2 slope has been selected and it is advised that this is populated with low maintenance vegetation. The estimated total consolidation settlements are estimated in the Preliminary Sources Study Report to be 100mm. However the presence of peat, such as in the area of Option 5, would significantly increase this value if any is found beneath the footprint of the embankments.
The flood map for the site, shown in Figure 2-2 below, indicates that the existing level crossing is not within the flood plain. However, the areas surrounding the level crossing are within flood zone 2 and flood zone 3.

Zone 2 floodplain estimates the annual probability of flooding as one in one thousand (0.1%) or greater from rivers and the sea but less than 1% from rivers or 0.5% from the sea. Alternatively, where information is available they may show the highest known flood level. Zone 3 estimates the annual probability of flooding as one in one hundred (1%) or greater from rivers and a one in two hundred (0.5%) or greater from the sea. Alternatively, where information is available they may show the highest known flood level.
2.1.4 Existing Utilities

Drawing 50400010_HW_SU_001 Statutory Undertakers Composite Plans has been provided by CCC for this feasibility assessment and has been used to identify potential utility services diversions (refer to Appendix C). The drawing shows that there are existing buried gas, electric, water, and BT services in the vicinity of the level crossing. There is also existing overhead BT. There is an electrical substation accessed from the westbound A605 approximately 190m to the east of the level crossing. The statutory undertakers have been consulted regarding possible utility diversions and associated costs and programme implications. The details of these consultations are included in the construction methodology reports for each of the options.

2.2 Design Standards and Assumptions

This feasibility study adheres to the following design standards:

- Civils assets will be developed in line with the suite of Network Rail standard design where appropriate, e.g. the requirements for piling adjacent to the railway are set out in NR/L3/INI/CP0063.
- New structures will be developed in accordance with the relevant Eurocodes with a design life of 120 years.
- Highways elements will be developed in accordance with the Design Manual for Roads and Bridges (DMRB), Traffic Signs Manual or other guidance as directed by Cambridgeshire County Council as appropriate.
- New parapets to overline road bridges will be in accordance with DMRB TD19/06 Requirements for Road Restraint Systems.
- Headroom to new overline structures have been confirmed by Network Rail; the overline structure is to comply with TRK/2049 Section A81.c which requests a 5800mm tolerance in order to fulfil TENS requirements considering the anticipated increase in freight and trans-European rail moves along this particular route.
- Footpath on the bridge structure and approaches is to be on the eastbound (‘northern’) side only and the proposed footpath will be 2m wide.
- There are no specific requirements for cyclist or equestrian use.
- The existing speed limit on the A605 is 40mph which will be retained for the proposed options.
- The proposed carriageway will be 7.3m wide in keeping with the existing. An overall bridge structure width has been assumed as 13.2m (comprising 7.3m carriageway, 2m footpath, 0.6m verge on non-footpath side, 2no 1m wide hard strips, and 2no 0.65m widths to allow for parapets). If noise barrier(s) or any other additional features are required, the width may need to increase. For the bridge approaches it is assumed that an overall width of 15.3m between the top of embankments is required (comprising 7.3m carriageway, 2m footpath, 0.6m verge on non-footpath side, 2no 1m wide hard strips, and 2no 1.7m widths to allow for lighting and vehicle restraint).
- It has been assumed that the “stopped” sections of the A605 once the level crossing is removed will remain as highway, to ensure that rights of access remain for the statutory utility undertakers for services in the existing highway boundary and the existing electrical substation.
2.3 Overbridge

For all overbridge options, the substructure will be set 4.5m back from the running edge of the cess rail on either side. This is to ensure that the substructures can be constructed with minimum or no possession. This setback will also eliminate the need to design the substructure for derailment impact, which means the substructure is likely to be more cost effective. To minimise the possession requirement for constructing the superstructure, a quick and self-supporting solution should be considered, e.g. beam and slab deck. The beams can be erected during a night-time possession, with permanent shutters spanning between the beams. This would allow the construction of the deck to follow continuously without possession.

Two options have been considered for the bridge construction; Option A Precast Prestressed Concrete (PCC) Beams and Option B Steel Composite Deck. For the purpose of this feasibility assessment and based on historical schemes, PPC beams have been assumed. However, supplementary cost information has been included to indicate the potential change in cost should CCC prefer the use of steel.

Option A - Precast Prestressed Concrete (PCC) Beams on Cantilever abutment

This form of superstructure construction is quick and requires minimum possession time. The bridge will consist of PPC beams simply supported on full height reinforced concrete abutments. An insitu reinforced concrete deck is designed to act compositely. Permanent formwork will be used to support the wet deck concrete during construction.

PPC beams are heavy and require a bigger crane for lifting when compared to other forms of construction. Taking into consideration the site constraints, the use of PCC beams is likely to be acceptable.

A preliminary assessment of the foundation type required for the proposed structure has been undertaken based on the available ground information in the proximity of the level crossing. The assessment concludes that spread foundations are not appropriate for the bridge abutments and a piled solution is required. A detailed investigation of the pile design has not been undertaken at this stage, but an initial assessment suggests that a CFA piling system will be appropriate due to its vibration free and quick installation. Note that full height abutments will generate additional horizontal pressures on the piles but these can be designed accordingly. The piling activity and full height abutments will increase the proportion of wet concreting on site, which will have an impact on health and safety, and will be a risk for the site force working in the close proximity of the live rail traffic. It is important to mention here that the final choice of foundation should be confirmed following a more detailed site investigation, which is outside the scope of this study.

Option B - Steel Composite deck on Cantilever abutment

This form of construction will require rail possessions for the installation of the steel beams. The steel beams can be installed in pairs with cross bracing, with the permanent framework already attached, providing the necessary stability during erection and reducing the possession duration. The steel beams are generally spaced between 2.5 to 3.5m apart resulting in fewer girders compared to a PPC beams solution.
Steel beams are lighter compared to PPC and allow for quick installation utilising a smaller crane with minimal possession duration. A steel composite bridge will also benefit the construction by minimising the construction depth and the height of the approach embankments when compared to the PPC option.

However, the long term maintenance cost of steel structure is generally recognised as higher than a PPC beam solution, particularly with regards to the protected paint system. Alternatively, the use of weathering steel should be considered to eliminate the requirement of maintenance painting.

A steel bridge will require earth bonding as it will potentially be adjacent to the future OLE. The requirements for the design of earthing and bonding systems for 25kV a.c. electrified lines would need to be as described in NR/SP/ELP/21085.

Consideration has been given to both PCC and steel beams and it has been determined for the purpose of this study that the use of PCC is assumed.

Abutments and wingwalls:

The abutments will be the width of the bridge deck + 0.7m which allows for cheek walls. Wingwall length will match the embankment section, and be the same height as the abutment dropping to zero at the toe of the embankment. Its alignment is typically in line with the abutment face and requires the shortest length of wall. It is also usual to provide a feature finish to the abutment and wingwalls.

For the approaches to the bridge structure, an earth embankment with a minimum slope of 1 in 2 has been used to determine land take. A shallower slope could be used, however this will increase land take. It could be that during future stages of the scheme, supporting the approach on piers could be looked into.

### 2.4 Drainage

The proposed options will require adequate drainage. The topographical survey shows that the A605 has existing road gullies along both sides of the carriageway. It is unknown where these gullies drain to however, it is assumed that the proposed works would drain to the existing highway drainage. For the bridge structure it is assumed that, due to the short span, the surface water will drain to the bridge approaches. For the bridge approaches, where these are earth embankments, it is assumed that kerb and gully drainage will be provided with a carrier drain buried within the earth embankment supporting the road. The carrier drains will connect into the exiting drainage system at tie in locations to the existing A605. For the bridge approach options with vertical walls rather than earth embankment, it is assumed that the drainage will be kerb drainage, such as Envirokerb or similar. A 1m corridor has been allowed both eastbound and westbound at the toe of the embankment or vertical wall for the provision of drainage, such as a ‘French’ drain with inspection chambers. Pollution control for the existing drainage system is unknown and it should be noted that this will be investigated and included for at the detailed design stage.

### 2.5 Lighting

The provision of street lighting will be evaluated at the detailed design stage. However, it is assumed for the purpose of this report that street lamps will be provided every 20m. It is possible that the proposed works could be street lit from one side of the carriageway only, or unlit, to reduce the overall proposed permanent works cross-section, and thus land take.
2.6 Vehicle Restraint System (VRS) Requirements

At this feasibility stage the following have been assumed for the VRS:

Bridge Structure

The bridge structure should be provided with an H4a containment class parapet with a minimum height of 1500mm and a very severe impact severity classification. It has been assumed that a 600mm wide plinth will be provided to support the parapet. A minimum distance of 600mm is required between the front face of the parapet and the kerb.

Transition

To provide a transition of VRS between the bridge structure and the approaches, an additional 8m of H4a parapet extending beyond the back of the abutment (supported on concrete walls cantilevered off the back of the abutment) will be required, 9.3m of N2 parapet supported on a solid concrete base 9m long x 2m wide x 1.2m deep, and 9m of N2 safety fence to N2 parapet transition piece.

Bridge Approaches

N2 safety fence with W1 working width is assumed to be required for the bridge approaches. The length of the VRS beyond the hazard (i.e. the embankment) has been assumed as 30m beyond the bottom of the embankment (where practical) – in all 4 corners (because errant vehicles could cross the carriageway as a protected central reservation is not provided). It should be noted that the practicalities of providing VRS for 30m beyond the hazard may be problematic where the proposed bridge approaches tie into the existing A605 and a deviation from the usual standards may be required.

The VRS will need to be risk assessed during the design phase (which is outside of this feasibility phase) and therefore may be subject to change.

2.7 Road Pavement Construction

As there is no information available on the CBR value, a pavement design has been based on a CBR of 2%. It should be noted that if during detailed design and future investigations for the design the CBR value is determined to be less than 2%, ground stabilisation will be required. This will increase the Option cost estimates contained within this report. The following pavement layers have been used for this feasibility study based on the CCC Road Construction Specification:

- 40mm (hot rolled asphalt) HRA surface
- 65mm HRA binder
- 215mm Base
- 520mm Type 1 Sub base
3 Option 1: Online within existing highway boundary

This option comprises an online bridge within the existing highway boundary to replace the existing level crossing.

Following an initial inspection of this option, it is considered that there is not enough room within the highway boundary to physically fit the required works cross-section for the temporary works and permanent solution and a number of concerns were raised. It would not be possible to incorporate a Contractors compound and traffic management within the exiting highway boundary. To construct this option, as well as an additional footprint of land required, the A605 would need to be closed for approximately 10 months. The diversion route, via North Bank, that would be required has a history of flooding and accidents and therefore is not favoured by CCC. An alternative diversion route would be via the B1040 and the A47, which is an approximately 50km round trip. All existing statutory utilities would need diverting, and access to the properties immediately south west of the level crossing does not appear to be possible due to the required height of the bridge over the railway and lack of space between the existing road alignment and property entrances. This would require relocation or removal of these properties.

Given the impracticalities of this option as described above, it has been agreed with CCC that the feasibility of this option is not to be pursued in further detail at this time.
4 Option 2: On Line within Highway Boundary, Temporary Works Outside

The basis of this option is an online bridge within the existing highway boundary, allowing for temporary working or traffic management on land outside the highway during construction. The proposed option is illustrated in a general arrangement drawing MMD-332955-C-DR-XX-3001 in Appendix D of this report.

Having reviewed the available information, it is not viable to fit in a 15.3m wide solution whilst maintaining one lane of traffic during the works. In terms of buildability, the existing A605 would have to be closed for the vast majority of the construction period for both the bridge structure and the approaches. The A605 closure diversion would be via the A47 Thorney Road to the north, an approximately 50 kilometres round trip.

If the A605 was not closed, costly temporary works would be required. Traffic management outside of the highway boundary during construction would require a temporary level crossing. However, NR have expressed that they would not be in favour of a temporary level crossing at Kings Dyke. This would also require the temporary road construction to A road standard which would be prohibitively expensive.

It is not practicable to maintain access to the existing properties to the south west of the crossing from within the current highway boundary due to the required height of the bridge over the railway and lack of space between the existing road alignment and property entrances. This option only appears to be viable if all of the properties to the south were acquired by CCC or relocated.

The bridge structure and approaches would require vertical reinforced earth embankments throughout and all of the existing utilities would need to be diverted from under the proposed footprint, into service corridors either side or if possible crossing the existing road into one service corridor on the north or south side.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Minimal land take for the permanent works.</td>
<td>A605 closure during the majority of the construction works or costly temporary works for traffic management and possible need for a temporary level crossing.</td>
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<tr>
<td>Access to Funthams Lane and the brickworks would be as per the existing access.</td>
<td>Acquisition by CCC or relocation of properties to the south west would be required as access from within the highway boundary is not possible.</td>
</tr>
<tr>
<td>Not building over exiting NR signal box.</td>
<td>Vertical embankments required throughout – increased cost compared to sloped earth embankments.</td>
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<td></td>
<td>Vertical embankments required throughout – may be perceived by members of the public to have lower aesthetic value than sloped earth embankments.</td>
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<tr>
<td></td>
<td>All existing utilities under proposed footprint would require diversion.</td>
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</table>
Advantages | Disadvantages
---|---
| Difficult to provide access to the level crossing track to the south of the railway and signal box.

Following discussions with CCC it has been agreed at this feasibility stage based on the above information that this proposed option is not favoured by CCC and that no buildability, costing, or programme information is to be produced for this option.

Figure 4.1: Option 2 drawing

Source: Mott MacDonald
5 Option 3: Part On Line

This option comprises a part on line solution contiguous to the existing highway, keeping one or more main line of traffic flowing under traffic management control during construction. The part on line solution could be to the north (Option 3a) or the south (Option 3b) of the existing highway.

The proposed north option is illustrated in a general arrangement drawing MMD-332955-C-DR-XX-3002 in Appendix E and typical cross sections drawings in Appendix F of this report.

The proposed south option is illustrated in a general arrangement drawing MMD-332955-C-DR-XX-3003 in Appendix G of this report.

5.1 Option 3a Part On Line North

For the part on line north option, vertical walls, rather than earth embankment, are proposed for the bridge approaches to minimise land take. Where space is thought to be adequate for an earth embankment as shown on the drawing, the slope proposed is 1 in 2. Access to the existing properties to the south west of the crossing would be via the existing A605. Access to Funthams Lane and the brickworks would be as per the existing access.

The construction methodology report (including site access, statutory utilities work, Contractors compound, traffic management, and construction methods), construction cost estimate, and construction programme have been produced and are included in Appendices H, I and J respectively. The construction cost estimate for this option is £6,055,417 and the construction programme estimated duration is 11 months.

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<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Less land take for the permanent works compared to many of the other options (4, 5 &amp; 7). Works not as close to Nene Lodge compared to option 3b.</td>
<td>Considerable temporary works. Traffic control (excluding traffic running normally but under narrow lane control) will be required for 68% of the time during the construction programme.</td>
</tr>
<tr>
<td>Access to the existing properties to the south (R&amp;R etc.) and existing NR track to the south of the railway remain unchanged.</td>
<td>Vertical embankments required throughout – increased cost compared to sloped earth embankments.</td>
</tr>
<tr>
<td>Access to Funthams Lane and the brickworks would be as per the existing access.</td>
<td>Vertical embankments required throughout – may be perceived by members of the public to have lower aesthetic value than sloped earth embankments.</td>
</tr>
<tr>
<td>Access to the electrical substation is as per existing.</td>
<td>Existing utilities in the northern footpath would require diversion.</td>
</tr>
<tr>
<td>Constructing the jointing of the proposed highway to the existing highway at both the east and west approaches present no engineering difficulties and minimum diversion works.</td>
<td>Building over the existing NR signal box – additional NR approvals are likely to be required which in turn is likely to require increases in cost and programme duration</td>
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<td>One weekend A605 road closure is required for installation of the bridge concrete beams due to the</td>
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Access to the existing properties to the south (R&R etc.) and existing NR track to the south of the railway remain unchanged.

Vertical embankments required throughout – increased cost compared to sloped earth embankments.

Vertical embankments required throughout – may be perceived by members of the public to have lower aesthetic value than sloped earth embankments.

Existing utilities in the northern footpath would require diversion.

Building over the existing NR signal box – additional NR approvals are likely to be required which in turn is likely to require increases in cost and programme duration.

One weekend A605 road closure is required for installation of the bridge concrete beams due to the
5.2 Option 3b Part On Line South

This option will require the closure of the existing access to the properties to the south west. Having considered the options for access, the layout drawing for this option includes a proposed service road to the back of the properties to the south west of the crossing to provide access. This service road will be located in Flood Zone 3.

<table>
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<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less land take for the permanent works compared to many of the other options (4,5 &amp; 7).</td>
<td>Considerable temporary works. Traffic control would be required for 100% of the time during the construction programme. Single lane traffic control would be required throughout the construction programme.</td>
</tr>
<tr>
<td>Access to Funthams Lane and the brickworks would be as per the existing access.</td>
<td>This option will almost certainly require significant land take at the frontage of the properties to the south west; considerable permanent works would be required to overcome access difficulties. Other disadvantages may result, such as access in EA Flood Zone 3 (possible planning difficulties).</td>
</tr>
<tr>
<td>Constructing the jointing of the proposed highway to the existing highway at both the east and west approaches present no engineering difficulties and should not present a diversion problem.</td>
<td>Vertical embankments required throughout – increased cost compared to sloped earth embankments.</td>
</tr>
<tr>
<td></td>
<td>Vertical embankments required throughout – may be perceived by members of the public to have lower aesthetic value than sloped earth embankments.</td>
</tr>
<tr>
<td></td>
<td>Existing utility services in the southern footpath (and northern if alignment is as per Option 3a east of the LC) would require diversion.</td>
</tr>
</tbody>
</table>

Following the above assessments of the two part online options, Option 3a to the north and Option 3b to the south, Option 3a has been taken forwards as the more practicable option of the two.
6 Option 4: Off Line Alignment to the North

This option comprises an off line alignment to the north of the existing highway. The proposed option is illustrated in a general arrangement drawing MMD-332955-C-DR-XX-3004 in Appendix K and typical cross sections drawings in Appendix F of this report.

A 1 in 2 earth embankment is proposed with vertical walls around the existing signal box. This option encroaches on the ‘Abbey’ building and car park, however a steeper reinforced earth embankment or vertical wall could be used in this area. Access to the properties to the south west would be via the existing A605 similar to as shown for Option 3a. Access to Funthams Lane and the brickworks would be as per the existing access.

The construction methodology report (including site access, statutory utilities work, Contractors compound, traffic management, and construction methods), cost estimate, and construction programme have been produced by Jackson Civil Engineering and are included in Appendices L, M and N respectively. The cost estimate for this option is £4,942,098 and the construction programme estimated duration is 11 months.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less land take for the permanent works compared to options 5 and 7.</td>
<td>More land take than for option 3a. Works closer to Nene Lodge than for option 3a. Works encroach on ‘Abbey’ building and car park, however this could be minimised by use of steeper / vertical wall in this area.</td>
</tr>
<tr>
<td>Access to Funthams Lane and the brickworks would be as per the existing access.</td>
<td></td>
</tr>
<tr>
<td>Access to the existing properties to the south (R&amp;R etc.) and existing NR track to the south of the railway are via the existing A605.</td>
<td></td>
</tr>
<tr>
<td>Constructing the jointing of the proposed highway to the existing highway at both the east and west approaches present no engineering difficulties and should not present a diversion problem.</td>
<td></td>
</tr>
<tr>
<td>Temporary works and long term traffic control are not considered to be problematic. The vast majority of the new road and bridge construction can be completed without any noticeable effect on the existing traffic. Traffic control (excluding traffic running normally but under narrow lane control) would be required for 22% of the time during the construction programme.</td>
<td></td>
</tr>
<tr>
<td>Minimal effect on the existing utilities.</td>
<td></td>
</tr>
<tr>
<td>Minimal use of vertical embankments – cost saving and potential improved aesthetics.</td>
<td></td>
</tr>
</tbody>
</table>
### Advantages

- Not building directly over existing NR signal box.
- Access to the electrical substation is as per existing

### Figure 6.1: Option 4 drawing

Source: Mott MacDonald
7 Option 5: Off Line Alignment to the South

This option comprises an off line alignment to the south of the existing highway.

The proposed option is illustrated in a general arrangement drawing in Appendix O and typical cross sections drawings in Appendix F of this report.

It is anticipated that a 1 in 2 earth embankment will be used for the bridge access. However a significant proportion of the road in this option will be founded within the peat. Two approaches to construction of the road in this area could be as follows:

1. Depending upon the maximum depth of the peat, it could be excavated and removed from the vicinity of the road and replacing with clean fill. This would be expensive due to the need to dispose of the excavated soil off site and the cost of the imported soil.

2. Alternatively, the ground could be pre-loaded with additional fill to accelerate ground settlement in advance of the road construction. However this would involve sourcing and transporting large quantities of soil onto and then off the site and would probably introduce a significant delay to the construction program.

Other means of stabilising the peat are potentially viable (for example deep soil mixing), but these techniques are generally more expensive than the options discussed above.

Access to Funthams Lane and the brickworks would be in their existing locations, but off the proposed roundabouts. Access to the properties to the south west and the existing NR track to the south of the railway would be via the existing A605 accessed off the west roundabout. Access could be provided off the east roundabout to the existing NR signal box and the electrical substation. The alignment is drawn to avoid as many existing properties as possible. However, this could be moved further north if required. This option footprint is within the EA Flood Zone 3. Provision for equestrian crossing of the proposed road is likely to be required for access to the paddocks to the south of the existing Sand Paddock Stables. The eastern end of this option passes very close to the existing clay pit and likely to require foundation works.

The construction methodology report (including site access, statutory utilities work, Contractors compound, traffic management, and construction methods), construction cost estimate, and construction programme have been produced by Jackson Civil Engineering and are included in Appendices P, Q and R respectively. The construction cost estimate for this option is £7,073,816 and the construction programme estimated duration is 14 months.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary works and long term traffic control are not considered to be</td>
<td>Most land take compared to all options except the wider bypass option (Option 7).</td>
</tr>
<tr>
<td>problematic. The vast majority of the new road and bridge construction can</td>
<td></td>
</tr>
<tr>
<td>be completed without any noticeable effect on the existing traffic. Traffic</td>
<td></td>
</tr>
<tr>
<td>control (excluding traffic running normally but under narrow lane control)</td>
<td></td>
</tr>
<tr>
<td>would be required for 20% of the time during the construction programme.</td>
<td></td>
</tr>
</tbody>
</table>
### Advantages

- Access to Funthams Lane and the brickworks are in the existing locations, but off the proposed roundabouts.
- Not building over exiting NR signal box.
- No works within existing level crossing, no effect on lines of sight at the signal box etc.
- Minimal impact to the utilities in the verge of the existing A605.

### Disadvantages

- Potentially very poor ground conditions (peat) – may require foundations to the approach road earth embankment.
- Construction in close proximity to existing open clay pit to the east and filled in clay pit to the west – may require considerable foundation works.
- Majority of this option would be located within EA Flood Zone 3 (possible planning problems and issues with providing flood compensation storage).
- Constructing the jointing of the proposed highway roundabout junctions to the existing highway at both the east and west approaches are relatively more complicated compared to all other options.
- The proposed alignment effectively cuts off access to the paddocks to the south and therefore access for equestrian crossing would be required.
- Utility diversions include relocation below ground of the overhead services adjacent to the farm track.
- Frontage access to existing residential properties no’s 266 to 272 would be removed by this option.
Figure 7.1: Option 5 drawing

Source: Mott MacDonald
8 Option 6 Tunnel Solution

This option comprises a tunnel below the existing railway.

The following extract from the Preliminary Sources Study Report (Atkins ref. GTG 20131584/R001) determined that a tunnel solution is not advised;

“Due to the high level of the groundwater in the area, cuttings and deep excavations will require a significant dewatering. As the overlying granular material is likely to have very high permeability and the Oxford Clay typically has a very low permeability, the main solution for the dewatering works would involve some form of diaphragm wall (sheet pile, contiguous bored pile etc.). The use of sheet piling may also be limited due to driveability issues relating to the very high strength Oxford Clay found to be present at depth on the site. The cost of providing a permanent cut off wall will be significant. For this reason it is not advised to construct an underpass for the replacement of King’s Dyke level crossing.

A cutting solution would also require significant dewatering works as part of the temporary and permanent works. Cut slopes in the Oxford Clay require a profile of around 1v in 3.5h to satisfy long term stability requirement in accordance with EC7. This would require a significant amount of earth movement and permanent and temporary land take for construction.

For the reasons outlined above it is not advised to construct an underpass for the replacement of King’s Dyke level crossing.”

In addition to the above, it should be noted that access to many of the properties to the south of the level crossing would not be practicable due to the depth of underpass required at this location. This would result in relocation or removal of these properties. It is considered that the most practicable and cost effective route to construct an underpass would be on the alignment of the existing A605, which would require closure of the A605 during the construction programme. An indicative underpass extent is shown on the plan in Figure 8-1 below which is based on a 6.5m headroom below the rail track and a 4% road gradient for the east and west approaches.

Taking the above information into account, it has been agreed with CCC that the feasibility of this option is not to be pursued in further detail at this time.
Figure 8-1 Indicative Extent of Underpass Route (as shown by the dashed line)
9 Option 7: Wider Area Bypass

This option comprises a wider area bypass. Without undertaking an in depth feasibility study, it has been agreed with CCC that this option will not be pursued in further detail at this time, due to the large scale of this option in terms of cost, deliverability, long lead in times, impact on the environment and surrounding landscape. It can be noted that Option 5 above doesn’t preclude a future wider area bypass solution.

The following image indicates two possible routes of approximately 3.5-3.8km or approximately 2.1 miles.

Source: OS Opendata mapping

Figure 9.1: Possible by-pass routes
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<td>Appendix S</td>
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1. Introduction

Cambridgeshire County Council are considering options for the replacement of a level crossing where the A605 crosses the Ely to Peterborough railway line at King’s Dyke, near Whittlesey in Cambridgeshire.

A Preliminary Sources Study Report (PSSR) has already been produced (Atkins, 2014), so it is not the intention of this note to repeat large sections of that report here. However, the PSSR does not address in detail the implications of its findings for each of the options currently under review.

This note therefore sets out the geotechnical design parameters and assumptions used in the development of the buildability / feasibility assessment for Options 3, 4 and 5 in the Kings Dyke Level Crossing replacement scheme proposals.

2. General Geological Setting

2.1 Published Geology

The geology of the area as surveyed by the British Geological Survey is shown in Figure 1.

![Figure 1: British Geological Survey map of Peterborough Kings Dyke Area](https://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html?src=topNav)
In summary, the ground conditions in the vicinity of the site comprise Made Ground, overlying March Gravels Member and River Terrace Deposits, overlying the Oxford Clay Formation. Peat may be present to the south of the study area. A history of brick making has left a number of quarries, some infilled and some not, in the area of the site.

2.2 Previous GI reports

Historical ground investigation information from the British Geological Survey is presented in the Preliminary Sources Study Report and consists of four trial pits at depths ranging between 2.40m and 3.50m below ground level and four boreholes to depths ranging between 10 and 30m.

2.3 Ground Conditions

From the previous ground investigation data the geological sequence in the immediate vicinity of the existing roadway and level crossing is confirmed as made ground underlain by March Gravels and Oxford Clay. No boreholes were undertaken in the area of expected peat to the south of the site.

2.4 Groundwater

The Preliminary Sources Study Report details a high perched water table between 1.1 and 4.0m below ground level (average of 2.0m) present on the site which will affect the construction of excavations and foundations on the site. The possible effects of previously contaminated groundwater, and the potential for contamination of groundwater during construction, will need to be mitigated as part of the further investigation and design. Information from the Environmental Agency flood map indicates that there is a greater than 1 in 100 risk of inundation from nearby rivers in many areas around and within 50m of the site. However, the site itself appears to be on slightly higher ground that has a less than 1 in 1000 chance of flooding.
3. Bridge Abutment and Approach Embankments - Design Parameters and Assumptions

3.1 Embankment Slopes

Following the advice of the contactor (Jackson Civil Engineer) the assumed locally available materials for the proposed highway embankments are Class 2B dry cohesive material, Class 1A well graded granular material and Class 1B uniformly graded granular material. The following material properties for each of these Highways materials classes have been assigned based upon BS 8002: 1994. For the Class 2B material, a sensitivity analysis of the minimum and maximum plasticity index (PI) range given in CIRIA C580 has been undertaken in order to find the minimum slope angle of the two and this is the value presented in the results.

A Mohr-Coloumb stability assessment has been carried out in order to estimate the maximum slope gradient which would provide a safety factor of 1.3 against slope failure with a failure depth of greater than 0.2m. A modest amount of groundwater pressure has also had to be assumed (Ru = 0.1).

<table>
<thead>
<tr>
<th>Class 1A Assumed Properties</th>
<th>Class 1B Assumed Properties</th>
<th>Class 2B Assumed Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well graded granular material</td>
<td>Uniformly graded granular material</td>
<td>Dry cohesive material (no chalk)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Class 1A</th>
<th>Class 1B</th>
<th>Class 2B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ru</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>c'</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>phi'</td>
<td>36</td>
<td>32</td>
<td>Minimum PI 15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>phi' 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maximum PI 30</td>
</tr>
<tr>
<td>phi''</td>
<td></td>
<td></td>
<td>phi'' 25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit Weight</th>
<th>Class 1A</th>
<th>Class 1B</th>
<th>Class 2B</th>
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</table>

<table>
<thead>
<tr>
<th>FOS</th>
<th>Class 1A</th>
<th>Class 1B</th>
<th>Class 2B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum Slope Angle</th>
<th>Class 1A</th>
<th>Class 1B</th>
<th>Class 2B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in 1.75</td>
<td></td>
<td>Maximum Slope Angle 1 in 2.25</td>
<td>Maximum Slope Angle 1 in 2.5</td>
</tr>
</tbody>
</table>

Based on these design slopes, the Class A material in conjunction with a 1 in 2 slope has been selected and it is advised that this is populated with low maintenance vegetation which will require cutting only one to two times a year. The estimated total consolidation settlements is estimated in the Preliminary Sources Study Report to be 100mm. However the presence of peat would significantly increase this value if any is found beneath the footprint of the embankments.
3.2 Bridge Abutments

3.2.1 Abutment Foundations

The choice of piles for the abutment foundations is based upon the ground investigation data presented in the Preliminary Sources Study Report (Cambridgeshire County Council, January 2014). The base of the abutment walls in each of the options explored would be expected to be founded on superficial deposits of March Gravels and underlain by Oxford Clay, although further ground investigation would be required to confirm this in each case.

The use of spread footings has been preliminary disregarded due to the claims in the Preliminary Sources Study Report that the top 5m of the Oxford clay horizon is heavily weathered and has a typical undrained shear strength of less than 100kPa. This could be re-examined at a later value engineering stage to see if a spread footing would be feasible. However, it is prudent at this stage to assume that piled foundations are indeed required.

Bored cast in-situ piles are recommended to minimise disturbance to the tracks. CFA piles in particular are recommended due to the proximity of the abutments to the railway line as they cause very low vibrations and physical ground disturbance and are suitable for constructing piles in both sands and stiff clays as found in this site. They are also suitable for installing in ground that has a high water table as at this site (approximately 2m below ground level).

It is recommended that the pile caps are kept as high and as shallow as possible in order to reduce the temporary works for excavating and dewatering the excavations during their construction.

Although there are plans to electrify the railway in the future, the current line is not electrified and therefore the proximity of the rig to overhead line equipment (OHLE) is not expected to be a constraint. However, the normal precautions to prevent piling rigs from toppling onto the railway will need to be put in place.

The assumed design loading per abutment is comprised of:

- 3000kN live load (half of this is considered in pile design)
- 3000kN dead load
- 3500kN self-weight
- 1360kN weight of wedge of soil embankment acting on the abutment

Assuming the pile layout in the sketch above i.e. 15 piles in a grid of 5x3, the following two options would maintain the necessary 3 pile diameters between pile centres, whilst providing sufficient load carrying capacity:

- 450mm diameter piles at 12m length
- 600mm diameter piles at 8m length
3.2.2 Abutment Wing Walls

For the wingwalls, a ‘Reinforced Earth’ solution is recommended, as in the photograph below, as these are often the most economical solution. If these are used, piles are not expected to be required but instead shallow spread footings are likely to be sufficient.

![Figure 3: Recommended wingwall construction style](image)

3.3 Vertical Retaining Walls

If vertical retaining walls parallel to the road carriageway are required, or if they are required in other areas, for example surrounding the Abbey building in Option 4, then a similar system to the abutment wing walls could be used. In this case, the ‘reinforced earth’ walls could be constructed with horizontal geogrids tied between each of the two walls as shown in the sketch below.

![Figure 4: Vertical retaining wall ‘Reinforced Earth’ style system](image)

3.4 Ground movements affecting railway lines

It is not anticipated that the weight of the abutments will affect the railway lines since the piles will transfer the load down to deeper strata. The installation of CFA piles is also likely to cause minimal ground movements. However, care will need to be taken in the detailing of the abutment wingwalls, particularly if these are not supported on piled foundations. However, it is anticipated that with careful choice of their alignment and careful detailing it will be possible to design them to avoid causing heave, settlement or lateral movement of the railway lines.
4. Additional Geotechnical Comments

4.1 Cuttings and Excavations

Due to the high level of groundwater in the area (2m below ground level), all but the shallowest excavations will require significant dewatering. Due to the risk of flooding of the area especially to the south (affecting Option 5), careful consideration will need to be given to drainage and even flood protection during detailed design.

4.2 Proximity to Clay Pits (Option 5)

It is unclear from the previous ground investigations and preliminary sources report as to the exact extents, depths and quality/extent of backfilling of the clay pit which is close to the roundabout at the western end of Option 5. Further ground investigation will be necessary here to determine the proximity of the roundabout to this pit, which could constitute a significant risk to the route. Potential works that could be required include additional foundation works, retaining walls and/or additional geotechnical works in the form of excavating, refilling and compacting soil into the pit if necessary. At the eastern end, the alignment of Option 5 passes within approximately 20m of the edge of a deep unfilled pit with standing water. Additional investigations will be required here to confirm the stability of the edge of the pit, and stabilisation works may ultimately be necessary.

4.3 Peat (Option 5)

A plan showing the approximate locations of surface deposits of peat in relation to option 5 is shown in Figure 5 below. Without additional ground investigation data, it is difficult to estimate the depth of the peat though it is expected to be at least a metre deep. It is not expected that the bridge abutments would fall into this peat region for any of the proposed options. However a significant proportion of the road in option 5 will be founded within the peat. Two approaches to construction of the road in this area could be as follows:

- Depending upon the maximum depth, excavating and removing the peat from the vicinity of the road and replacing with clean fill. This would be expensive due to the need to dispose of the excavated soil off site and the cost of the imported soil.

- Alternatively, the ground could be pre-loaded with additional fill to accelerate ground settlement in advance of the road construction. However, this would involve sourcing and transporting large quantities of soil onto and then off the site and would probably introduce a significant delay to the construction program.

Other means of stabilising the peat are potentially viable (for example deep soil mixing), but these techniques are generally more expensive than the options discussed above.
5. **Summary of Geotechnical Hazards**

Excessive settlement of the bridge structure should be avoided by providing piled foundations. Settlement of the approach embankments is expected to be largely complete during construction, except in the case of Option 5.

Settlement, heave or lateral movement of the railway lines as induced by the bridge abutments are expected to be negligible due to the choice of CFA piles. Settlements due to the placing of embankments or reinforced earth abutments should also be minimal, but will need more careful design. During construction, movements will need careful monitoring.

Settlement of the road options in particular that proposed in Option 5 due to its foundation on the peat is likely to be a large source of risk and uncertainty and further ground investigation is recommended to determine the depths and extents of the superficial peat deposits in order to further quantify this. Dig out and replace or pre-loading are two options for the road construction for Option 5.

The high water table is expected to have an influence on all of the proposed options in particular with regards to temporary works and health and safety during construction. In addition, inadequate management of drainage of the bridge abutments and highway embankments could ultimately lead to local flooding or failure.

Construction in the vicinity of the clay pits and the previous underpass below the railway line as mentioned in the Preliminary Sources Study Report also carry significant uncertainty with regards to the geographical extents and/or the infill materials involved. Further ground investigations will be required to confirm the actions required and establish the design measures and specific support requirements of each area, as necessary.

A table summarising the key geotechnical features of each option is presented below.

---oo0oo---

Reference:

### Table: Additional Geotechnical Comments

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Slope Angle</th>
<th>Abutment Piles</th>
<th>Close Proximity to Clay Pits</th>
<th>Founded on Peat</th>
<th>Vertical Walls Required</th>
<th>Additional Geotechnical Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Part online north</td>
<td>1 in 2</td>
<td>15 piles at 450mm diameter and 12m length for each abutment</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Off line north</td>
<td>1 in 2</td>
<td>15 piles at 450mm diameter and 12m length for each abutment</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Off line to the south</td>
<td>1 in 2</td>
<td>15 piles at 450mm diameter and 12m length for each abutment</td>
<td>Disused clay pits to the west and south of the west and east roundabouts respectively will require further ground investigations and possibly remedial works</td>
<td>Yes for the road abutments are in march gravels underlain by Oxford clay</td>
<td>No</td>
<td>Road carriageway will require dig out and replacement of the peat or pre-loading of ground to reduce the risk of post-construction settlement.</td>
</tr>
</tbody>
</table>
NOTE

2. The contractor is required to comply with any statutory undertakers special requirements when working in the vicinity of underground utilities.

3. To: 4 c to 120 E a
A605 Kings Dyke Crossing

Option 3a: Part On-line North

Statement on the methodology to construct a bridge railway crossing.

Final - (8 April 2014)
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<td>Site Location</td>
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<td>3.0</td>
<td>Existing traffic and Pedestrian System</td>
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Appendix A: BBA Roads and Bridges Agrément Certificate  
reference 99/R106  
Appendix B:  BBA HAPAS Certificate reference 12/H182  
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Appendix E:  Possession Programme Kings Dyke/prel/pos/01  
Appendix F:  Embankment Fill Calculation
1.0 Introduction

This document sets out the outline methodology for the proposed construction of a bridge with approach roads to replace the existing railway level crossing on the Ely to Peterborough rail lines, using the route detailed as ‘Option 3: Part Off-Line North’.

Cambridgeshire County Council has identified the necessity to close the existing barrier type level crossing, particularly with regard to Network Rail’s (NR) intention to increase the number of passenger and freight trains using the line, the general increase in traffic crossing the level crossing and current safety issues at barrier type railway level crossings and to provide an alternative crossing.

The proposed scheme provides an alternative crossing which will enable the current barrier type crossing to remain permanently closed.

This proposal positions the approach roads and new bridge crossing the railway to the north of the existing A605 as shown on drawing MMD-332955-C-DR-XX-3002.

The methodologies set out in this document are at a preliminary stage and subject to planning, approvals, the completion of the final design, temporary works design and the appointment of the Contractor for the works.

Photo 1

Kings Dyke Level Crossing looking west.
2.0 Site Location

Kings Dyke level crossing is an at-grade crossing located approximately 2.6 kilometres west of the centre of Whittlesey on the A605 road between Whittlesey and Peterborough where the railway line between Ely and Peterborough crosses the carriageway.

The level crossing is an electronically remote controlled full barrier type, operated on-site by Network Rail operatives from an existing signal box located adjacent to the railway line to the north east of the junction.

The site extends from Funthams Lane to the west and the residential houses to the east on the northern side.
3.0 Existing Traffic and Pedestrian System

The A605 currently carries in excess of 12,000 vehicles per day across the existing crossing. The railway companies operate approximately 120 train movements across the crossing each day, which requires closure of the level crossing to traffic.

The closure of the level crossing results in significant delays to traffic travelling on the A605 to and from Peterborough. Currently, the closure time for the level crossing can be between 11 to 15 minutes per hour. The length of closed time for the level crossing will increase in the near future due to Network Rail’s (NR) intention to increase the number of passenger and freight trains using the line. Traffic queues can, therefore, be quite extensive, sometimes in excess of 300m (Photo 3).

There is an alternative route known as the “the North Bank”. This alternative road is of a lower classification, offering a less direct route between Whittlesey and Peterborough and is located to the north of the A605. During the winter months this road is susceptible to local flooding and can be closed for long periods. This exacerbates the amount of traffic using the Kings Dyke level crossing.

In addition to through traffic, there are further heavy goods vehicle movements joining/leaving the carriageway at approximately 215 metres east of the railway crossing. These vehicles are from Hanson’s (local brick manufacturer) access road which lies to the east of the crossing. There is also further traffic joining/leaving the carriageway at approximately 400 metres west of the railway crossing from Funthams Lane Industrial Estate.

Several industrial, business and residential properties are also sited along the southern approach to the level crossing from the west. These properties add to the traffic requiring access and egress to and from the A605.

Pedestrians approaching the level crossing from Whittlesey (east to west) have the provision of a continuous footpath on the north of the carriageway (Photo 4).

There is also a footpath on the southern side which starts just west of the sub station and continues to the level crossing (Photo 5).

The footpath on the north side of the road continues across the level crossing and beyond the proposed extent of the site.

The footpath on the southern side changes to verge after the level crossing (Photo 6).
Photo 4
Looking west to the level crossing. Continuous footpath on North side. Footpath on the south side commencing just west of the sub station.

Photo 5
Looking east from the level crossing showing a footpath both sides of the road.

Photo 6
Looking west from the level crossing. The south reverting to verge.
4.0 Site Access

Access to the site for construction traffic is restricted to the area of the proposed site works along the A605 from either the east or the west.

Access from the east passes through Whittlesey. Whittlesey is a town located between Peterborough (10km) and March (18km). Historically it was connected to Peterborough via a Roman built road known as the Fen Causeway and is the route which is approximately followed by the current A605.

Access from the west is via Peterborough City, the largest city in Cambridgeshire. Peterborough provides excellent north and south connections via the A1 and east and west via the A605 and A47.

Large plant and equipment required at the site would preferably come from the west via Peterborough.

Although there is no major height or road restriction from either the east or west, approaching the site from the west would be the preferred route as potentially, it will offer less impact on residential areas.

Access to the bridge site will be:

West Abutment:
Construction traffic, plant and materials will gain access for the construction of the west abutment via an access over the northern footway, directly into the works area from the A605 west of the Kings Dyke level crossing (Photo 7).

East Abutment:
Construction traffic, plant and materials will gain access for the construction of the east abutment via widening the current access adjacent to the signal box via a purpose built track (Photo 8).
Photo 8
Access from north side of A605 for east abutment construction via the signal box access being widened to the east.
5.0 Statutory Utilities Equipment

5.1 Details of services within the area of the proposed works

The majority of the services are located underground in both the northern footpath and southern footpath/verge.

Northern footpath and the area North of the A605:

Anglian Water

An 8” (200mm) cast iron water main belonging to Anglian Water crosses the A605 from the southern footpath to the northern footpath approximately 30m east of the Kings Dyke level crossing. On entering the northern footpath the water main turns west and continues beneath the level crossing. The water main continues along the northern footpath, crossing the entrance to Funthams Lane and continues west beyond the proposed site boundary.

BT

BT underground cables cross the A605 in the area of the electrical sub station from the southern footpath. Entering the northern footprint the service splits, turning west to continue to the level crossing and east to the Hanson access road where the service turns north away from the A605. After crossing the level crossing the cables continue along the northern footpath, crossing the entrance to Funthams Lane with a joint box either side of the Lane, then continue west beyond the proposed site boundary. On the north east corner of Funthams Lane, 2 further services head north from a joint box along the eastern edge of Funthams Lane. A two further underground services cross the A605 approximately 56m and 86m west of the level crossing.

Two BT overhead cables cross the A605 approximately 163m and 169m west of the level crossing.

Another cable track is located in the area north of the A605 between a joint box on the north side of the A605 continuing west towards the railway, then turning north to end at a distribution box.

Gas

A Low High Pressure gas main which originates from an “above ground installation” starts north before turning west towards the railway. The gas main then follows an erratic course which involves a return south towards the A605 then follows the eastern edge of the railway lines north, before crossing the railway lines approximately 166m north of the level crossing. This gas main continues north away from the proposed works.

UK Power Networks

Several cable tracks cross the A605 from the sub station and enter the northern footpath before splitting and turning as multiple tracks both east and west along the northern footpath.

The cables heading east towards Whittlesey continue in the footpath beyond the proposed site boundary.
The cable tracks heading west also continue in the northern footpath until they reach the signal box entrance (Photo 10, blue arrow).

At this point the cables split into two separate tracks:

1. One cable track continuing to diagonally cross the railway level crossing to enter the southern verge. It is not totally clear from the current information available, but it appears this track then re-crosses the A605 back to the northern footpath.

2. The other track turns north and splits again into 2 further tracks passing the signal box to continue north on the eastern side of the railway.

The track in “item 1” continues along the northern footpath across Funthams Lane and beyond the proposed site boundary.

At approximately 170m west of the Kings Dyke level crossing, another cable track crosses the A605 to the southern footpath connecting with cable tracks running east/west.

At approximately 386m west of the level crossing a further cable track heads north, joining another track crossing the A605 from the southern footpath. These cables both continue north via a dogleg, east of Funthams Lane.

At approximately 418m west of the level crossing a further cable track heads north to continue along the western side of Funthams Lane.

**Southern Footpath and south of the A605:**

**Anglian Water**

A 12” (300mm) asbestos cement potable water main belonging to Anglian Water is located in the southern footpath. It crosses the level crossing via a dogleg to the south.

There is a hydrant just west of the level crossing.

The main continues west possibly in the verge (requires confirmation). Approximately 80m west of the level crossing the water main doglegs north, possibly entering beneath the carriageway, before continuing west beyond the proposed site boundary.

Private service connections will possibly be from this main into the properties along the south side west of the level crossing.

**BT**

BT underground cables are located in the southern footpath/verge from the direction of Whittlesey.

At a joint box just east of the level crossing the service track splits:

- One track crosses the level crossing in the line of the footpath/verge.
• The second crosses the railway in a dog leg via a joint box just south of the level crossing.

The two tracks then rejoin into a single track just west of the level crossing and continue underground west along the southern verge beyond the proposed site boundary.

From the track in the southern footpath at separate joint boxes further underground crossings (at 56m and 86m west of the level crossing) cross the A605 to the northern footpath.

From the joint box at 86m from the level crossing a short track of underground cables head south to serve a pole and overheads to the properties south of the A605.

From a further joint box in the southern verge at approximately 142m west of the level crossing, additional cables serve a pole. These overhead cables then divide into 3 cable tracks from this pole:

• One to serve property to the south of the A605.
• One to cross the A605 diagonally at approximately 163m from the level crossing then continuing across the northern footpath where it returns underground approximately 34m north of the north kerbline.
• One to continue west in the south verge to another pole before crossing the A605 diagonally at approximately 169m west of the level crossing and continues across the northern footpath to serve properties north of the A605.

At another joint box approximately 351m west of the level crossing underground cables cross the A605 passing beneath the northern footpath to serve the wind turbine and Nene Lodge.

At approximately 186m east of the level crossing a BT overhead cable crosses the A605. As it crosses the southern footpath adjacent to the electrical sub station it turns west at a pole towards the level crossing (Photo 9). This overhead service continues west to a pole approximately 92m east of the level crossing.

Gas

From the “above ground installation” north of the A605 a medium pressure gas main passes beneath the northern footpath, crossing the A605 to enter the south footpath approximately 275m east of the level crossing.

On entering the southern verge it continues east towards Whittlesey and west towards the level crossing. It remains in the southern verge after passing beneath the level crossing. At Funthams Lane the gas main enters the A605 carriageway to cross diagonally to the northern footpath, approximately 45m west of the centre of Funthams Lane.

UK Power Networks

There is an electrical sub station approximately 176m east of the level crossing on the southern side (Photo 11).

From the sub station a cable track crosses the A605 to the northern footpath. On entering the northern footpath it continues east towards Whittlesey and west towards the level crossing.
Immediately west of the sub station is an area containing various cables starting from a point south west of the sub station. There is another cable track starting at the same south west point that continues north across the A605, possibly joining the cable tracks in the northern footpath (to be confirmed).

Further cables from the sub station head west along the southern footpath towards the level crossing.

At approximately 151m from east of the level crossing a cable track crosses the A605 and continues north across the northern footpath.

Just prior to the Kings Dyke level crossing the underground cable track running along the southern footpath turns into the carriageway to cross the level crossing. It turns back south to re-enter the southern verge joining the track from the northern footpath before continuing west along the verge beyond the proposed site boundary.

Additional underground cable tracks from the south converge at the same point to join those in the southern verge.

At approximately 39m west of the Kings Dyke level crossing a cable track branches south to serve properties.

At approximately 102m west of the level crossing a cable track branches north, crossing the A605 and the northern footpath to continue north before turning north west in parallel to the railway lines.

At approximately 386m west of the level crossing a cable track branches north, crossing the A605 and the northern footpath continuing along the eastern side of Funthams Lane, adjacent to the branch from the northern footpath tracks.

At approximately 69m west of the centre of Funthams Lane a new cable track appears from the south and turns east along the A605, turning north to continue along the western side of Funthams Lane.
Photo 10
Point at which the electricity cable tracks split to cross the railway and where further tracks head north passing the signal box.

Typical BT joint box within the site area. This particular one is in the northern footpath just east of the railway level crossing.

Photo 11
Electricity Sub Station.

Photo 12
Overhead BT cables and pole at 142m west of the level crossing, south side.

Photo 13
BT crossing at 169m west of level crossing.
There are no details of storm water sewers available. Only one section of foul sewer is identified appearing west of the Hanson entrance and continues east in the carriageway towards Whittlesey.
5.2 Details of possible SU works

Option 3 indicates that the majority of the works is sited on or off of the northern edge of the A605 carriageway.

The exception is the bellmouth to the new section of road for residents’ access where it crosses the existing southern verge. This should not present a problem for the statutory utility companies as it represents a normal road crossing. Some protection works (e.g. to the gas service) or the lowering of services, for example BT cables, may be required.

On the north side of the A605 all services in the northern footpath between the eastern side of Funthams Lane to chainage 250 and between chainage 520 to 680 will possibly require diversion works.

At the eastern end the new embankment covers the northern footway between chainage 520 and 680.

- UKPN cable tracks crossing the A605 from the sub station split and turn as multiple tracks both east and west along the northern footpath. Those heading east towards Whittlesey continue in the footpath beyond the proposed site boundary. The cable tracks heading west also continue in the northern footpath until they reach the signal box entrance. Numerous jointing areas are shown within the footprint of the new works. These cables will possibly require diversion from the southern side of the A605 to be re-routed along the southern side, both east and west to clear the new embankment footprint before returning the northern footway. The cables crossing at chainage 502 and 630 may require an additional duct placed beneath the eastern approach to allow future cable replacement. The twin cable crossing at an angle at chainage 485 and 492 may require re-routing to clear the abutment works, in particular the cable chainage 485. During a meeting with Mr. Trevor Garrot (BT) on 3 April 2014, he confirmed that the BT cable tracks and chambers in the northern footpath beneath the approach road will require re-routing along the southern side both east and west to clear the new embankment footprint before returning to the northern footway. Further investigation is required to plot the single track running west then turning north, to confirm position. However, the diversion works may change depending upon the presence of fibre optic cables. A budget quotation will be issued which will include the Cambridge County Council’s (CCC) discount. In addition, BT require confirmation that the “stopped” sections of the A605 will remain under CCC highway control, to ensure their rights of access remain.

- The water main crossing the new embankment at chainage 597 may require an additional duct placed beneath the eastern approach to allow for future water main repair/replacement.

At the western end of the new works the new approach road crosses the northern footpath and the services therein. However, the probable diversion works are more complex.

- The UKPN cable crossing at chainage 380 may require an additional duct placed beneath the eastern approach to allow for future cable replacement. The cables running
east / west in the footpath that will be covered by the new embankment will require diversion. However, the diversion route is not obvious to allow the cables to return to the northern side beyond the new works.

- The BT cable tracks and chambers in the northern footpath beneath the approach road will require re-routing along the southern side both east and west to clear the new embankment footprint before returning to the northern footway probably west of Funthams Lane (re meeting 3 April 2014). The diversion works may change depending upon the presence of fibre optic cables. A budget quotation will be issued which will include the CCC discount. The BT overhead cables crossing the new works at chainage 300-305 will also either be raised in height to clear the new carriage or be re-located underground.

- The water main running east / west in the footpath that will be covered by the new embankment will possibly require diversion. However, the diversion route is not obvious to allow the water main to return to the northern side beyond the new works.

No allowance has been made within the programme for the diversion works, with the exception of new ducts and protection works. Ideally, the SU diversion works would be completed prior to the main contract works commencing.

If this is not possible the effect on the programme would be to increase the overall contract period by 6 weeks at minimum, and at maximum, 12 weeks. This increase in programme time would be required to undertake the actual diversion works and does not include the lead in time which can amount to a further 12 -14 weeks.
6.0 Contractors Offices and Welfare Compound

The contractor’s offices and welfare compound for the proposed works would comprise of a series of 32’ x 10’ linked office units. The number will vary between Contractors, but is estimated at a minimum of 7. These units allocate space for the Contractor, Client and his representatives, welfare facilities and a meeting room. Additional units would be required for mess, welfare, drying facilities and materials storage.

Overall area required would be approximately 850m² - 900m², the shape of the compound site varying to suit the area available.

There are two favourable locations to position the Contractor’s compound for this option.

Location 1

Photo 15
A605 Kings Dyke Level Crossing

The proposed area is located to the east of the level crossing adjacent to the A605 and will be accessed by crossing the southern footpath via a temporary crossing. It will require a temporary bellmouth to ensure efficient and safe access and egress onto the A605, which must include protection to the statutory services within the footpath area.

It is considered to be the preferred location for Option 3 as it is clear of all permanent works.
The proposed area is located to the west of the level crossing opposite Funthams Lane and will be accessed by crossing the southern footpath via a temporary crossing. It will require a temporary bellmouth to ensure efficient and safe access and egress onto the A605, which must include protection to the statutory services within the footpath area.

The area identified is clear of the west bound carriageway bus stop, but the compound would also need to share the area with the new access to the old carriageway which, in turn, provides access to the properties between the compound and the level crossing.
Other areas to consider:  

Location 3  

Photo 17

There is an area within the Hanson storage yard north of the A605, but outside that required for the permanent works. Access is gained by sharing the Hanson access road off of the A605.

Location 4  

Photo 18

A605 East of the Kings Dyke Level Crossing  

There is an area within the Hanson storage yard south of the A605. Access is gained by sharing the Hanson access road off of the A605 or by creating a new access from the A605.
7.0 Traffic Management

The Traffic Management (TM) for these works are split into 4 phases:

Phase 1
The A605 traffic remains open in both directions but is restricted to 2 narrow lanes of 3.25m wide and the speed limit is temporarily reduced to 30mph over the whole length of the works.

This enables works to commence to all areas to the north of the A605.

Phase 2
The majority of Phase 1 TM remains the same, the eastbound lane is closed to allow the initial approach road embankment works to be completed. The westbound lane remains open to single file traffic. Traffic will be controlled by temporary traffic signals. Due to the proximity of the level crossing these lights will be manually controlled with the operator working with and under the instruction of the Network Rail Signalman.

Phase 3
Phase 3 diverts the eastbound traffic along the new western approach road, crossing the new bridge to rejoin the A605 at the eastern end of the eastern approach road. The westbound traffic continues along the existing A605.

Phase 3a
Phase 3a immediately follows Phase 3 to close the eastbound carriageway at the bottom of the eastern approach. Both eastbound and westbound traffic will use the single lane carriageway along the new works under the control of temporary traffic signals. This releases the construction area for the final south east section of the eastern approach, approximately 60m x 8m wide together with the reinforced earth wall.

Phase 4
Phase 4 opens the eastern end of the new works to traffic and restricts the western end to single lane. Traffic will be controlled using 3 way temporary traffic signals. This releases the area to complete the western tie in, carriageway and the new access road.

All signage to enable the operation of the TM detailed will be in accordance with the requirements of the Traffic Signs Manual – Chapter 8: Traffic Safety Measures and Signs for Road Works and Temporary Situations – Part 1: Design and Part 2: Operations.

TM is based on the following:
- Narrow lane operation of 3.25m (Chapter 8 “desirable minimum”)
- Temporary 30mph speed restriction throughout the works and approaches
- All changes between phases will made during the night prior to the scheduled change, during times of low – little traffic.
- All changes will be completed at least 2 hours prior to the start of the rush hour commencing.

It is essential that robust and adequate temporary works and procedures are in place to undertake all TM changes and re-locations.
Where construction is at or near level with the existing road surface adjacent, the safety zone will be identified using a double line of traffic cones set at 500mm apart. Road danger lamps will be placed on the outer boundary of safety cones during hours of darkness. The purpose of the inner line is to indicate the start of the safety zone and to attract operatives’ attention not to step into danger. The inner line will be reinforced by connecting the cones with a suitable traffic tape. The establishment of well defined minimum safety zones, in which operatives should not enter and neither plant or materials should be deposited, is essential for ensuring safety during road works and construction.

Where applicable temporary road studs and white lining will be used at each phase.

Close liaison between the Contractor and interested parties will be required to ensure safe operation and systems of TM during the contract period. These will include:
- Client representative
- Highways Authority
- Police
- Other emergency services
- Other third parties
- Bus operating companies
- Local users
- Local businesses e.g. Hanson
8.0 Bridge and Road Construction

8.1 Approach Roads

For the main reinforced earth walls, that is the complete north and south approach road facing walls, it is proposed to use ReCo Modular Precast Concrete facing panels or similar.

Photo 19
Facing panels can be supplied in various shapes and sizes ranging from rectangular to cruciform.

Photo 20
There is also a variety of textures and surface features available.

Photo 21
Different colours can also be provided by using pigmented concrete.

Photo 22
The soil reinforcement used for the Precast Panels systems can be of 2 types:

- **High Adherence Galvanised Steel Soil Reinforcement.** These are galvanised metal strips generally supplied in 2 sizes, 504HA (50mm wide x 4mm thick) and 455HAR (45mm wide x 5mm thick) with transverse ridges cast into the surface. These strips are connected to the panel by galvanised steel alloy nuts and bolts to a galvanised lug cast into the back of the concrete panel. The length and orientation of the reinforcement strips will be confirmed in the final design and detailed on the project drawings. This system is covered by a BBA Roads and Bridges Agrément Certificate reference 99/R106 (Appendix A).

- **Synthetic Soil Reinforcement** is a geosynthetic strip comprising a number of discrete channels of individually tensioned, closely packed, high-tenacity polyester tendons, encased in a low-density polyethylene sheath 50mm wide and are supplied in 100m long rolls. Various grades are available and the length and orientation of the reinforcement strips will be confirmed in the final design and detailed on the project drawings. There are 2 alternative methods of fixing the soil reinforcement to the panels. One is by a galvanised steel loop cast into the panel during manufacture. The alternative is a one-piece, high density polyethylene sleeve also cast into the concrete during manufacture of the panel units. This system is covered by a BBA HAPAS Certificate reference 12/H182 (Appendix B).

Both systems have their advantages and disadvantages:

- The galvanised metal strips require the fill to be compliant with the electrochemical requirements in Table 2 SHW series 600. They are robust and will resist damage from most types of fill materials.

- The synthetic strips allow the possible use of recycled materials having no restriction on the salt contents and resistivity, but require a pH between 4 and 9. Although robust and suffer very little damage in common fill materials, care and consideration must be taken if the fill is a freshly crushed material with sharp edges.

Pre cast concrete panels are delivered by road on articulated trucks and trailers in stacks of 4 to 5 panels and a total of 20 - 30 panels per load. For the A605 Kings Dyke works, it is anticipated that approximately 58 loads of PCC panels will be required for the approach road outside walls. There will also be a requirement for approximately 2 loads of wire panels for the intermediate wall. In addition, an extra 3 – 6 loads of associated equipment, soil reinforcement, geotextiles, joint pads etc will be required. Care must be exercised in the temporary storage and the handling of the panels on site.

Rubber bearing pads are positioned in the horizontal joints to prevent concrete to concrete contact. A geotextile, supplied to site in 1.2m wide rolls and cut to suit on site is glued to the back of the panels. Generally, this would be 300mm wide for horizontal joints and 400mm wide for vertical joints.

It is recommended that a filter drain is installed with a suitable filter material backfill in front of the retaining wall.

An insitu concrete ground beam serves as a level and firm working surface for the positioning of the first row of panels. Depending upon the ground conditions and design the concrete beam
can be either plain concrete or reinforced. Generally the beam would be 150mm deep x 350mm to 500mm wide. Steel dowels would be cast into the top of the beam to coincide with the panel joint setting out. The top of the beam should have a trowel finish to a tolerance of +0mm and ±5mm. All setting out levels will be as depicted on the contract drawings.

It is anticipated that approximately 50m² of wall per day should be achieved. This would result in the following programme times for the main embankments:

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<tr>
<th>Description</th>
<th>Area (m²)</th>
<th>Programme Time (Days)</th>
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</thead>
<tbody>
<tr>
<td>West side north and south walls</td>
<td>495m² x 2</td>
<td>990/50 = 20</td>
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<tr>
<td>East side stage 1 north and south walls</td>
<td>495m² + 370m² = 865/50</td>
<td>18 days</td>
</tr>
<tr>
<td>Intermediate wire wall</td>
<td></td>
<td>Included in above</td>
</tr>
<tr>
<td>East side stage 2 (wall completion)</td>
<td>125m²</td>
<td>2-3 days</td>
</tr>
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</table>

The programme time for the embankments can often be driven by the availability and delivery rate of the fill detailed in 8.1.2.

It is proposed to use Terra Trel – MSE (Mechanically Stabilised Earth) Wire Faced Retaining Wall for the temporary/intermediate wall to the east approach road stage 1 section. This combines the performance and structural integrity of their reinforced and retained earth systems without the additional cost of a concrete facing unit. This system basically performs and is constructed in the same way as the reinforced/retained earth systems, but utilising a lightweight wire facing. It is ideal where the aesthetics are not a critical item.

This system can be designed to use galvanised steel strip, welded bar mat or high-tenacity polyester based geostrap soil reinforcements, depending upon the site specific requirements. The system has the same design life as the other walls of 120 years.

Normal 5m soil reinforcements should be sufficient to accommodate the temporary line of varioguard vehicle restraint that will be positioned a minimum 1m away from the back of the Terra-Trel unit, allowing the diversion of the west bound traffic through the new works.

Major plant and equipment for the construction of the walls will be as follows:

PCC panels vary between 1.25 tonnes and 1.82 tonnes.

Panel and associated equipment unloading, including panel placement a UNIC URW-1006 10 tonne tracked spider crane.

Proprietary edge protection where necessary, the provision of this can vary with the type of panel used.

**Costs:**

- For design and supply of galvanised steel soil reinforcement  £118.50 per m²
- For design and supply of GeoStrap Synthetic soil reinforcement  £103.00 per m²
- For intermediate wall design and supply of Terra Trel Wire  £72.50 per m²

For the purpose of the costing exercise it is proposed to use the more expensive system as this allows for additional costs that may result from the design and the selection of a coloured/textured finish.
An additional cost of £55.00 per m² has been allowed for the labour and plant element of the installation.

An additional cost of £12.00 per m² has been allowed for the temporary works and materials required to install the wall.

8.1.1 Fill to Embankment

A 6I fill material to series 600 SHW is recommended for filling the embankment.

Total quantity required is as follows:

West embankment ......................... 24050 tonnes
Stage 1 east ................................. 25730 tonnes
Stage 2 east ................................. 1150 tonnes

The above quantities result from using the agreed cross section dimensions of the new embankments and the longitudinal section using a conversion factor of 1.8 tonnes per m³ with a 5% additional allowance for bulking and compaction.

The nature of the fill can vary with the type of soil reinforcement system adopted. A possible cost saving could be made by using a recycled material. The costing exercise reflects the cost for an imported granular material.

Suppliers have provided current quotations around £11.25 per tonne.

The programme time for the embankment construction may be driven by the rate of fill delivered to the site. The site is located on a busy trunk road entering Peterborough and is subject to a high level of peak traffic. Traffic volume remains reasonably high during the remainder of the working day and this may have an effect on the delivery rates of the fill material, depending on turn round time and the number of lorries available. Variation could be between 750 tonne per day to 1100 tonne per day.

The programme has assumed a delivery rate of 900 tonne per day.

West embankment ................. 24050 tonnes/900 = 26.7 days.
Stage 1 east ....................... 25730 tonnes/900 = 28.5 days.
Stage 2 east ....................... 1150 tonnes/900 = 1½ - 2 days.

These differ from the wall construction times. However, if both Stage 1 east and the west embankment walls are to run concurrently to give the most efficient programme duration, it would require twice the lorries to deliver 1800 tonne of fill per day where the programme items overlap. This number of lorries is a risk due to availability. There is not a problem with the supply of plant and operatives to achieve the programme durations.

**Major plant for the fill operation:**

D6 dozer or similar to place fill
Small back actor to trim and depending on the type of soil reinforcement, prepare the fill to receive the reinforcement
Compactor plate for area within 2m of the wall
Bomag 1800 sheep’s foot or similar for main compaction
The above would result in a fill layer of 250mm increment.

**Costs:**
A rate of £13.00 per tonne has been calculated to place the embankment fill delivered to site.

8.1.2 Pre Cast Units to Top of the Retaining Walls

Each wall would be topped with a pre cast concrete unit to complete the wall when stitched into an insitu slab. The unit is generally supplied approximately 1.5m long and weigh 1.4 tonne each. The anchor beam would be cast in sections of approximately 7.5m allowing an expansion joint which would coincide with a capping unit joint.

![Photo 23](Typical insitu support slab for reinforced earth wall showing the stitch links to receive pre cast concrete (PCC) units.)

![Photo 24](Detail showing the PCC unit in position and the stitch reinforcement in position ready for the installation of the stitch beam concrete.)

![Photo 25](Showing an outside view of the finished coping unit with aluminium parapet.)
This PCC unit would also provide a foundation for the N2 aluminium parapet.

The UNIC URW-1006 10 tonne tracked spider crane would be suitable for unloading and the installation of the PCC coping units.

**Cost:**
An allowance of £270.00 per metre run for the pre cast coping units supplied to site. A further £125.00 has been added for the installation of the pre cast units and construction of the stitch beam.

Total cost per metre run = £395.00.

The insitu slab is measured separately.

8.1.3 N2 Parapets

A N2/W1 aluminium parapet system has been costed over the length of the new embankments.

Total length of parapet = $2 \times 2 \times 173m = 692m$.

**Cost:**

£ 375.52.00 per metre run supplied, fixed including mesh and bolt inserts and fixings.

8.1.4 Methodology

The methodology for the construction of the reinforced earth retaining walls varies slightly depending on the shape of the PCC panel and the soil reinforcement used.

However, the following gives an indication of the operations required:

- Prepare the site, including excavation and installation of the filter drain and any cross drainage or services.
- Construct the ground beam, to found position and support the first row of panels.
- Install the first row of panels using the spider crane (pattern and layout will depend on the type of panel chosen) starting at the bridge abutment in each case. Each panel will be securely clamped, wedged and propped before the lifting chains are removed and proceeding to the next panel.
- Panels must be given a slight tilt towards the backfill. This will compensate for a subsequent outward movement which will occur due to the placement and compaction of the backfill. Follow the batter sequence that will be detailed on the project design drawings.
- Attach the geotextiles to the back of the horizontal and vertical joints. The geotextiles should extend approximately 300mm below the finished ground level at the base of the
wall but finish approximately 200mm from the bottom of the wall to allow passage of water.

- Spread and compact the backfill up to the lowest level of the synthetic strips forming a 3% slope away from the facing panels. Using a compactor plate in the area adjacent to the new wall and a sheep’s foot (grid) roller elsewhere.

- The strips will be “tensioned” as much as possible by using the earthworks in one of 3 ways:
  - Option 1: A step is located in the last 0.5m of the synthetic strip 100mm deep and the end of the strip anchored tightly by wooden pegs or steel pins.
  - Option 2: Dig out a trench 0.5m wide and 100mm deep at a distance of \( \frac{3}{4} \) strip length from the wall, anchor the strip tightly across the trench.
  - Option 3: Form an uncompacted berm 0.5m wide and 100mm high at 0.5m away from the end of the strip. The strip is then anchored tightly across the berm.

- Place backfill on the ends of the strip, continue by backfilling the trench in both Option 1 and Option 2, or along towards the wall in Option 3.
Photographs 26 and 27 show the trench layout and backfilling for Option 2.

- In the case of the galvanised soil reinforcement, spread and compact the fill up to the lowest panel lug. Install the first row of soil reinforcement. Nuts are usually installed at the top to prevent omission of the fixing, illustrated in photograph 28.

- Spread the backfill on the galvanised strips and compact.
- The same procedure will be used for the intermediate wall using wire panels instead of the PCC panels. The single significant difference being the inclusion of a full covering of geotextile at the back of the wire panel to retain the fill. Position temporary edge protection along the length.

- Repeat the cycle of backfilling and compacting in lifts, inserting strips, placing geotextiles and bearing pads and setting panels as described until the wall is complete.

- When the backfill has reached the top of the first row propping can be removed.

- It is important to position a protection barrier to prevent possible undermining of the wall. This can be in the form of a concrete upstand sitting on the ground beam in front of the first row of panels, sealing the joint of the panel with the ground beam.

- When the wall has reached its final height, trim the fill, place blinding concrete and construct the in situ reinforced concrete stitch beam slab in 7.5m increments along the edge of the stage 1 construction.

- Receive and position the PCC coping units. Replace edge protection as work proceeds.

- Shutter and place stitch concrete.

- Trim and install kerbs.

- Prepare the area between the stitch beam and kerbs, place ducting and concrete.

- Install the parapets.

- Trim road formation and place type 1 and construct road.

In the eastern embankment where an intermediate wall is to be positioned:

- Prepare the area between the stitch beam and intermediate wall.

- Install the parapet to the northern edge.

- Trim road formation place type 1 and construct road to within 1m of the intermediate wall.

- Install varioguard vehicle restraint, apply temporary road lining for 3.25m narrow lane. Complete temporary tie in at bottom of the new embankment with existing A 605 and open the lane to east bound traffic in accordance with the TM procedure.

- For stage 2 of the new east embankment, prepare the site, including excavation and installation of the filter drain to the southern wall extend any cross drainage or services.

- Construct the ground beam along the southern wall line to found, position and support the first row of panels.

- Install the first row of panels using the spider crane (pattern and layout will depend on the type of panel selected) starting at the under bridge abutment in each case. Each panel to be securely clamped, wedged and propped before the lifting chains are removed and proceeding to the next panel.
- No further work is required at the interim wall. The stage 2 backfill butts up to the face of the intermediate wall and is compacted.

- Panels must be given a slight tilt towards the backfill, this will compensate for a subsequent outward movement which will occur due to the placement and compaction of the backfill. Follow the batter sequence that will be detailed on the project drawings.

- Attach the geotextiles to the back of the horizontal and vertical joints. The geotextiles should extend approximately 300mm below the finished ground level at the base of the wall but finish approximately 200mm from the bottom of the wall to allow passage of water.

- Spread and compact the backfill up to the lowest level of the synthetic strips forming a 3% slope away from the facing panels. Using a compactor plate in the area adjacent to the new wall and a sheep’s foot (grid) roller elsewhere.

- Repeat the construction procedure to complete the south wall and backfill between the south wall and the interim wall.

- When the wall has reached its final height, trim the fill place blinding concrete and construct the insitu reinforced concrete stitch beam slab in 7.5m increments along the southern edge of the stage 2 construction.

- Receive and position the PCC coping units. Replace edge protection as work proceeds.

- Shutter and place stitch concrete.

- Trim and install kerbs.

- Prepare the area between the stitch beam and kerbs, place ducting and concrete.

- Install the parapets.

- Trim road formation place type 1 and construct new road. Complete the ties in at the end of the new embankment.

8.2 Bridge Construction

Details for the construction for the railway crossing bridge are shown on Motts sketch drawings issued by David Carr and in the Geotechnical Advice note GAN01 dates 24/03/2014. The position of the bridge is detailed on drawing MMD-332955-C-DR-XX-3002.

Superstructure Construction

The east and west insitu reinforced concrete abutment walls (approximately 14m wide x 1m thick widening at the top to 1.4m x 5.8m high) are founded on insitu reinforced concrete pile caps which in turn are supported upon 15 No. 450mm diameter x 12m long or, 600mm diameter x 8m long bored cast insitu or CFA reinforced concrete piles. Either of these piling methods is suitable for positioning adjacent to the railway track to minimise disturbance to the tracks.
Each pile cap is approximately 15m long x 5m wide x 1m deep (top surface approximately 300mm below ground level) with the 15 piles set in a grid of 5 rows of 3.

All buried concrete surfaces to have bitumen paint waterproofing.

The 27m span skewed insitu bridge deck will be supported by 2 No. Standard UM9 U shaped pre cast concrete edge beams approximately 1m wide at the base and 1200mm high, in-filled with 8 No. standard M10 pre cast concrete beams approximately 1m wide at the base x 1200mm high. The insitu concrete deck 200mm thick will be supported on a GRP permanent shuttering system. A 1.60m wide canter levered slab section will run continuously along the bridge span on the north and south sides which includes a 600mm wide parapet upstand section for the H4a vehicle restraint system.

Deck width:
7.3m carriageway with 1m strips
2m footway/cycleway
650mm verge
2 x 600mm parapet upstands
Total width 13.2m

Each end of the bridge deck will be closed with a diaphragm downstand wall approximately 1.4m deep (from the deck slab surface) x 300mm thick. The precast beams will sit on 20 No. 500 x 350 x 120 elastomeric or similar bridge bearings founded on purpose built reinforced concrete bearing support plinths on the abutment wall shelf.

A 3m stepped reinforced concrete transition slab with steps at approximately 1m spacing x approximately 1.2m deep will be constructed at each road side of the bridge deck to accommodate the road construction surfacing.

For costing purposes the following has been assumed:

- Reinforcement generally at average of 200kg/m³.
- Piles at 450mm diameter x 12m deep, reinforcement at 150kg/m³.
- Structural concrete C50.
- Permanent GRP soffit as EMJ or similar. Cost per m² £45 plus £3.70/m² for jointing tape/butyl and delivery.
- 20 No. laminated elastomeric bearings at £500.00 each plus £200 delivery.
- Deck waterproofing Stirling Lloyd Eliminator one coat bridgedeck waterproofing system BBA 11/H170.
- Road surfacing 65mm binder course with 40mm surface course. Binder regulating if required.
- 2 No. ducts in 2m wide footway with concrete surface.
- H4a vehicle parapet system.
- Kerb drainage system to one side discharging down approach embankments also through kerb drainage.
- Silaine protection to stringer area concrete.
- An allowance has been made in the shuttering rates for an F6 textured finish to exposed concrete surfaces.
- An allowance has been made for bearing shelf and back of wall drainage.
The installation of the piled foundations will be undertaken using a specialised piling sub contractor, utilising plant and equipment designed and purpose built for the work. The sub contractor shall install the piles during normal working hours, working to an agreed methodology which incorporates among other, the follow items:

- Type and orientation of the plant.
- Working from a piling platform which has been designed to accommodate the particular plant thus negating the risk of plant movement or overturning.
- Experienced piling sub contractor staff and operatives.
- Experienced principle contractor utilising agreed working procedures.
- All method statements and temporary works designs subject to Form 3 Network Rail (NWR) approval.

It is not considered necessary for personnel and operatives’ to be PTS trained.

Construction will continue with the pile caps. Subject to final design and confirmation of levels and position the excavation to the west pile cap may require temporary support along the line parallel with the NWR boundary. The pile cap on the east will be adjacent to the signal box and will require temporary works to support and ensure the integrity of the signal box structure. This would be subject to a risk assessment, ground conditions and temporary works design and NR approval. The remaining sides of the pile cap excavation would be stepped or battered in profile.

Ground water will be controlled by placing a cut off french drain around the base of the excavation to enable a pumped system to reduce and control any ground water throughout the construction of the pile cap.

![Photo 29](Photo 29)
Bored cast insitu pile rig adjacent to NR Cambridge to London main line.
The abutment walls approximately 6m high overall will be constructed using traditional concrete shuttering methods and require an access scaffold for access for reinforced, shuttering and placing concrete. The scaffold of the west abutment will be founded partly on pile cap and would be subject to temporary design approval from NWR. The scaffold to the east abutment will also incorporate the close proximity of the signal box. Part of the design for the eastern abutment scaffold will include an element over the signal box providing protection during the construction of the abutment and deck.

The works will require the attendance of a crane for the lifting and placement of materials and shutters, etc. This would normally be an 80 -100 tonne tracked crawler crane. However, the abutments required for this work are not huge and do not include reinforced concrete wingwalls. Therefore, mobile cranes may be utilised as and when required. The orientation and working procedure for the crane would be included in the method statement. The piling platform would be designed to accommodate this item of plant together with the piling plant and the use of a truck mounted concrete pump for placing the structural concrete.
On completion of the abutment wall the access scaffold will be removed with the exception of the front elevation to allow for the reinforced earth retained embankment to be constructed. The front elevation scaffold will provide access for the fixing of the bearings and for the positioning of the pre cast concrete beam installation.

It is envisaged that all of this work will be undertaken during normal working hours under the procedures and methodology agreed and approved in the method statements by NWR.

**Deck Construction**

The proposed deck construction comprises:

10 No. pre cast concrete beams, 8 intermediate U beams 1200mm high x 970mm wide overall and 2 outside edge beams 1200mm high x 1020mm wide but providing U shape twin supports.

Details are shown within the sketch in Appendix C.

The pre cast concrete beams will be topped with a 200mm thick insitu reinforced concrete deck which canter-levers at both longitudinal sides for a further 1.60m, providing a 650mm x 450mm high parapet.

Permanent GRP shuttering will be positioned between the pre cast beams to provide support for the insitu deck concrete.

Stirling Lloyd Eliminator Single Coat Waterproofing or similar will be placed onto the concrete deck and at the edges of the concrete parapet.

Bullnose kerbs and kerb drainage will form a verge on the south side and footpath/cycleway on the north.

An H4a containment class parapet with a minimum height of 1500mm with a “very severe impact severity” classification will be installed at the bridge edges to provide vehicle restraint and protection over the railway.

![Photo 33](https://example.com/photo33.jpg)

**Typical H4a Vehicle Restraint Parapet, showing transition.**
Photo 34
Mobile set up for lifting SY concrete bridge beams.

Photo 35
Mobile crane lifting SY beams

Photo 36
Landing a pre cast concrete beam on bearings

Photo 37
Positioning a concrete beam on temporary hardwood wedge supports. Elastomeric bearing shown between temporary supports.
The installation of the pre cast concrete beams will require a 500 tonne mobile crane, using 165 tonne counterweight with a Guyed Main Boom. Lifting specifications are:

Lift Details: Maximum 40 tonne(s) at a maximum radius of 27 metre(s).

Description of item(s) to be lifted: 10 No Precast concrete beams (maximum 27m in length)

Maximum height to lift top of beam is 8m from ground level at the crane position.

The installation requires the protection of a weekend 15 hour rail possession. The timing of the weekend will follow the completion of both the east and west approach roads, together with the bearing shelf to both abutments and the positioning of the bearings.

To enable the positioning and safe operation of the 500 tonne mobile crane and completion of the pre cast concrete beams installation, a full closure of the A605 will be required.

The crane will arrive on site on Friday night. The positioning and construction of the 500 tonne crane will take the remainder of Friday night and part of Saturday morning. The 500 tonne crane has outrigger centres at 10m x 9.6m and requires up to 3 attendant lorries for the associated equipment, ballast etc together and possibly a further mobile crane to assist.

Due to the restricted space and embankment width, the 500 tonne crane would be positioned straddling the existing A605 carriageway and the northern verge immediately west of the level crossing. The methodology layout drawing is attached as Appendix D.

The crane outriggers on the north of the 500 tonne crane will be founded off of the road on soft/unmade ground. The nature and extent of the temporary work for the outrigger support will need to be confirmed following final design, confirmation of the pre cast concrete beam weights and subject to full temporary works design and NWR Form 3 approvals.

A preliminary programme of works reference Kings Dyke/prel/pos/01 for the possession works is attached as Appendix E.

Following confirmation of the NWR possession, the northern edge beam will be positioned. Due to the shape of the proposed beams, no temporary bracing will be required while the beams are in a free condition.

Work will continue with the intermediate beams and complete with the southern edge beam. Access will be achieved by using mobile access platforms (cherry pickers) and the front section of the abutment scaffolding.

When the intermediate beam operation is clear, work can commence on positioning and fixing the GRP permanent soffit shutters. This operation will seal the work space above the railway lines and allow the bridge finishes to be completed in isolation from the working rail lines below and within normal working hours.

Other Possessions Required

Other possessions are required as follows:

It would be prudent to arrange a contingent 15 hour possession. This will allow for any delay in the works which fall outside the control of the contractor. For example, strong winds preventing the crane from operating, delays imposed by NWR direct.
A further 12 hour possession will be required at the completion of the new bridge deck to enable the safe removal of the edge protection.

The bridge construction consists of embankments behind the abutments. NWR operations will normally require a system to monitor the permanent way for line, level and cant prior to, during, and for a period of time following the completion of the embankments.

Survey targets on the rails can be positioned during Engineering Access Hours possession (previously known as Rules of the Route).

Immediately following the completion of the works and opening of the new approach roads and bridge crossing.

The existing level crossing will be closed. To achieve this a line of temporary vertical concrete barriers (TVCB) may be positioned across the A605 on the east and west sides of the Kings Dyke level crossing, thus preventing vehicle access. It will also require a section of fencing to prevent pedestrian access.

NR has estimated the removal of the level crossing will cost approximately £400k, the majority of costs allocated for signaling design changes. The crossing equipment would be removed as soon as possible, following the completion of the new and road closure with the signaling data changes subject to NR programming. Actual timescales are difficult to define.

Photo 38
Appendix A:
BBA Roads and Bridges Agrément Certificate reference 99/R106
Product

- THIS CERTIFICATE REPLACES ROADS AND BRIDGES CERTIFICATE No. 87/RO30 AND RELATES TO THE HIGH ADHERENCE STRIP AND PANEL LUG SYSTEM FOR REINFORCED SOIL RETAINING WALL AND BRIDGE ABUTMENTS.
- The system is based on the use of galvanized, hot-rolled steel strips with transverse ridges formed during the rolling process and galvanized, hot-rolled strip panel lugs to be embedded in precast reinforced concrete facing panels.
- The design and construction must be in accordance with the requirements of the Highways Agency (HA), acting on behalf of the Department for Transport, the Scottish Executive Development Department, the Welsh Assembly Government, and the Department for Regional Development, Northern Ireland, and the conditions set out in the Design Data and Installation parts of this Certificate.
- Marketing, design and supervision of the construction of reinforced soil structures incorporating the system are carried out by the Certificate holder. Formal training is provided where construction is not carried out by the Certificate holder.

Highways Agency Requirements

1 Requirements

1.1 All proposals for adopting the system shall comply with current HA design and certification procedures and relevant Design Data shall be submitted in accordance with the requirements of section 4 of this Certificate.

1.2 The design, materials specification and construction methods adopted shall be in accordance with HA Technical Standard BD 70/03 (Use of BS 8006 : 1995). Design Manual for Roads and Bridges (DMRB 2.1.5) and Manual of Contract Documents for Highway Works (MCD/M), Volume 1 (MCD/M1), May 2001 Edition.

Readers are advised to check the validity of this Certificate by either referring to the BBA’s website (www.bbaserts.co.uk) or contacting the BBA direct (Telephone Hotline 01952 201733).
4 Delivery, storage and site handling
4.1 Components should be handled and stored generally in accordance with HA requirements.
4.2 The High Adherence Strips are supplied in bundles. Each bundle carries a label bearing the BBA identification mark and the number of this Certificate.
4.3 Panel Lugs in bundles or crates, each carrying a label bearing the BBA identification mark and the number of this Certificate, are supplied for costing into the precast reinforced concrete panels before delivery to site.

5 General
5.1 High Adherence Strip and Panel Lugs are satisfactory for use in providing reinforcement for reinforced soil structures with stability achieved through interaction of the soil particles with the High Adherence Strips. A typical sectional elevation and plan are shown in Figures 3 and 4 respectively.
5.2 Design details, including the required length, type and spacing of High Adherence Strips, are satisfactory when determined in accordance with Technical Standard RD 701/015.
5.3 The arrangement of High Adherence Strip and parapet support structure (as shown on the Certificate holder's drawings Nos S93, S94, S95, and S99) is satisfactory for the requirements of the design load case associated with vehicle impact on P1 and P2 parapets for highways structures, where the highway design traffic surcharge is HA or up to 4.5 units of HB. The strip requirement for other load cases, e.g. HA and/or HB traffic surcharge, is to be determined separately and the maximum strip requirement provided. The anchor beam dimensions shown on the Certificate holder's drawings are satisfactory for the global stability of the anchor beam to prevent overturning and forward sliding, as demonstrated by the results of a full-scale impact test.
5.4 High Adherence Strips are easily installed and are able to withstand the forces imposed by compaction plant provided the composition of the fill and the compaction methods are in accordance with HA requirements, and this Certificate.
5.5 The connection between the High Adherence Strips and the Panel Lugs is easily made.
5.6 To prevent damage, High Adherence Strips must not come into direct contact with compaction plant. Strips must be covered and protected with fill prior to any trafficking.
5.7 Fill should be placed to a minimum depth of 1.50 m before each pass of the compaction plant and, to avoid movement of the facing panels, heavy compaction plant should not be employed within 2 m of the face.
5.8 Prior to the commencement of the work, the designer shall satisfy the HA technical approval requirements.

![Diagram](image-url)
5.9 Where appropriate to specific projects, the designer should provide the main contractor with details of:
• working drawings
• calculations
• specification for fill material
• acceptable moisture content of fill material at time of placement
• sequence of placing fill material
• estimated movement of facing units during filling and compaction operations
• tolerance on the position of finished line of the wall.

5.10 Where appropriate, the reinforced soil structure should be protected against horizontal impact loads caused by possible vehicle collision with the lower facing units of the wall.

5.11 The precast concrete facing units should be designed to conform to the requirements of HA Technical Standards BD 24/92. Use of BS 5400-4:1990 (DWRB 1.3.3) and BD 57/01 (DWRB 1.3.7).

6 Design considerations
Reinforced soil structures incorporating the products shall be designed in accordance with BD 70/03 and other HA requirements.

7 Mechanical properties
Design strength (Tf)
7.1 The appropriate design strength, Tf, for a particular combination of High Adherence Strip and Panel Lug, may be taken from Table 1, this allows for:
• a design life of 120 years
• a partial material factor, f_p = 1.5
• a partial load factor, f_L = 1.1, dealing with ramifications of failure.

High Adherence Strip/frictional soil interaction
7.2 The fill material used in the structures shall be 6f or 6j frictional fill as described in MCHW 1 with electrochemical properties in accordance with Table 4 of BS 8006:1995, or frictional fill material as described in clause 7.3 of this Certificate.

7.3 Fill material used in structures that complies with the following grading limits (see Table 2), has a uniformity coefficient not less than two, and the characteristics parameters defined in clause 7.4 of this Certificate can be used in design without further tests except where the fill is chalk, in which case shear box (300 mm) tests must be carried out. Where fill in the reinforced earth structure is within a vertical distance of 1 m of a trafficked road surface, it must have a uniformity coefficient not less than 5.

<table>
<thead>
<tr>
<th>BS size</th>
<th>Percentage passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 mm</td>
<td>100</td>
</tr>
<tr>
<td>75 mm</td>
<td>not less 75</td>
</tr>
<tr>
<td>10 mm</td>
<td>not less 10</td>
</tr>
<tr>
<td>80 mm</td>
<td>D 0 to 1.5</td>
</tr>
</tbody>
</table>

*Particulate less than 10 mm and up to 250 mm may be used at the discretion of the engineer.

7.4 For frictional fill complying with the grading requirements of clauses 7.2 or 7.3 of this Certificate, shear strength characteristics will be equal to or better than:
- $\phi'$ = 36$^\circ$, where $\phi'$ is the effective angle of shearing resistance of the fill.
- $\mu_{\phi}' = 1.2 + \log$ (Uniformity Coefficient) and
- $\mu_{\phiB}' = \tan\phi'$, where $\mu_{\phi}$ and $\mu_{\phiB}$ are as defined in Figure 5, and represent enhanced pullout resistance as described in clause 2.12 of BS 8006:1995.

These values are conservative and may be used in routine design of structures in accordance with BD 70/03 unless more definitive data on uniformity coefficient (CU) and $\phi'$ are available.

7.5. Definitive data for uniformity coefficient (CU) of the frictional fill can be obtained from particle size distribution tests (where CU = D50/D10). Definitive data for $\phi'$ for the frictional fill can be obtained from shear box (300 mm) tests.

7.6. When the fill has more than 15% passing the 10 micron sieve, special procedures are required for determining the suitability of the frictional fill. These are shown on drawing No S429 available from the BBA or the Certificate holder.

7.7. Frictional fill material containing particles greater than 250 mm is not covered by this Certificate but may be acceptable at the discretion of the engineer. The following provisions should be considered:

- the size of the largest particles is not greater than 70% of the vertical spacing of the High Adherence Strips.
- the material is well graded.
- frictional fill containing these large particles is not placed within a distance of 2 m of the facing.
- compaction of the frictional fill can be carried out to achieve the required density.

Parapet support structure

7.8. The parapet support units must be constructed to the design of the Certificate holder as approved by the BBA and shown in drawings Nos S94, S95, S98 and S99 available from the BBA or the Certificate holder. The general arrangement is shown in Figure 6.

7.9. The number and layout of the High Adherence Strips below the parapet support structure must be to the requirements of the Certificate holder and approved by the BBA as shown on drawing No S93 available from the BBA or the Certificate holder (see section 5.3).

8. Durability

In the opinion of the BBA, when used and installed in accordance with this Certificate, the system can achieve a design life of 120 years as required by HA for permanent structures.

9. Procedure

9.1. The formation level is prepared, the concrete levelling pad constructed and the first course of facing panels erected and temporarily propped.

9.2. Fill material is placed and compacted behind the facing up to the level of the first layer of High Adherence Strips.

9.3. The High Adherence Strips are then laid and attached to the Panel Lug embedded in the precast concrete facing panels, using galvanized steel connection bolts.
9.4 A further course of facing panels is fixed and successive layers of fill are placed and compacted on top of the High Adherence Strips until the level of the next layer of High Adherence Strips is reached. The sequence is repeated up to the required height of the structure.

9.5 The parapet support units are constructed using normal reinforced concreted construction techniques.

### Technical Investigations

The following is a summary of the technical investigations carried out on the High Adherence Strip and Panel Lug System for Reinforced Soil Retaining Wall and Bridge Abutments as part of this and previous BBA assessments:

#### 10 General

The system has been assessed for compliance with HA requirements.

#### 11 Tests

As part of this assessment in the investigation of previous Certificates Nos B1/19 and B1/30, tests were carried out to establish:
- Thickness of galvanizing on High Adherence Strips and Panel Lugs
- Coefficient of friction between High Adherence Strips and frictional fill
- Performance of parapet support structure under full-scale impact test.

#### 12 Investigations

As part of this and previous assessments, the following investigations were carried out:

11 Existing data on the High Adherence Strip were examined in relation to:
- Coefficient of friction between the strips and the fill
- Quality and composition of steel
- Tensile properties of steel
- Quality of galvanizing
- Design calculations

12 Existing data on the Panel Lug were examined in relation to:
- Quality and composition of steel
- Tensile properties of steel
- Quality of galvanizing
- Design of High Adherence Strip/Panel lug connection

13 Existing data relating to the quality of the bolts were examined.

14 The manufacturing processes for the High Adherence Strip and Panel Lugs were examined, including the methods of quality control.

#### Additional Information

All suppliers of the High Adherence Strip and Panel Lug System components to the Certifica holder’s specification are required to have had their management systems assessed and registered as meeting the requirements of BS EN ISO 9002.

#### Bibliography

- **BS 3692: 2001** ISO metric precision hexagon bolts, screws and nuts — Specification
- **BS 5400-4: 1990** Steel, concrete and composite bridges — Code of practice for design of concrete bridges
- **BS 8006: 1995** Code of practice for strengthening/reinforced soils and other fills
- **BS EN 10025: 1993** Hot rolled products of non-alloy structural steels — Technical delivery conditions
- **BS EN 20808: 1994** Mechanical properties of fasteners — Nuts with specified proof load values — Coarse thread
- **BS EN ISO 698-1: 1999** Mechanical properties of fasteners made of carbon steel and alloy steel — Bolts, screws and studs
- **BS EN ISO 1461: 1999** Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods
- **BS EN ISO 4014: 2001** Hexagon head bolts — Product grades A and B
- **BS EN ISO 4032: 2001** Hexagon nuts, style I — Product grades A and B
- **BS EN ISO 9002: 1994** Quality systems — Model for quality assurance in production, installation and servicing
- **BD 24/92** The design of concrete highway bridges and structures use of BS 5400-4:1990
- **BD 57/01** Design for Durability
- **BD 70/03** Strengthened/Reinforced Soils and compaction fill for Retaining Walls and Bridge Abutments
13 Conditions

13.1 This Certificate:
(a) relates only to the product that is described, installed, used and maintained as set out in this Certificate;
(b) is granted only to the company, firm or person identified on the front cover — no other company, firm or person may hold or claim any entitlement to this Certificate;
(c) has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective;
(d) is copyright of the BBA.

13.2 References in this Certificate to any Act of Parliament, Regulation made thereunder, Directive or Regulation of the European Union, Statutory Instrument, Code of Practice, British Standard, manufacturers' instructions or similar publication, shall be construed as references to such publication in the form in which it was current at the date of this Certificate.

13.3 This Certificate will remain valid for an unlimited period provided that the product and the manufacture and/or fabricating process(es) thereof:
(a) are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA;
(b) continue to be checked by the BBA or its agents;
(c) are reviewed by the BBA as and when it considers appropriate; and
(d) remain in accordance with the requirements of the Highways Agency.

13.4 In granting this Certificate, the BBA makes no representation as to:
(a) the presence or absence of any patent or similar rights subsisting in the product or any other product;
(b) the right of the Certificate holder to market, supply, install or maintain the product; and
(c) the nature of individual installations of the product, including methods and workmanship.

13.5 Any recommendations relating to the use or installation of this product which are contained or referred to in this Certificate are the minimum standards required to be met when the product is used. They do not purport in any way to restate the requirements of the Health & Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of this Certificate or in the future; nor is conformity with such recommendations to be taken as satisfying the requirements of the 1974 Act or of any present or future statutory, common law or other duty of care. In granting this Certificate, the BBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the installation and use of this product.
Appendix B:
BBA HAPAS Certificate reference 12/H182
Reinforced Earth Company Ltd
Innovation House
Euston Way
Telford
Shropshire TF3 4LT
Tel: 01952 201920 Fax: 01952 201753
email: info@reinforcedearth.co.uk
website: www.reinforcedearth.co.uk

REINFORCED EARTH SOIL REINFORCEMENT SYSTEMS

GEOSTRAP REINFORCEMENT FOR REINFORCED SOIL RETAINING WALLS AND BRIDGE ABUTMENTS

This HAPAS Certificate is issued by the British Board of Agrément (BBA), supported by the Highways Agency (HA) acting on behalf of the overseeing organisations of the Department for Transport, Transport Scotland; the Welsh Assembly Government and the Department for Regional Development, Northern Ireland; the Association of Directors of Environment, Economy, Planning and Transport (ADEPT); the Local Government Technical Advisers’ Group and industry bodies. HAPAS Agrément Certificates are normally each subject to a review every five years.

PRODUCT SCOPE AND SUMMARY OF CERTIFICATE

This Certificate relates to GeoStrap Reinforcement for Reinforced Soil Retaining Walls and Bridge Abutments, a geosynthetic strip used in conjunction with precast concrete facing units and compacted fill material to construct reinforced soil retaining walls and bridge abutments.

HAPAS CERTIFICATION INCLUDES:

- factors relating to compliance with HAPAS requirements
- factors relating to compliance with Regulations where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal five-yearly review.

KEY FACTORS ASSESSED

Soil/GeoStrap Reinforcement interaction — interaction between the soil and the GeoStrap Reinforcement has been considered and coefficients relating to direct sliding and pull-out resistance are proposed (see section 6).

Mechanical properties — the short and long-term tensile strength and elongation properties of the GeoStrap Reinforcement, loss of strength due to installation damage and reduction in strength at the connection to the facing panels have been assessed and reduction factors established for use in design (see sections 7 and 9).

Durability — the resistance of the GeoStrap Reinforcement to the effects of hydraulic, chemical and biological degradation and exposure to UV light normally encountered in reinforced soil retaining walls and bridge abutments in the UK has been assessed and reduction factors established for use in design (see sections 8, 9 and 11).

The BBA has awarded this HAPAS Certificate to the company named above for the products described herein. These products have been assessed by the BBA as being fit for their intended use provided they are installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of First issue: 17 April 2012

Brian Chamberlain
Head of Approvals — Engineering

Greg Cooper
Chief Executive

The BBA is a UKAS accredited certification body — Number 113. The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk

Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

British Board of Agrément
Buckland Lane
Gianstone, Watford
Herts WD25 9BA

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Page 1 of 12
Requirements

In the opinion of the BBA, GeoStrip Reinforcement for Reinforced Soil Retaining Walls and Bridge Abutments when used in accordance with the provisions of this Certificate, will meet the requirements of the Highways Agency and local Highway Authorities for the design and construction of reinforced soil retaining walls and bridge abutments.

Regulations

Construction (Design and Management) Regulations 2007
Construction (Design and Management) Regulations (Northern Ireland) 2007

Information in this Certificate may assist the client, CDM co-ordinator, designer and contractors to address their obligations under these Regulations.

See sections: 1 Description (1.2 and 1.4), and 13 Installation (13.9) of this Certificate.

Additional Information

CE marking

The manufacturer has taken responsibility for CE marking the GeoStrip Reinforcement in association with harmonised Standard BS EN 13251 : 2001. An asterisk (*) appearing in this Certificate indicates that data shown is given in the manufacturer’s Declaration of Performance.

General

GeoStrip® Reinforcement is used in conjunction with precast concrete facing units and compacted fill material to construct reinforced soil retaining walls and bridge abutments.

The reinforcement strips are connected to the facing units either via galvanised mild steel loops and toggles or via proprietary GeoMega® connectors made from high density polyethylene.

(1) GeoStrip and GeoMega are registered trademarks.

Technical Specification

1 Description

GeoStrip Reinforcement

1.1 GeoStrip Reinforcement is a geosynthetic strip comprising a number of discrete channels of individually tensioned, closely packed, high tenacity polyester tendons, encased in a low-density polyethylene sheath (see Figure 1).
1.2 The types and grades of GeoStrap Reinforcement assessed by the BBA and covered by this Certificate are shown in Table 1.

<table>
<thead>
<tr>
<th>Type</th>
<th>Strength grade (kN)</th>
<th>Coil length (m)</th>
<th>Nominal Weight of coil (kg)</th>
<th>Mean width (mm)</th>
<th>Mean thickness (mm)</th>
<th>Weight of LDPE Coating (g/m²)</th>
<th>Characteristic short-term tensile strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5B</td>
<td>57.5</td>
<td>100</td>
<td>11.3</td>
<td>49.5 ± 0.5</td>
<td>2.5 ± 0.5</td>
<td>62 ± 2</td>
<td>37.5*</td>
</tr>
<tr>
<td>5B</td>
<td>50</td>
<td>100</td>
<td>18.2</td>
<td>49.5 ± 0.5</td>
<td>4.0 ± 0.5</td>
<td>70 ± 2</td>
<td>50*</td>
</tr>
<tr>
<td>6B</td>
<td>65</td>
<td>100</td>
<td>18.2</td>
<td>49.5 ± 0.5</td>
<td>4.5 ± 0.5</td>
<td>90 ± 3</td>
<td>65*</td>
</tr>
<tr>
<td>9B</td>
<td>90</td>
<td>100</td>
<td>14.0</td>
<td>90 ± 1.0</td>
<td>1.5 ± 0.5</td>
<td>105 ± 3</td>
<td>90*</td>
</tr>
<tr>
<td>9B</td>
<td>90</td>
<td>100</td>
<td>19.3</td>
<td>90 ± 1.0</td>
<td>2.5 ± 0.5</td>
<td>125 ± 4</td>
<td>90*</td>
</tr>
<tr>
<td>9B</td>
<td>75</td>
<td>100</td>
<td>26.2</td>
<td>90 ± 1.0</td>
<td>3.5 ± 0.5</td>
<td>150 ± 5</td>
<td>75*</td>
</tr>
<tr>
<td>9B</td>
<td>100</td>
<td>100</td>
<td>30.4</td>
<td>90 ± 1.0</td>
<td>4.0 ± 0.5</td>
<td>165 ± 5</td>
<td>100*</td>
</tr>
</tbody>
</table>


1.3 The product type and CE mark are embossed on one face of the product during the manufacturing process and the product grade and company logo are embossed on the other face (see Figure 2).

Figure 2: GeoStrap Reinforcement — face markings:

![GeoStrap 5 B CE GeoStrap 5 B](image)

Specification for precast concrete facing units

1.4 The BBA has assessed GeoStrap Reinforcement for use with precast concrete facing units designed and manufactured in accordance with BS 8006-1: 2010, BS EN 14475: 2006, BS EN 1990: 2002 and BS EN 1992-2: 2005, including relevant national annexes and the requirements of the Design Section of this Certificate [see sections 6.7 to 6.13]. Other facing systems are available but are outside the scope of the Certificate.

1.5 The following two alternative means of attaching GeoStrap Reinforcement to the precast concrete facing units have been assessed by the BBA:

- **Loops** — galvanized steel attachment loops cast into the concrete during manufacture of the panel units. The steel attachment loops are used with galvanized steel toggle bars spanning between them (see Figure 3). This system can be used with all grades of GeoStrap Reinforcement. The strip is wrapped around the toggle bars during installation. All metallic components must be designed to BS 8006-1: 2010. The toggle bars must have a minimum diameter of 25 mm (see sections 6.7 and 7.9).

- **GeoMega connectors** — one-piece, high-density polyethylene sleeve (see Figure 4) cast into the concrete during manufacture of the panel units. This system can only be used with Type 5B (30 mm wide) GeoStrap Reinforcement. The strip is pulled through the sleeve during installation with the aid of a draw chord. As with steel attachment loops, the pullout strength is dependent upon the concrete strength, panel dimensions and reinforcement details. This system gives a minimum bend radius of 22.5 mm (equivalent to a 45 mm diameter toggle bar).

(1) For more information, the advice of the Certificate holder should be sought.
Specification for fill materials

1.6 Fill materials must comply with the requirements set out in BS 8006-1:2010 and the MCHW, Volume 1: Specification for Highway Works.

Ancillary items used during installation

1.7 The following ancillary items are used during installation, but are outside the scope of the Certificate:
- clamps and wedges — to temporarily hold the panels in position during installation;
- timber pegs or steel pins — for temporary fixing of the GeoStrap Reinforcement.

2 Manufacture

2.1 GeoStrap Reinforcement is manufactured from high tenacity polyester yarns drawn through an extrusion-coating die where they are individually and homogeneously tensioned and packed. The yarns are finally coated in a low-density polyethylene sheath. The coated yarns are then fed between rollers to ensure dimensional accuracy and are cooled.

2.2 To check product quality is consistently maintained to the required specification, the BBA has:
- agreed with the Certificate holder/manufacturer the quality control procedures and product testing to be undertaken;
- assessed and agreed the quality control operated over batches of incoming materials;
- monitored the production process and verified that it is in accordance with the documented process;
- evaluated the process for management of non-conformities;
- checked that equipment has been properly tested and calibrated;
- undertaken to carry out the above measures on a regular basis as part of a surveillance process to check that standards are maintained and that the product or system remains as Certificated.
2.3 GeoStrap Reinforcement is manufactured by Terre Armée Internationale.

3 Delivery and site handling

3.1 GeoStrap Reinforcement is delivered to site in 100 m coils, wrapped in transparent polythene film.

3.2 Each coil of GeoStrap Reinforcement includes a label bearing the product name, product type, characteristic strength, coil length and weight, product width and constituent materials (see Figure 5).

![Table 1: GeoStrap Specifications](image)

<table>
<thead>
<tr>
<th>TYPE</th>
<th>GEOSTRAP 5 B</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHARACTERISTIC STRENGTH</td>
<td>50 KN</td>
</tr>
<tr>
<td>LENGTH / WEIGHT</td>
<td>100 M / 14 ± 1 KG</td>
</tr>
<tr>
<td>WIDTH</td>
<td>50 MM</td>
</tr>
<tr>
<td>SHEATH</td>
<td>POLYETHYLENE</td>
</tr>
<tr>
<td>YARN</td>
<td>HIGH- TENACITY POLYESTER</td>
</tr>
<tr>
<td>TERRE ARMEE INTERNATIONALE</td>
<td></td>
</tr>
</tbody>
</table>

3.3 Care should be taken to prevent damage to the product during transit and handling and whilst in storage.

3.4 GeoStrap Reinforcement should be stored under cover, in clean, dry conditions and should be protected from exposure to sunlight and extreme temperatures (see also Section 8.1).

3.5 Concrete facing panels and other components should be handled and stored in accordance with the manufacturers’ instructions, the requirements of BS 8006-1: 2010, BS EN 14475: 2006 and the Highways Agency's Specification for Highway Works.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on GeoStrap Reinforcement for Reinforced Soil Retaining Walls and Bridge Abutments.

4 General

4.1 When designed and installed in accordance with this Certificate, GeoStrap Reinforcement is satisfactory for use in the construction of reinforced soil retaining walls and bridge abutments.

4.2 Structural stability is achieved by the connection strength between the GeoStrap Reinforcement and concrete facing panels and by the frictional interaction between the soil particles and the GeoStrap Reinforcement.

4.3 The fill specification and method of placement and compaction, design strength of the GeoStrap Reinforcement and length of embedment within the compacted fill are key design factors.

4.4 Prior to the commencement of work, the designer must satisfy the design approval and certification procedures of the relevant Highway Authority.

4.5 The BBA has not assessed the structures for supporting parapet loading caused by vehicle collision at the top of the facing units.

4.6 Particular attention should be paid in design to:

- site preparation
- fill material properties
- specification for placing and compaction of the fill material
- drainage
- protection of the GeoStrap Reinforcement against damage during installation
- design of the facing units and means of attachment of the GeoStrap Reinforcement
- the required construction tolerances for the completed structure.

4.7 Typical sectional and plan views of reinforced soil structures constructed using GeoStrap Reinforcement are shown in Figures 6 and 7.
5 Practicability of installation

GeoStrap Reinforcement is easily installed in accordance with the specifications and construction drawings by trained contractors.

6 Design

Design methodology:
6.1 Reinforced soil retaining walls and bridge abutments constructed using GeoStrap Reinforcement should be designed in accordance with BS 8006-1:2010 and the Specification for Highway Works.

6.2 In accordance with BS 8006-1:2010 Annex B, the required design life for permanent walls and bridge abutments is 120 years.

GeoStrap Reinforcement
6.3 The design strength of the GeoStrap Reinforcement (T_r) is calculated as:
- for ultimate limit state (ULS):
  \[ T_{ul} = \frac{T_{cr}}{f_{y}} \]
- for serviceability limit state (SLS):
  \[ T_{sl} = \frac{T_{cr}}{f_{y}} \]

where:
- \( T_{cr} \) is the long-term tensile creep rupture strength of the reinforcement at the specified design life and design temperature,
- \( f_{y} \) is the maximum allowable tensile load to ensure that the prescribed post-construction, limiting strain specified for the SLS is not exceeded,
- \( f_{y} \) is the partial factor for ramification of failure in accordance with BS 8006-1:2010 Table 9.
6.4 The long-term tensile creep rupture strength \( T_{cry} \) for each grade of GeoStrip Reinforcement is calculated using the formula:
\[
T_{cry} = T_{c,dur} / R_{CR}
\]
where:
- \( T_{c,dur} \) is the characteristic short-term strength taken from Table 1.
- \( R_{CR} \) is the reduction factor for creep (see Section 7).

6.5 The material safety factor \( f_s \) used in determining \( T_c \) is calculated as:
\[
f_s = R_{FD} \times R_{FW} \times R_{CH} \times f_s
\]
where:
- \( R_{FD} \) is the reduction factor for installation damage.
- \( R_{FW} \) is the reduction factor for weathering, including exposure to ultra violet light.
- \( R_{CH} \) is the reduction factor for chemical/environmental effects.
- \( f_s \) is the factor of safety for the extrapolation of data.

6.6 Recommended values for \( R_{FD}, R_{FW}, R_{CH} \) and \( f_s \) are given in sections 7, 8 and 9 of this Certificate. Conditions of use outside the scope for which the reduction factors are defined are not covered by this Certificate and advice should be sought from the Certificate holder.

6.7 Tests have shown that the design strength of GeoStrip Reinforcement is reduced locally at the point that it is bent to a tight radius around the connection toggle or GeoMega connector. Reduction factors for use in design are given in section 7.

Soil/GeoStrip Reinforcement interaction

6.8 For the purposes of checking direct sliding and pull out resistance, the friction coefficient \( f' \) relating soil friction angle to the soil/GeoStrip Reinforcement bond can be taken conservatively as 0.6. Enhanced values of \( f' \) can be justified in design by carrying out soil and site-specific pull out tests in accordance with BS EN 13736 : 2004.

Concrete facing panels

6.9 The precast concrete facing units must be designed in accordance with the relevant provisions of BS 8006-1 : 2010, BS EN 14473 : 2006, BS EN 1990 : 2002 and BS EN 1992-2 : 2005, including relevant national annexes.

6.10 The appropriate combination of concrete exposure classes should be selected from Table A1 of BS 8500-1 : 2006 and Table 1 of BS EN 206-1 : 2000 to suit the proposed location and level of exposure of the proposed structure. Design and detailing of the facing units should provide adequate durability for an intended design life of at least 100 years.

6.11 Where concrete facing units are to be embedded in soils which could be potentially aggressive, the guidance in BRE Special Digest 1 : 2005 Concrete in aggressive ground : Part C Assessing the aggressive chemical environment should be followed.

6.12 Where connection loops and toggles are used for connection of the GeoStrip Reinforcement, these should be designed in accordance with the requirements of BS 8006-1 : 2010 and with adequate anchorage strength.

6.13 The Certificate holder’s advice should be sought where it is proposed to use GeoMega connectors to form the connection.

Fill materials

6.14 Fill materials should meet the requirements of BS 8006-1 : 2010 and the Highways Agency’s Specification for Highway Works.

7 Mechanical properties

Short-term tensile strength

7.1 The characteristic short-term tensile strength of each grade of GeoStrip Reinforcement is given in Table 1.

7.2 A typical short-term stress/strain curve is shown in Figure 8. The average strain at breaking load is 12% ± 4%.
Long-term tensile creep rupture strength

7.3 The long-term creep rupture performance of GeoStrap Reinforcement has been determined in accordance with the principles of PD ISO/TR 20432 : 2007. A stress rupture line (see Figure 9) has been determined using conventional long-term creep rupture test data (up to 2,000 hours) and time-shifted, stepped isothermal method (TSM) test data (up to 58,500 hours) for the load-carrying polyester yarn used for manufacture of the GeoStrap Reinforcement. As the amount of available conventional test data was limited to 2,000 hours, the long-term creep performance of the load-carrying polyester yarn has also been compared with that of other similar products, for which data is available in the public domain. The factor of safety for the extrapolation of data [7] presented in section 8 takes into account the extent of available data.

Figure 9 Regression line for life expectancy at given stress defined by percentage of characteristic short-term tensile strength

7.4 For a 120-year design life and design temperature of 20°C, the long-term tensile strength ($T_{cd}$) for GeoStrap Reinforcement can be taken as 64.5% of characteristic short-term tensile strength ($T_{	ext{test}}$), giving a long-term creep reduction factor ($RF_{cd}$) of 1.55.
Post construction strain

7.5 The prescribed maximum allowable post-construction creep strains allowed by BS 8006-1: 2010 for the serviceability limit state of reinforced soil retaining walls and bridge abutments are shown in Table 2.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Strain (%)</th>
<th>Design period for purposes of determining limiting strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge abutments and retaining walls with permanent structural loading</td>
<td>0.5</td>
<td>2 months / 120 years</td>
</tr>
<tr>
<td>Retaining walls, with no applied structural loading i.e. transient live loadings only</td>
<td>1.0</td>
<td>1 month / 120 years</td>
</tr>
</tbody>
</table>

7.6 The relationship between the prescribed post-construction strain limit and the tensile load \(T_{cs}\), causing that post-construction strain is illustrated in Figure 10.

7.7 Reduction factors \(RF_{CS}\) for determining \(T_{cs}\) from the characteristic short-term tensile load \(T_{C0}\) for each grade of GeoStrap Reinforcement are given in Table 3. The following formula is used to calculate \(T_{cs}\):

\[ T_{cs} = \frac{T_{C0}}{RF_{CS}} \]

<table>
<thead>
<tr>
<th>Prescribed allowable post-construction strain (%)</th>
<th>(RF_{CS})</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>2.00</td>
</tr>
<tr>
<td>1.0</td>
<td>1.54</td>
</tr>
</tbody>
</table>

Reduction factor for installation damage (\(RF_{IP}\))

7.8 To allow for loss of strength due to mechanical damage sustained during installation, the appropriate reduction factor \(RF_{IP}\) should be selected from Table 4. These reduction factors have been established from full-scale installation damage tests using a range of materials. For soils not covered by Table 4, appropriate values of \(RF_{IP}\) may be determined from site-specific trials or the engineer responsible for design of the project may exercise engineering judgment to interpolate between the values given. The reduction factors shown assume that well-graded material is used with a minimum compacted depth of 150 mm.

<table>
<thead>
<tr>
<th>GeoStrap Reinforcement type/grade (kN)</th>
<th>(RF_{IP})</th>
<th>Particle size (d_{50}/d_{10}) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 / 1.5</td>
<td>32 / 8</td>
</tr>
<tr>
<td>5B/37.5</td>
<td>1.00</td>
<td>1.02</td>
</tr>
<tr>
<td>5B/50</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>5B/65</td>
<td>1.00</td>
<td>1.01</td>
</tr>
<tr>
<td>9B/30</td>
<td>1.00</td>
<td>1.07</td>
</tr>
<tr>
<td>9B/50</td>
<td>1.00</td>
<td>1.03</td>
</tr>
<tr>
<td>9B/75</td>
<td>1.00</td>
<td>1.03</td>
</tr>
<tr>
<td>9B/100</td>
<td>1.00</td>
<td>1.02</td>
</tr>
</tbody>
</table>
Connection strength

7.9 Reduction factors to allow for the local reduction in design strength of the GeoStrap Reinforcement at the point of connection to the concrete facing panel, where the strip is wrapped around the galvanized steel attachment toggles, or fed through the GeoMega connector are given in Table 5.

<table>
<thead>
<tr>
<th>Means of connection</th>
<th>Factor for reduction in strength at connections (for all grades of GeoStrap reinforcement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galvanized steel loops and toggle(1)</td>
<td>1.15</td>
</tr>
<tr>
<td>GeoMega connector(2)</td>
<td>1.05</td>
</tr>
</tbody>
</table>

(1) Suitable for use with all grades of GeoStrap Reinforcement.
(2) Toggle with a minimum diameter of 25 mm.
(3) Suitable for use with 50 mm wide GeoStrap Reinforcement only.
(4) Equivalent to a toggle with a diameter of 45 mm.

8 Effects of environmental conditions

Weathering (including exposure to ultra violet light)

8.1 Evidence from tests in accordance with BS EN 12224 : 2000 shows that GeoStrap Reinforcement has adequate resistance to weathering and exposure to sunlight, when protected in accordance with the recommendations of this Certificate and provided it is covered within one month of installation. Subject to compliance with this exposure time limit, a reduction factor (RF_w) of 1.0 may be used for design purposes. Exposure periods of up to four months may be acceptable depending upon the season and location, but are outside the scope of this Certificate. Further guidance is given in PD ISO/TR 20432 : 2007.

Chemical and biological degradation

8.2 Evidence from tests in accordance with BS EN 12447 : 2001 shows that GeoStrap Reinforcement has adequate resistance to hydrolysis for soil environments typically encountered in the United Kingdom.

8.3 Evidence from tests in accordance with BS EN 12225 : 2000 shows that GeoStrap Reinforcement is highly resistant to microbiological attack.

8.4 For a design life of 120 years, a design temperature of 20°C and soil environments with pH values between 4.0 and 9.0, the reduction factor for chemical/environmental effects (RF_m) for GeoStrap Reinforcement should be taken as 1.06.

9 Factor of safety for the extrapolation of data (f_s)

For GeoStrap Reinforcement the factor of safety for the extrapolation of data (f_s) should be taken as 1.15 for a 120-year design life and design temperature of 20°C.

10 Maintenance

As the product is confined within the soil and has suitable durability, maintenance is not required.

11 Durability

11.1 GeoStrap Reinforcement will have adequate durability for a design life of 120 years when used and installed in accordance with the provisions of this Certificate.

11.2 The precast concrete facing panels will have adequate durability for the proposed life of the structure under exposure conditions normally encountered in reinforced earth retaining walls and bridge abutments in the UK when designed and installed in accordance with the provisions of BS 8006-1 : 2010, BS EN 14475 : 2006 and the requirements of this Certificate (see sections 6.8 to 6.12).

12 Re-use and recyclability

12.1 The concrete facing units can be crushed and reused as aggregate. The fill material can be reused.

12.2 The steel loops and toggles can be readily recycled.

Installation

13 General

13.1 Installation should be carried out in accordance with the Certificate holder's installation instructions, the requirements of BS EN 14475 : 2006 and the Specification for Highway Works.

13.2 The site is prepared, including excavation and installation of drainage systems and a concrete levelling pad.

13.3 The initial course of facing panels is set and braced using wedges and clamps to hold the panels in position (see Figure 11). The panels are given a slight batter towards the backfill to accommodate the outward movement that will occur as the fill material is placed and compacted.
13.4 Lengths of GeoStrap Reinforcement are cut to the required dimensions and threaded around the facing panel attachment toggles, or pulled through the GeoMega connectors as appropriate (see Figures 2 and 3). Where GeoMega connectors are selected as the means of connection of the GeoStrap Reinforcement to the facing panels, a draw chord may be required to pull the strip through the connector.

13.5 The GeoStrap Reinforcement strips are laid flat across the fill, parallel to each other and perpendicular to the facing panels. They are then pulled taught and fixed in position using timber pegs or steel pins. Care should be taken to ensure that the GeoStrap Reinforcement is not twisted.

13.6 To assist in tightening the GeoStrap Reinforcement before the next layer of soil is placed, a 150 mm deep step, or a 100 mm to 150 mm deep by 500 mm wide trench is excavated at a point 500 mm from the end of the reinforcement.

13.7 Placing of fill is started at the free ends of the GeoStrap Reinforcement, furthest from the facing panels and over the step/trench excavated to assist in tightening the reinforcement. Filling continues progressively outwards to within 2 m of the back face of the facing panels. The remaining 2 m of fill should be placed and compacted using lighter compaction plant in accordance with the panel manufacturer’s recommendations. Backfill is placed and compacted in layers as specified by the designer until the next course of reinforcement is reached, or to within 75 mm to 150 mm of the top edge of the facing units.

13.8 The construction sequence is repeated, with further courses of facing units, GeoStrap Reinforcement and fill added, until the formation level for the parapet base or finished level of the structure is reached.

13.9 Vehicles and other construction plant should not be allowed to run directly on the GeoStrap Reinforcement until it has been adequately covered with fill material.

**Technical Investigations**

14 Tests

Dimensional checks have been carried out on each grade of GeoStrap Reinforcement.

15 Investigations

15.1 The manufacturing process of the GeoStrap Reinforcement was examined, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

15.2 An examination was made of test data relating to:
- long- and short-term tensile properties
- resistance to damage caused during installation
- long- and short-term load/strain characteristics
- connection strength
- resistance to weathering including exposure to ultraviolet light
- resistance to hydrolysis
- resistance to biological degradation.

**Bibliography**

- BS 8006-1: 2010 Code of practice for strengthened/reinforced soils and other fills
- BS 8500-1: 2006 Concrete — Complementary British Standard to BS EN 206-1 — Method of specifying and guidance for the specifier
- BS EN 206-1: 2000 Concrete — Specification, performance, production and conformity
- BS EN 1990: 2002 Eurocode — Basis of structural design
BS EN 12224 : 2000 Geotextile and geotextile-related products — Determination of the resistance to weathering
BS EN 12225 : 2000 Geotextile and geotextile-related products — Method for determining the microbiological resistance by a soil burial test
BS EN 12447 : 2001 Geotextiles and geotextile-related products — Screening test method for determining the resistance to hydrolysis in water
BS EN 13251 : 2001 Geotextiles and geotextile-related products — Characteristics required for use in earthworks, foundations and retaining structures
BS EN 13738 : 2004 Geotextiles and geotextile-related products — Determination of pullout resistance in soil
BS EN 14475 : 2006 Execution of special geotechnical works — Reinforced fill
BS EN ISO 10319 : 2008 Geotextiles — Widthwise tensile test
PD ISO/TR 20432 : 2007 Guidelines for the determination of the long-term strength of geosynthetics for soil reinforcement

Conditions of Certification

16 Conditions

16.1 This Certificate:
• relates only to the product/system that is named and described on the front page
• is issued only to the company, firm, organisation or person named on the front page — no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
• is valid only within the UK
• has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective
• is copyright of the BBA
• is subject to English Law.

16.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

16.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:
• are manufactured at or above the levels which have been assessed and found to be satisfactory by the BBA
• continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
• are reviewed by the BBA as and when it considers appropriate.

16.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

16.5 In issuing this Certificate, the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:
• the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
• the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
• individual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
• any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
• any loss or damage, including personal injury, however caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal
• any claims by the manufacturer relating to CE marking

16.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to state the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.
APPENDIX C
A 605 KINGS DYKE LEVEL CROSSING OPTION 3 PART ON LINE NORTH

Details of Traffic Management, Plant positions and Dimensions taken in the Methodology.
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- 63 -
## Summary

**A605 Kings Dyke Railway Bridge. Option 3**

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<th>Length (m)</th>
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<th>Additional Works</th>
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### Base Construction Cost

- **Base Construction Cost**: £4,449,391.54
- **Additional Items (Permanent works)**: £208,601.49
- **Construction Issues (eg. Temp works)**: £94,875.00
- **Preliminaries (Fixed costs)**: £28,600.00
- **Preliminaries (Time related costs)**: £678,862.50

### Estimated total construction cost (less risk and fee%)

- **£5,455,330.53**

### Identified construction risk items

- **(50%tile)**: -
- **General construction risk allowance**: 0%

### Estimated total construction cost (incl. risk)

- **£5,455,330.53**

### Overheads and profit

- **%**: 11.00%
- **£600,096.36**

### Estimated total construction cost (incl. risk and fee%)

- **£6,055,416.89**
### Additional Items

**A605 Kings Dyke Railway Bridge, Option 3**

#### Additional Construction Costs (Permanent Works)

<table>
<thead>
<tr>
<th>Description</th>
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<th>Unit</th>
<th>Rate</th>
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<td>days</td>
<td>1,010.00</td>
<td>6,060.00</td>
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<td>days</td>
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<td>12,000.00</td>
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<tr>
<td>Concrete shed abutment (up to 100m mobile)</td>
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<td>days</td>
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<td>Possession costs for bridge access</td>
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#### East Approach Road meet the eye

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<th>Unit</th>
<th>Rate</th>
<th>Estimated General Cost</th>
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</thead>
<tbody>
<tr>
<td>Traffic Management included elsewhere</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diamond cut road surface</td>
<td></td>
<td>200</td>
<td>m</td>
<td>25.00</td>
<td>5,000.00</td>
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<tr>
<td>Steel road lighting column of 6 metre nominal with planted base and single bracket arm having a projection of 1.5m with cut off luminaires incorporating a 250w S.E.N.T+ lamp and lamp control gear</td>
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<td>10</td>
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<td>330</td>
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<td>Two number 100 mm internal diameter upvc service ducts Type A to HCD 15 depth to invert not exceeding 2 metres, average depth to invert 0.5 metres</td>
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<td>m</td>
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<td>600</td>
<td>m</td>
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#### West Approach Bridge meet the eye

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<th>Estimated General Cost</th>
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</thead>
<tbody>
<tr>
<td>Traffic Management included elsewhere</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diamond cut road surface</td>
<td></td>
<td>200</td>
<td>m</td>
<td>25.00</td>
<td>5,000.00</td>
</tr>
<tr>
<td>Steel road lighting column of 6 metre nominal with planted base and single bracket arm having a projection of 1.5m with cut off luminaires incorporating a 250w S.E.N.T+ lamp and lamp control gear</td>
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<td>16</td>
<td>item</td>
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<tr>
<td>Trunk for cables not exceeding 300mm wide in depth not exceeding 1.5 metres in verges and central reserves</td>
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<td>350</td>
<td>m</td>
<td>17.47</td>
<td>6,115.80</td>
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<tr>
<td>Two number 100 mm internal diameter upvc service ducts Type A to HCD 15 depth to invert not exceeding 2 metres, average depth to invert 0.5 metres</td>
<td></td>
<td>350</td>
<td>m</td>
<td>37.16</td>
<td>12,214.17</td>
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<tr>
<td>16mm 2 core XPLE/ESWAM/PIPE cable with copper conductors in trunk depth not exceeding 1.5 metres</td>
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<td>700</td>
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<td>4.71</td>
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<td>Single way cut out termination to 16mm 2 core XPLE/ESWAM/PIPE cable in road lighting column</td>
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<td>Feeder pillar</td>
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<td>2,500.00</td>
</tr>
<tr>
<td>Closure barriers to A605, pinned to road surface</td>
<td></td>
<td>3</td>
<td>m</td>
<td>300.00</td>
<td>900.00</td>
</tr>
<tr>
<td>Plastic coated chain link fencing 1.8m high with steel angle posts</td>
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<td>20</td>
<td>m</td>
<td>35.17</td>
<td>703.40</td>
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<td>5,000.00</td>
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<tr>
<td>Traffic Management included elsewhere</td>
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<tr>
<td><strong>Total</strong></td>
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### Temporary Works

**A695 Kings Dyke Railway Bridge, Option 3**

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<th>Option Cost</th>
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### East Approach Road and the in:

- (insert)
- (insert)
- (insert)
- (insert)
- (insert)

### West Approach Road and the in:

- (insert)
- (insert)
- (insert)
- (insert)
- (insert)

### New Access Road:

- (insert)

### Traffic Management:

- (insert)
- (insert)
Fixed Costs
A605 Kings Dyke Railway Bridge. Option 3

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<tr>
<th>Fixed cost items</th>
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<td>Site establishment and removal</td>
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### Time related costs

**A805 Kings Dyke Railway Bridge, Option 3**

#### 07 April 2014 (Mod)

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<th>Duration (weeks)</th>
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<tbody>
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Total Cost: 678,662.50
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<th>Unit</th>
<th>Rate</th>
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<td><strong>ACID Flail Drive</strong></td>
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<td><strong>Excavation of post for cast-in-place concrete plus sec. 48mm diameter tendon rut</strong></td>
<td>2</td>
<td>item</td>
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<td>30</td>
<td>m</td>
<td>64.80</td>
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<td><strong>Vertical cast-in-place pipe, diameter 60, sec. 12.0m in depth</strong></td>
<td>946</td>
<td>m</td>
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<td>m</td>
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<td>m³</td>
<td>14.88</td>
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**Notes:**
- All rates are in Canadian Dollars (CAD).
- Quantities and rates are subject to change based on actual site conditions.
- Excavation rates include site preparation and backfilling.
- Post excavation rates are exclusive of tendon installation costs.
- In-place concrete mix 57/1 in labeling 35cm of trees in borrow area, final volume exceeding 360m³ but not exceeding 2000m³.
### Structural Concrete - Slab per 1m²

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<th>Grade Code</th>
<th>Slab per 1m²</th>
<th>Notes</th>
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<tr>
<td>B25</td>
<td>B25</td>
<td>1.37</td>
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<td>B20</td>
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<tr>
<td>B15</td>
<td>B15</td>
<td>3.02</td>
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### Structural Concrete - Column per Unit |

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### Structural Concrete - Beam per 1m² |

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<td>B25</td>
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### Structural Concrete - Wall per 1m³ |

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<td>B15</td>
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<tr>
<td>B10</td>
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### Structural Concrete - Slab per 1m² for Slabs |

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<tr>
<td>B25</td>
<td>B25</td>
<td>1.37</td>
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<tr>
<td>B20</td>
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<td>B15</td>
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### Structural Concrete - Column per Unit for Columns |

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### Structural Concrete - Beam per 1m² for Beams |

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### Structural Concrete - Wall per 1m³ for Walls |

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### Structural Concrete - Slab per 1m² for Slabs |

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### Structural Concrete - Column per Unit for Columns |

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### Structural Concrete - Beam per 1m² for Beams |

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### Structural Concrete - Wall per 1m³ for Walls |

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<td>20021501</td>
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<td>Brickwork</td>
<td>m³</td>
<td>1.00</td>
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<tr>
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<td>Steel</td>
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<td>20021511</td>
<td>Timber</td>
<td>m³</td>
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<tr>
<td>20021513</td>
<td>Glass</td>
<td>m²</td>
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<tr>
<td>20021515</td>
<td>Lighting</td>
<td>m</td>
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**Notes:**
- Waterproofing with 2 coats of bitumen, sprayed or brushed, applied more than 60° to the horizontal.
- Insulation referred to 50mm thickness, 45% density, in place.
- Brickwork includes all necessary programming and including Houston 50mm joints.
- Insulation includes all necessary programming and air sealing.
- Concrete includes all necessary programming and air sealing.
- Timber includes all necessary programming and finish.
- Glass includes all necessary programming and air sealing.
- Lighting includes all necessary programming and air sealing.

**Additional Information:**
- All items are priced per unit as specified.
- Total cost is calculated based on the specified measurement and unit cost.
<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
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<th>Rate</th>
<th>Cost</th>
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<tbody>
<tr>
<td>General, Medium density walled</td>
<td>0</td>
<td>m³</td>
<td>2,083.49</td>
<td>0.00</td>
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<tr>
<td>Four red bricks 4.5 ft high with lower people</td>
<td>1,000</td>
<td>m³</td>
<td>21.69</td>
<td>21,690.00</td>
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<tr>
<td>Conserved of acceptable material Class AA</td>
<td>665</td>
<td>m³</td>
<td>31.87</td>
<td>21,089.55</td>
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<tr>
<td>Conserved of acceptable material excluding Class AA in cutting and other excavation</td>
<td>1,154</td>
<td>m³</td>
<td>2.93</td>
<td>4,369.02</td>
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<td>SO excavation for hand breakout</td>
<td>820</td>
<td>m³</td>
<td>79.60</td>
<td>64,848.00</td>
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<tr>
<td>Abandonment of road</td>
<td>923</td>
<td>m³</td>
<td>23.02</td>
<td>21,460.96</td>
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<tr>
<td>Imported and Dress @ Material in embankments</td>
<td>14,499</td>
<td>m³</td>
<td>24.80</td>
<td>356,069.96</td>
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<tr>
<td>Soakaway - 8 x 150mm boxes, and drainage and crossover</td>
<td>412</td>
<td>m</td>
<td>77.48</td>
<td>32,205.68</td>
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<tr>
<td>Design, supply and install reinforced earth FRC panels, facing and associated reinforcement</td>
<td>1,496</td>
<td>m²</td>
<td>267.29</td>
<td>0.00</td>
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<tr>
<td>Design, supply and install reinforced earth wire facing and associated reinforcement</td>
<td>129</td>
<td>m²</td>
<td>70.39</td>
<td>9,147.21</td>
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<td>Design, supply and install RCC paving beam including setting</td>
<td>412</td>
<td>m</td>
<td>88.00</td>
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<td>Concrete, slab at top of all wall</td>
<td>77</td>
<td>m³</td>
<td>585.79</td>
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<td>Concrete, slab at top of all wall</td>
<td>347</td>
<td>m³</td>
<td>379.14</td>
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<td>10</td>
<td>m</td>
<td>1,635.22</td>
<td>16,352.20</td>
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<tr>
<td>High peak side reinforced type 3 bar reinforcement nominal size 46mm and under not exceeding 12 metres in length</td>
<td>48</td>
<td>m</td>
<td>1,672.20</td>
<td>80,177.60</td>
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<td>Column 2</td>
<td>Column 3</td>
<td>Column 4</td>
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<td>Column 1</td>
<td>Column 2</td>
<td>Column 3</td>
<td>Column 4</td>
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</tbody>
</table>
###防水层

**防水层类型**
- **防水层材料**
  - 3.0 mm TPO
  - 2.0 mm SBS
  - 2.0 mm PVC
  - 2.0 mm FPO
  - 2.0 mm APP

**防水层厚度**
- 10.0 mm

**防水层面积**
- 300 m²

**防水层单价**
- 2500.00 €/m²

**防水层总费用**
- 750,000.00 €

###防火板

**防火板材料**
- 450 m²

**防火板单价**
- 300.00 €/m²

**防火板总费用**
- 135,000.00 €

###排水和防洪

**排水和防洪材料**
- 空心排水板

**排水和防洪面积**
- 420 m²

**排水和防洪单价**
- 1000.00 €/m²

**排水和防洪总费用**
- 420,000.00 €

###桥梁支撑

**桥梁支撑材料**
- 桥梁支撑

**桥梁支撑面积**
- 30 m

**桥梁支撑单价**
- 32.73 €/m

**桥梁支撑总费用**
- 981.90 €

###桥墩

**桥墩材料**
- 桥墩

**桥墩面积**
- 46 m²

**桥墩单价**
- 1000.00 €/m²

**桥墩总费用**
- 46,000.00 €
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<td>Cement, Medium density washed</td>
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<td>bag</td>
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<td>Cased hole boring, 4.5m high with timber plates</td>
<td>594</td>
<td>m</td>
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<td>Excavation of acceptable material excluding Class 5A in cutting and other excavation</td>
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<td>m³</td>
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<td>Excavation for road alignment</td>
<td>800</td>
<td>m³</td>
<td>23.88</td>
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<td>Excavation of unacceptable WT</td>
<td>800</td>
<td>m³</td>
<td>60.59</td>
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<td>Intersected and Planed AI Material in embankments</td>
<td>12,419</td>
<td>m³</td>
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<td>Silverson s &amp; Elbow Roofing, incl. drain and shalley</td>
<td>544</td>
<td>m</td>
<td>77.02</td>
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<td>unit</td>
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<td>Design, supply and install PPC circular beam including head</td>
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<td>unit</td>
<td>280.06</td>
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<td>In situ concrete mix SI71 in 75mm batching for in situ concrete works</td>
<td>103</td>
<td>m³</td>
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<td>19,317.46</td>
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<td>In situ concrete mix at top of IBC wall</td>
<td>505</td>
<td>m³</td>
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<td>In situ concrete mix for drain line</td>
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<td>f</td>
<td>1,774.29</td>
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<td>High yield white deformed type 2 bar reinforcement nominal size 8mm and under not exceeding 15 metres in lengths</td>
<td>63</td>
<td>f</td>
<td>1,672.39</td>
<td>105,954.63</td>
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<td>Framework below 75% vertical more than 355mm width</td>
<td>110</td>
<td>m²</td>
<td>75.74</td>
<td>8,331.80</td>
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<td>Dewatering combined drainage system with 755mm upstand in re-uses at alleys carriageways and road tunnel units</td>
<td>548</td>
<td>m</td>
<td>22.67</td>
<td>12,532.68</td>
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<td>Task 1</td>
<td>Heavy-duty macadam with 50mm aggregate base Type 1</td>
<td>m2</td>
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<td>Heavy-duty macadam with 50mm aggregate binder course Type 2</td>
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<td>30.81</td>
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<td>Thin surfacing course system in tarmac Type 5</td>
<td>m2</td>
<td>4.12</td>
<td>44.32</td>
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<td>Bituminous pavement up to 150mm thick</td>
<td>m2</td>
<td>0.03</td>
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<td>Task 5</td>
<td>Bituminous asphalt with 50mm aggregate bituminous pavement course</td>
<td>t</td>
<td>0.02</td>
<td>0.40</td>
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<td>Bitumenised bituminous thermoplastic coated 100 mm thick with 5 mm thick</td>
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<td>0.04</td>
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<td>Continuous rubbit surfacing in white thermoplastic coated 50mm wide</td>
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<td>Road signs and road markings</td>
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<td>0.03</td>
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<td>Drainage and Sidewalks</td>
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<td>Near-Corneration side</td>
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<tr>
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<td>Four self-drilled 1.4m high with timber posts</td>
<td>190</td>
<td>m</td>
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<td>Stabilization (Cost)</td>
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<td>182</td>
<td>m³</td>
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<td>Near-Corneration side</td>
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<td>Excavation of accessible material excluding Class SA in cutting and other excavation</td>
<td>425</td>
<td>m³</td>
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<td>Near-Corneration side</td>
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<td>Nominal for hard pavement</td>
<td>225</td>
<td>m³</td>
<td>18.20</td>
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<td>Near-Corneration side</td>
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<td>Nominal for unconditioned use</td>
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<td>m³</td>
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<td>Near-Corneration side</td>
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<td></td>
<td>Type II sub base</td>
<td>750</td>
<td>m³</td>
<td>17.86</td>
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<tr>
<td></td>
<td>Precast concrete kerb, Type IRC, cast straight or curbed exceeding 12 meters radius</td>
<td>250</td>
<td>m</td>
<td>18.20</td>
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<td>Near-Corneration side</td>
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<tr>
<td></td>
<td>Precast concrete kerb, Type IRC, cast not exceeding 12 meters radius</td>
<td>50</td>
<td>m</td>
<td>18.20</td>
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<tr>
<td></td>
<td>Near-Corneration side</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Heavy duty macadam with 50mm aggregate base Type 2/7 base block in compaction</td>
<td>706</td>
<td>m²</td>
<td>24.45</td>
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<td>Near-Corneration side</td>
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</tr>
<tr>
<td></td>
<td>Heavy duty macadam with 50mm aggregate binder course Type IRC/ 40mm block in compaction</td>
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A605 Kings Dyke Crossing

Option 4: Off Line North

Statement on the methodology to construct a bridge railway crossing.

Final - (08/04/2014)
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1.0 Introduction

This document sets out the outline methodology for the proposed construction of a bridge with approach roads to replace the existing railway level crossing on the Ely to Peterborough rail lines, using the route detailed as ‘Option 4: Off-Line North’.

Cambridgeshire County Council has identified the necessity to close the existing barrier type level crossing, particularly with regard to Network Rail’s (NR) intention to increase the number of passenger and freight trains using the line, the general increase in traffic crossing the level crossing and current safety issues at barrier type railway level crossings and to provide an alternative crossing.

The proposed scheme provides an alternative crossing which will enable the current barrier type crossing to remain permanently closed.

This proposal positions the approach roads and new bridge crossing the railway to the north of the existing A605 as shown on drawing MMD-332955-C-DR-XX-3004.

The methodologies set out in this document are at a preliminary stage and subject to planning, approvals, the completion of the final design, temporary works design and the appointment of the Contractor for the works.

Photo 1

Kings Dyke Level Crossing looking west.
2.0 Site Location

Kings Dyke level crossing is an at-grade crossing located approximately 2.6 kilometres west of the centre of Whittlesey on the A605 road between Whittlesey and Peterborough where the railway line between Ely and Peterborough crosses the carriageway.

The level crossing is an electronically remote controlled full barrier type, operated on-site by Network Rail operatives from an existing signal box located adjacent to the railway line to the north east of the junction.

The site extends from Funthams Lane to the west and the residential houses to the east on the northern side.
3.0 Existing Traffic and Pedestrian System

The A605 currently carries in excess of 12,000 vehicles per day across the existing crossing. The railway companies operate approximately 120 train movements across the crossing each day, which requires closure of the level crossing to traffic.

The closure of the level crossing results in significant delays to traffic travelling on the A605 to and from Peterborough. Currently, the closure time for the level crossing can be between 11 to 15 minutes per hour. The length of closed time for the level crossing will increase in the near future due to Network Rail’s (NR) intention to increase the number of passenger and freight trains using the line. Traffic queues can, therefore, be quite extensive, sometimes in excess of 300m (Photo 3).

There is an alternative route known as the “the North Bank”. This alternative road is of a lower classification, offering a less direct route between Whittlesey and Peterborough and is located to the north of the A605. During the winter months this road is susceptible to local flooding and can be closed for long periods. This exacerbates the amount of traffic using the Kings Dyke level crossing.

In addition to through traffic, there are further heavy goods vehicle movements joining/leaving the carriageway at approximately 215 metres east of the railway crossing. These vehicles are from Hanson’s (local brick manufacturer) access road which lies to the east of the crossing. There is also further traffic joining/leaving the carriageway at approximately 400 metres west of the railway crossing from Funthams Lane Industrial Estate.

Several industrial, business and residential properties are also sited along the southern approach to the level crossing from the west. These properties add to the traffic requiring access and egress to and from the A605.

Pedestrians approaching the level crossing from Whittlesey (east to west) have the provision of a continuous footpath on the north of the carriageway (Photo 4).

There is also a footpath on the southern side which starts just west of the sub station and continues to the level crossing (Photo 5).

The footpath on the north side of the road continues across the level crossing and beyond the proposed extent of the site.

The footpath on the southern side changes to verge after the level crossing (Photo 6).
Photo 4
Looking west to the level crossing. Continuous footpath on North side. Footpath on the south side starting just west of the sub station.

Photo 5
Looking east from the level crossing showing a footpath both sides of the road.

Photo 6
Looking west from the level crossing.
4.0 Site Access

Access to the site for construction traffic is restricted to the area of the proposed site works along the A605 from either the east or the west.

Access from the east passes through Whittlesey. Whittlesey is a town located between Peterborough (10km) and March (18km). Historically it was connected to Peterborough via a roman built road known as the Fen Causeway and is the route which is approximately followed by the current A605.

Access from the west is via Peterborough City, the largest city in Cambridgeshire. Peterborough provides excellent north and south connections via the A1 and east and west via the A605 and A47.

Large plant and equipment required at the site would preferably come from the west via Peterborough.

Although there is no major height or road restriction from either the east or west, approaching the site from the west would be the preferred route as potentially, it will offer less impact on residential areas.

Access to the bridge site will be:

West Abutment:
Construction traffic, plant and materials will gain access for the construction of the west abutment via an access over the northern footway, via a short length of temporary track, directly into the works area from the A605 west of the Kings Dyke level crossing (Photo 7).

![Photo 7](image)
Access from the north side of the A605 directly over the footpath adjacent to the Kings Dyke level crossing into the area of the west abutment.

East Abutment:
Construction traffic, plant and materials will gain access for the construction of the east abutment via widening the current access adjacent to the signal box via a purpose built track (Photo 8).
Photo 8
Access from north side of A605 for east abutment construction via the signal box access being widened to the east.
5.0 Statutory Utilities Equipment

5.1 Details of services within the area of the proposed works

The majority of the services are located underground in both the northern footpath and southern footpath/verge.

**Northern footpath and the area North of the A605:**

**Anglian Water**

An 8” (200mm) cast iron water main belonging to Anglian Water crosses the A605 from the southern footpath to the northern footpath approximately 30m east of the Kings Dyke level crossing. On entering the northern footpath the water main turns west and continues beneath the level crossing. The water main continues along the northern footpath, crossing the entrance to Funthams Lane and continues west beyond the proposed site boundary.

**BT**

BT underground cables cross the A605 in the area of the electrical sub station from the southern footpath. Entering the northern footprint the service splits, turning west to continue to the level crossing and east to the Hanson access road where the service turns north away from the A605. After crossing the level crossing the cables continue along the northern footpath, crossing the entrance to Funthams Lane with a joint box either side of the Lane, then continue west beyond the proposed site boundary. On the north east corner of Funthams Lane, 2 further services head north from a joint box along the eastern edge of Funthams Lane. A two further underground services cross the A605 approximately 56m and 86m west of the level crossing.

Two BT overhead cables cross the A605 approximately 163m and 169m west of the level crossing.

Another cable track is located in the area north of the A605 between a joint box on the north side of the A605 continuing west towards the railway, then turning north to end at a distribution box.

**Gas**

A Low High Pressure gas main which originates from an “above ground installation” starts north before turning west towards the railway. The gas main then follows an erratic course which involves a return south towards the A605 then follows the eastern edge of the railway lines north, before crossing the railway lines approximately 166m north of the level crossing. This gas main continues north away from the proposed works.

**UK Power Networks**

Several cable tracks cross the A605 from the sub station and enter the northern footpath before splitting and turning as multiple tracks both east and west along the northern footpath.

The cables heading east towards Whittlesey continue in the footpath beyond the proposed site boundary.
The cable tracks heading west also continue in the northern footpath until they reach the signal box entrance (Photo 10, blue arrow).

At this point the cables split into two separate tracks:

1. One cable track continuing to diagonally cross the railway level crossing to enter the southern verge. It is not totally clear from the current information available, but it appears this track then re-crosses the A605 back to the northern footpath.

2. The other track turns north and splits again into 2 further tracks passing the signal box to continue north on the eastern side of the railway.

The track in “item 1” continues along the northern footpath across Funthams Lane and beyond the proposed site boundary.

At approximately 170m west of the Kings Dyke level crossing, another cable track crosses the A605 to the southern footpath connecting with cable tracks running east/west.

At approximately 386m west of the level crossing a further cable track heads north, joining another track crossing the A605 from the southern footpath. These cables both continue north via a dogleg, east of Funthams Lane.

At approximately 418m west of the level crossing a further cable track heads north to continue along the western side of Funthams Lane.

**Southern Footpath and south of the A605:**

**Anglian Water**

A 12” (300mm) asbestos cement potable water main belonging to Anglian Water is located in the southern footpath. It crosses the level crossing via a dogleg to the south.

There is a hydrant just west of the level crossing.

The main continues west possibly in the verge (requires confirmation). Approximately 80m west of the level crossing the water main doglegs north, possibly entering beneath the carriageway, before continuing west beyond the proposed site boundary.

Private service connections will possibly be from this main into the properties along the south side west of the level crossing.

**BT**

BT underground cables are located in the southern footpath/verge from the direction of Whittlesey.

At a joint box just east of the level crossing the service track splits:

- One track crosses the level crossing in the line of the footpath/verge.
- The second crosses the railway in a dog leg via a joint box just south of the level crossing.
The two tracks then rejoin into a single track just west of the level crossing and continue underground west along the southern verge beyond the proposed site boundary.

From the track in the southern footpath at separate joint boxes further underground crossings (at 56m and 86m west of the level crossing) cross the A605 to the northern footpath.

From the joint box at 86m from the level crossing a short track of underground cables head south to serve a pole and overheads to the properties south of the A605.

From a further joint box in the southern verge at approximately 142m west of the level crossing, additional cables serve a pole. These overhead cables then divide into 3 cable tracks from this pole:

- One to serve property to the south of the A605.
- One to cross the A605 diagonally at approximately 163m from the level crossing then continuing across the northern footpath where it returns underground approximately 34m north of the north kerbline.
- One to continue west in the south verge to another pole before crossing the A605 diagonally at approximately 169m west of the level crossing and continues across the northern footpath to serve properties north of the A605.

At another joint box approximately 351m west of the level crossing underground cables cross the A605 passing beneath the northern footpath to serve the wind turbine and Nene Lodge.

At approximately 186m east of the level crossing a BT overhead cable crosses the A605. As it crosses the southern footpath adjacent to the electrical sub station it turns west at a pole towards the level crossing (Photo 9). This overhead service continues west to a pole approximately 92m east of the level crossing.

**Gas**

From the “above ground installation” north of the A605 a medium pressure gas main passes beneath the northern footpath, crossing the A605 to enter the south footpath approximately 275m east of the level crossing.

On entering the southern verge it continues east towards Whittlesey and west towards the level crossing. It remains in the southern verge after passing beneath the level crossing. At Funthams Lane the gas main enters the A605 carriageway to cross diagonally to the northern footpath, approximately 45m west of the centre of Funthams Lane.

**UK Power Networks**

There is an electrical sub station approximately 176m east of the level crossing on the southern side (Photo 11).

From the sub station a cable track crosses the A605 to the northern footpath. On entering the northern footpath it continues east towards Whittlesey and west towards the level crossing.

Immediately west of the sub station is an area containing various cables starting from a point south west of the sub station. There is another cable track starting at the same south west point
that continues north across the A605, possibly joining the cable tracks in the northern footpath (to be confirmed).

Further cables from the sub station head west along the southern footpath towards the level crossing.

At approximately 151m from east of the level crossing a cable track crosses the A605 and continues north across the northern footpath.

Just prior to the Kings Dyke level crossing the underground cable track running along the southern footpath turns into the carriageway to cross the level crossing. It turns back south to re-enter the southern verge joining the track from the northern footpath before continuing west along the verge beyond the proposed site boundary.

Additional underground cable tracks from the south converge at the same point to join those in the southern verge.

At approximately 39m west of the Kings Dyke level crossing a cable track branches south to serve properties.

At approximately 102m west of the level crossing a cable track branches north, crossing the A605 and the northern footpath to continue north before turning north west in parallel to the railway lines.

At approximately 386m west of the level crossing a cable track branches north, crossing the A605 and the northern footpath continuing along the eastern side of Funthams Lane, adjacent to the branch from the northern footpath tracks.

At approximately 69m west of the centre of Funthams Lane a new cable track appears from the south and turns east along the A605, turning north to continue along the western side of Funthams Lane.
Photo 10
Point at which the electricity cable tracks split to cross the railway and where further tracks head north up passed the signal box.

Typical BT joint box within the site area. This particular one is in the northern footpath just east of the railway level crossing.

Photo 11
Electricity Sub Station.

Photo 12
Overhead BT cables and pole at 142m west of level crossing south side.

Photo 13
BT crossing at 169m west of level crossing.
There are no details of storm water sewers available. Only one section of fouls sewer is identified appearing west of the Hanson entrance and continuing east in the carriageway towards Whittlesey.
5.2 Details of possible SU works

Option 4 indicates that the majority of the works is sited on or off of the northern edge of the A605 carriageway.

The exception is the bellmouth to the new section of road for residents’ access where it crosses the existing southern verge. This should not present a problem for the statutory utility companies as it represents a normal road crossing. Some protection works (e.g. to the gas service) or the lowering of services, for example BT cables, may be required.

On the north side of the A605 all services in the northern footpath between the eastern side of Funthams Lane to chainage 250 and between chainage 520 to 680 will possibly require diversion works.

At the eastern end the new embankment covers the northern footway between chainage 560 and 680.

- UKPN cable tracks crossing the A605 from the sub station split and turn as multiple tracks both east and west along the northern footpath. Those heading east towards Whittlesey continue in the footpath beyond the proposed site boundary. The cable tracks heading west also continue in the northern footpath until they reach the signal box entrance. Numerous jointing areas are shown within the footprint of the new works. These cables will possibly require diversion from the southern side of the A605 to be re-routed along the southern side, both east and west to clear the new embankment footprint before returning the northern footway. The cables crossing at chainage 502 and 630 may require an additional duct placed beneath the eastern approach to allow future cable replacement. The twin cable crossing at an angle at chainage 485 and 492 may require re-routing to clear the abutment works, in particular the cable chainage 485.

- During a meeting with Mr. Trevor Garrot (BT) on 3 April 2014, he confirmed that the BT cable tracks and chambers in the northern footpath beneath the approach road will require re-routing along the southern side both east and west to clear the new embankment footprint before returning to the northern footway. Further investigation is required to plot the single track running west then turning north, to confirm position. However, the diversion works may change depending upon the presence of fibre optic cables. A budget quotation will be issued which will include the Cambridge County Council’s (CCC) discount. In addition, BT require confirmation that the “stopped” sections of the A605 will remain under CCC highway control, to ensure their rights of access remain.

- The water main crossing the new embankment at chainage 597 may require an additional duct placed beneath the eastern approach to allow for cable replacement.

At the western end of the new works the new approach road crosses the northern footpath and the services therein. However, the probable diversion works are more complex.

- The UKPN cable crossing a chainage 380 may require an additional duct placed beneath the eastern approach to allow for future cable replacement. The cables running east / west in the footpath that are covered by the new embankment will require diversion.
However, the diversion route is not obvious to allow the cables to return to the northern side beyond the new works.

- The BT cable tracks and chambers in the northern footpath beneath the approach road will require re-routing along the southern side both east and west to clear the new embankment footprint before returning to the northern footway probably west of Funthams Lane (re meeting 3 April 2014). The diversion works may change depending upon the presence of fibre optic cables. A budget quotation will be issued which will include the CCC discount. The BT overhead cables crossing the new works at chainage 300-305 will also either be raised in height to clear the new carriage or be re-located underground.

- The water main running east / west in the footpath that is covered by the new embankment will possibly require diversion. However, the diversion route is not obvious to allow the water main to return to the northern side beyond the new works.

No allowance has been made within the programme for the diversion works, with the exception of new ducts and protection works. Ideally, the SU diversion works would be completed prior to the main contract works commencing.

If this is not possible the effect on the programme would be to increase the overall contract period by 6 weeks at the least, and at worst possibly 12 weeks. This increase in programme time would be required to undertake the actual diversion works and does not include the lead in time which can amount to a further 12 -14 weeks.
6.0 Contractors offices and Welfare Compound

The contractor’s offices and welfare compound for the proposed works would comprise of a series of 32’ x 10’ linked office units. The number will vary between Contractors, but is estimated at a minimum of 7. These units will allow space for the Contractor, Client and his representatives, welfare facilities and a meeting room. Additional units would be required for mess, welfare, drying facilities and materials storage.

Overall area required would be approximately 850m² - 900m², the shape of the site varying to suit the area available.

There are two favourable locations to position the Contractor’s compound for this option.

Location 1

Photo 15
A605 Kings Dyke level Crossing

The proposed area is located to the east of the level crossing adjacent to the A605 and will be entered by crossing the southern footpath via a temporary crossing. It will require a temporary bellmouth to ensure efficient and safe access and egress onto the A605, which must include protection to the statutory services within the footpath area.

This can be considered the favourite for Option 4 as it is clear of all permanent works.
The proposed area is located to the west of the level crossing opposite Funthams Lane and will be accessed by crossing the southern footpath via a temporary crossing. It will require a temporary bellmouth to ensure efficient and safe access and egress onto the A605, which must include protection to the statutory services within the footpath area.

The area identified is clear of the west bound carriageway bus stop, but the compound would also need to share the area with the new access to the old carriageway which, in turn, provides access to the properties between the compound and the level crossing.
Other areas to consider:
Location 3
Photo 17

An area of the Hanson storage yard north of the A605, but outside that required for the permanent works. Access gained by sharing the Hanson access road off of the A605.

Location 4
Photo 18

An area of the Hanson storage yard south of the A605. Access gained by sharing the Hanson access road off of the A605 or by creating a new access from the A605.
7.0 Traffic Management

The Traffic Management (TM) for these works are split into 5 phases:

Phase 1
The A605 traffic remains open in both directions but is restricted to 2 narrow lanes of 3.25m wide and the speed limit is temporarily reduced to 30mph over the whole length of the works.

This enables works to commence to the all areas to the north of the A605.

Phase 2
The traffic is restricted to single lane at the western end tie in area. Traffic will be controlled by temporary traffic signals. Due to the proximity of the level crossing these lights will be manually controlled with the operator working with and under the instruction of a Network Rail Signalman.

Phase 3
The traffic lanes open in both directions but restricted to 2 narrow lanes of 3.25m wide and the speed limit is temporarily reduced to 30mph over the whole length of the works.

Phase 4
The traffic is restricted to single lane at the eastern end tie in area. Traffic will be controlled by temporary traffic signals. Due to the proximity of the level crossing these lights will be manually controlled with the operator working with and under the instruction of a Network Rail Signalman.

Phase 5
Both lanes of traffic are diverted over the new bridge, but is restricted to 2 narrow lanes of 3.25m wide and the speed limit temporarily reduced to 30mph over the whole length of the works.

All signage to enable the operation of the TM detailed will be in accordance with the requirements of the Traffic Signs Manual – Chapter 8: Traffic Safety Measures and Signs for Road Works and Temporary Situations – Part 1: Design and Part 2: Operations.

TM is based on the following:
- Narrow lane operation of 3.25m (Chapter 8 “desirable minimum”)
- Temporary 30mph speed restriction throughout the works and approaches
- All changes between phases will made during the night prior to the scheduled change, during times of low – little traffic.
- All changes will be completed at least 2 hours prior to the start of the rush hour commencing.

It is essential that robust and adequate temporary works and procedures are in place to undertake all TM changes and re-locations.

Where construction is at or near level with the existing road surface adjacent, the safety zone will be identified using a double line of traffic cones set at 500mm apart. Road danger lamps will be placed on the outer boundary of safety cones during hours of darkness. The purpose of the inner line is to indicate the start of the safety zone and to attract operatives’ attention not to step into danger. The inner line will be reinforced by connecting the cones with a suitable traffic tape.