Flow Bridge - Feasibility Technical Memo

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Contents

Related Project Documents

Document Reference	Document Title
-	Cradle Bridge FPS Passive Level Crossing Risk Assessment
-	Bolleaux FPS Passive Level Crossing Risk Assessment
PROW/AU17/15/NR	Proposed diversion of public footpath AU17 (part) at Kennington
PROW/AU22/14/NR	Proposed diversion of public footpath AU22 (part) at Kennington – from the level crossing to a ramped and stepped bridge
186814-NRD-1700-ACR-REP-EHF-000001	Diversity Impact Assessment
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Document Control

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Executive Summary

The installation of a Flow Bridge is deemed feasible at this site with a C-shape layout to the north east of the existing crossing. It should be noted however there are several constraints at the site, which would impact the cost and duration of the overall programme, which are:

- Existing third party 11kV power cables (UK Power Network) along the Down side of the railway shall require removal to facilitate the installation of the bridge.
- Existing buried water main (South East water) along the Up side of the railway shall require local diversion to facilitate the installation of the bridge.
- Potential additional land purchase may be required for the footprint of the footbridge

The above constraints shall require validation at the AiP design stage upon the completion of surveys. Furthermore, there is scope to reduce these interfaces through the reduction of the overall span length (currently shown to be 20m) at the next design stage subject to further assessments.

After due consideration, the Flow Bridge design, fabrication and installation cost is anticipated to be in the region of £1.3M.

Existing Site

The site is situated in Conningbrook, to the east of Ashford in Kent and along the *ELR:* ACR (Ashford East Junction – Ramsgate via Canterbury West) line between Ashford International Station to the south west and Wye Station to the north east.

Specifically, this Flow bridge looks to replace 2 No. pedestrian crossings:

- Cradle Bridge Crossing at 058m 0804yds on the *ELR:* ACR line.
- Bolleaux Crossing at 058m 1170yds on the *ELR:* ACR line.

Cradle Bridge FPS Crossing

Cradle Bridge Crossing is a footpath crossing situated on the AU22 public footpath. The crossing features a boarded surface over the railway with styles at the railway boundary on both sides of the railway. On the north side of the crossing there are 2 No. steps down to footpath level, on the south side there are 2 No. gates on approach to the crossing. Both sides feature grassed footpaths on approach.

The crossing has signage reading 'Stop, Look, Listen' however there are no additional safety features at the crossing for pedestrians.

The Passive Level Crossing Risk Assessment undertaken in 2022 for this crossing recommends the replacement of the crossing with a bridge.

Bolleaux FPS Crossing

Bolleaux Crossing is a footpath crossing situated on the AU17 public footpath. The crossing features a boarded surface over the railway with styles at the railway boundary on both sides of the railway. On approach within the railway boundary are steep concrete ramps from footpath level up to track level. Both sides feature grassed footpaths with a copse on both sides on approach.

The crossing has signage reading 'Stop, Look, Listen' however there are no additional safety features at the crossing for pedestrians.

The Passive Level Crossing Risk Assessment undertaken in 2022 for this crossing recommends the diversion over Cradle Bridge Crossing.

Surroundings

The site for the proposed footbridge is at Cradle Bridge Crossing, the southern of two at-level railway crossings which are part of a rural footpath network across mainly fields at the outskirts of Ashford, Kent. To the south of the site is a recently completed residential housing estate, and a few leisure attraction programmes such as the Conningbrook Lakes and nature reserve, which generate some use for the crossing. The northern side is currently a large field; however, a new housing development is planned in the near future. The footpaths connecting the two railway crossings are partially very narrow and mostly covered by grass, with some dense shrubs and trees on both sides of the crossings, especially to the south. The landscape is predominantly flat, with the railway line sitting on a slightly raised embankment with steps on one side leading up to and stiles to cross over on both sides to reach the existing crossing. An overhead powerline runs parallel to the tracks along the northern embankment.

Future Development

Currently, both crossings are not used very often. The new development, which includes a new school and park adjacent to the site, is likely to increase the footfall across, meaning that a new footbridge is vital in order to maintain the connection across and increase the safety of users.

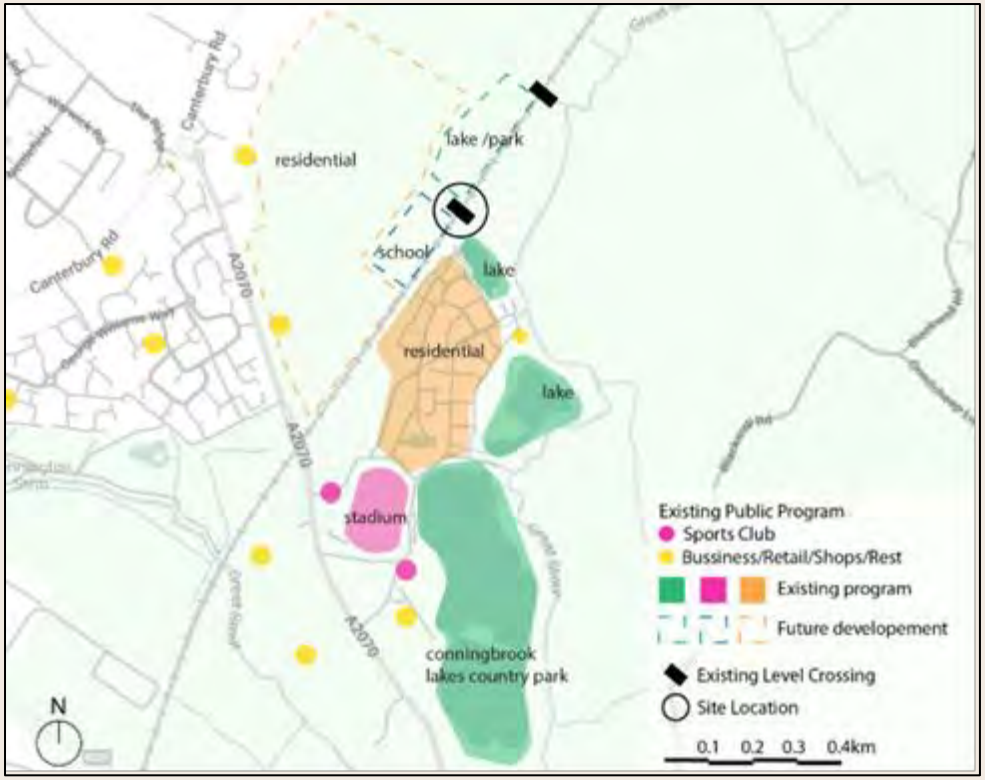


Figure 1 - Overview of site

Flow Bridge Overview

The Flow Bridge system is part of Network Rail's Level Crossing Replacement Safety Programme. It is primarily intended to improve the safety of pedestrian crossings across the railway network. Its modular design offers a range of layout configurations and span lengths. While the current Flow Mk2 is stepped only, the modularity allows it to offer ramped and lift configurations in the future to suit a wider variety of locations.

The project challenged the design team to deliver a user-focused bridge that was cheaper and quicker to produce than a steel equivalent, and created a safe, enjoyable and attractive user experience.

The unique properties of modern composites allow a lightweight, strong, and cost-effective solution. This in turn allows the use of concrete free foundations (ground conditions dependent).

The modular design was developed using parametric modelling tools, which allowed for a highly collaborative process and real-time design evolution. The result is a standardised product which accurately reflects the concept, whilst offering a variety of configurations to respond to different site characteristics.

Figure 2 - Flow Mk1 Prototype in Wistanstow

Flow Bridge Principle

The corner and user experience

On traditional footbridges across railways, ramps and stairs are positioned at 90 degrees to the main span and use opaque high-containment parapets up to 1.8m height.

Those parapets lead to visually heavy designs that are more difficult to integrate within their surroundings. They also carry safety problems, as they can create 'blind corners' that block the view and make users unable to see other people using the bridge.

Smoothing this corner out helps create a much safer and more welcoming user experience. However, doing so can lengthen the bridge, pushing the stairs / ramps away from the rail fence line and clearance envelope. This increases the cost, material use, and the land required for crossings.

The Spine

The bridge resolves this with the addition of a structural 'spine'. Whilst the deck turns smoothly around the corner, the supporting spine remains orthogonally aligned to the railway. This 'disconnect' between spine and deck allows the deck to 'flow' around the corner, whilst maintaining a minimalistic structural footprint. The addition of a spine also unlocks other benefits.

The spine acts as two arch-like structures, supporting the main span and the stair units. The supports are very much an integrated part of the design.

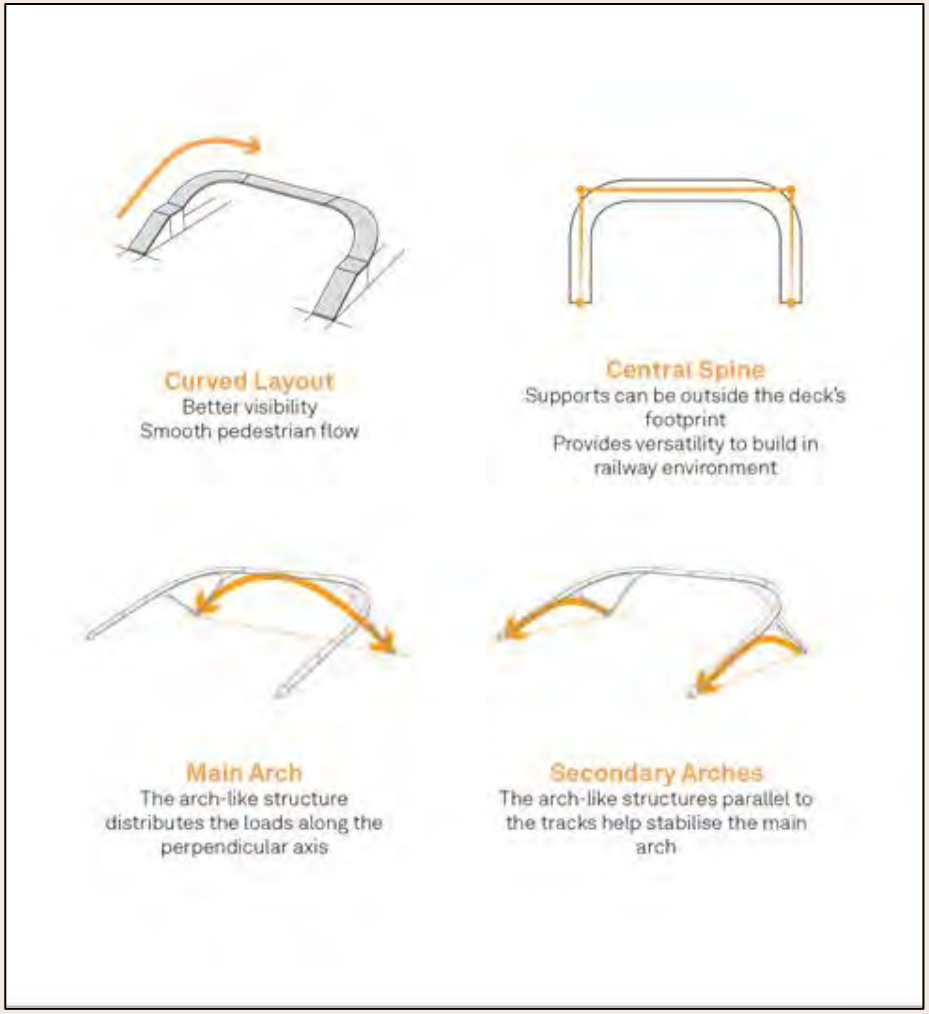


Figure 3 - Flow Bridge principles

The Parapet

The containment requirements of the railway often lead to solid, tall parapets, which create an oppressive, tunnel-like experience. The view from the structure is restricted, and the resulting enclosed space being poorly overlooked can even feel unsafe. In response to this, the team wanted to return bridges to being enjoyable ‘moments’ within a walk and provide opportunities to take in a new view of the surrounding environment.

Opening the view up also increases safety, as it provides more visibility of who is on the bridge and people can see their entire route before they embark upon it. Knowing that they can be seen will make people feel safer when using the bridge. For this, a toughened glass laminate is used for the upper part of the parapet. This provides transparency and sufficient robustness against vandalism in remote areas, which maintains its function as parapet even if damaged until the panel can be replaced.

The deck

The deck has been designed to allow for the deck modules to be lifted in incrementally, allowing for smaller, more manageable components to be transported and installed, or even replaced if necessary. The modules are lifted into place and fixed to the spine using shear connections.

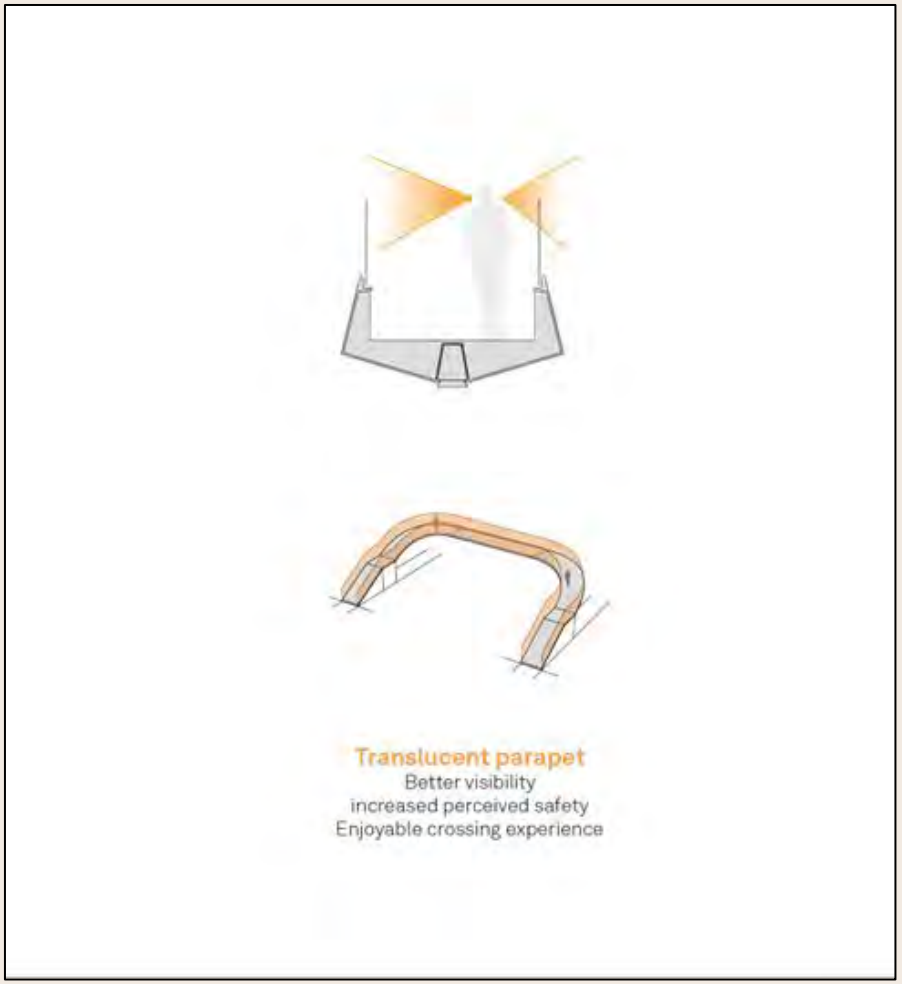


Figure 4 - Flow Bridge principles

Flow Bridge Sustainability

The Flow bridge is made from Fibre-Reinforced Polymer (FRP) – a lightweight material that is widely used in other industries, including the manufacture of aircraft and cars.

FRP is a combination of strong fibres set in resin, effectively like a man-made wood. This bridge mainly uses glass fibres, with carbon fibres for high-stress components. The mix of resin and fibres offers great design and fabrication advantages, yet they are often thought of as carbon heavy materials and as such the infrastructure industry is weary of their use. However, upon closer inspection the team found the lightness and material efficiency of the FRP outweighs the carbon footprint of the production process and the bridge was estimated to have 10 to 15 tons less embedded carbon than the conventional steel option: approximately a 10% reduction.

The lightweight nature of the bridge is its key attribute; all components weigh under 2 tonnes, making it easier to transport, requiring smaller plant equipment for installation, and it can be installed in under 3 weeks - all of which results in cost savings and a lower carbon footprint.

It also allows the use of concrete-free foundations like the rapid root system, which greatly reduces the carbon footprint of the scheme, is cost-saving, and reduces the amount of site works required.

Figure 5 - Flow Bridge pier

Flow Bridge System

It is essential that any modular solution carefully considers the identity of the railway and the specifics of the sites in which the bridges will sit. Local stakeholders often view standardised solutions as insufficient, utilitarian and inward-looking – focusing only on the requirements of the rail, often at the expense of local objectives.

The Flow Bridges are designed to be an asset within their communities, with each design taken as an opportunity to provide a beneficial, tangible link between the railway and the people surrounding it.

One of the key challenges for any 'standard' bridge solution is how one design can 'fit' a variety of sites. Standardisation is driven by consistency and repetition, yet good design is traditionally seen as a site-specific response. The Flow Bridge addresses this with contemporary, refined forms paired with careful detailing and a 'human-scale', to enhance the user experience.

To respond to the specific characteristics of a site, the system offers a wide variety of configurations. These extend from geometric adaptability such as altering the span or width of the deck, through to texture, pattern and colour modifications all of which are readily achievable with composites.

Figure 6 - Overview of shapes and span limits

Whilst the current prototype has been built as a stair-only version, the system will be capable of offering an accessible crossing with the addition of ramps and lifts as necessary. The Flow Bridges will demonstrate that by embedding variability into the system, and focusing on user experience, modular design can be good design.

The choice between the configurations will be based on the following questions:

- The site context and its constraints (such as land boundaries or services).
- The current and future desire lines and key views.
- Who the users are and how do they currently use the level crossing.
- The accessibility of the current and future level crossing and site, and whether or not the level crossing will be maintained.
- Train frequency at the location.
- The current and future capacity for the crossing.
- Is the line currently electrified? Will it be in the future?

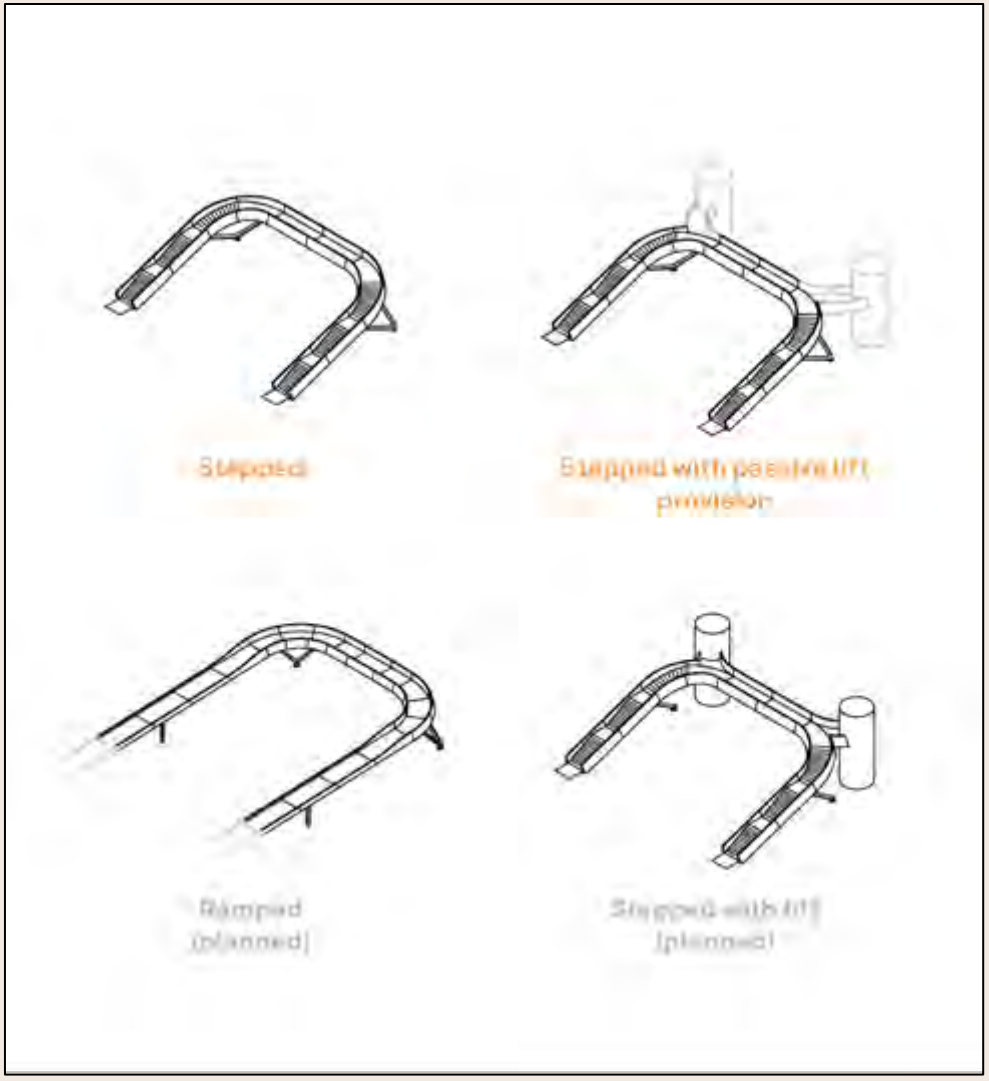


Figure 7 - Flow Bridge stepped / step-free options

General Considerations and Risks

The following considerations and risks relate to the site at the existing Cradle Bridge crossing where the proposed bridge is to be situated.

Land Boundaries

The land owned by Network Rail around the crossing consists of a strip of land along the railway, which varies in width. Approximate widths of this strip of land are shown below in Figure 8. There are physical demarcations on site such as vegetation as well as timber and chain link fences to safeguard access from members of the public to the track.

Figure 8 – Network Rail's land boundaries around the footbridge (in green)

It is understood the land adjacent to the railway is privately owned farmland.

Topography

No topographical survey has been undertaken for the railway at this site and thus levels and site topography are based off AIS data.

Whilst the site does not feature an earthwork and is considered 'at grade', the track is at a higher level than the adjacent land. The track level of the railway corridor is approx. 1.35m high along the Down

side of the railway and 0.8m high on the Up side. The slopes are generally gentle throughout.

Along the paths on approach to the existing crossing the level change is achieved by a slope on the Up side and 2 No. stairs and a slope on the Down side.

Services

A services search (reference KEN67981) was undertaken in September 2024. A list of the services that services that are in close proximity to the site can be found below:

- 11kV Overhead line power cable owned by UK Power Networks running parallel to the Down side of the track.
- South East Water distribution main running parallel to the Up side of the track.
- A drainage ditch is found along the Down side of the railway – commencing south west of the crossing in the direction of Ashford away from the crossing.
- Cable troughing routes are found on both sides of the railway with 33kV High Voltage (HV) traction power distribution and pilot cables found in the Down side trough route, with Signalling and Telecoms cables in the Up side trough route. A LOC box is also noted as being in close proximity to the Down side of the crossing.
- 750V DC electrification system for providing traction power to electric trains through conductor rails (third rails) are found in the 6ft between the Up and Down lines.
- A land drain in the site on the Down (north west) side of the railway is currently present. This land is due to be developed and thus. The Great Stour river is also in close proximity to the railway on the Up (south east) side of the railway.

Environment and Ecology

At this stage, no environmental or ecological appraisals have been undertaken and thus it is recommended this is undertaken at the next design stage. This section highlights ecological constraints based off a Geo-RINM desk study.

Any tree felling / vegetation clearance activities that need to be undertaken should be done outside bird nesting season.

Designated sites and habitats

Geo-RINM has identified a number of environmental and ecological hazards and considerations that should be taken into account during at this stage. Figure 9 shows a map identifying these hazards.

To the north there are 2 No. areas of Coenonympha Pamphilus butterflies commonly known as Small Heath.

The area highlighted in orange identifies as a local wildlife site, Great Stour, Ashford to Fordwich.

Finally, the leaf shows the presence of an invasive species plant close to the crossing. This has been identified to be Himalayan Balsam.

To the south of the map, away from the crossing but close to the railway around where Conningbrook Lakes housing development is found, are Great Crested Newts.

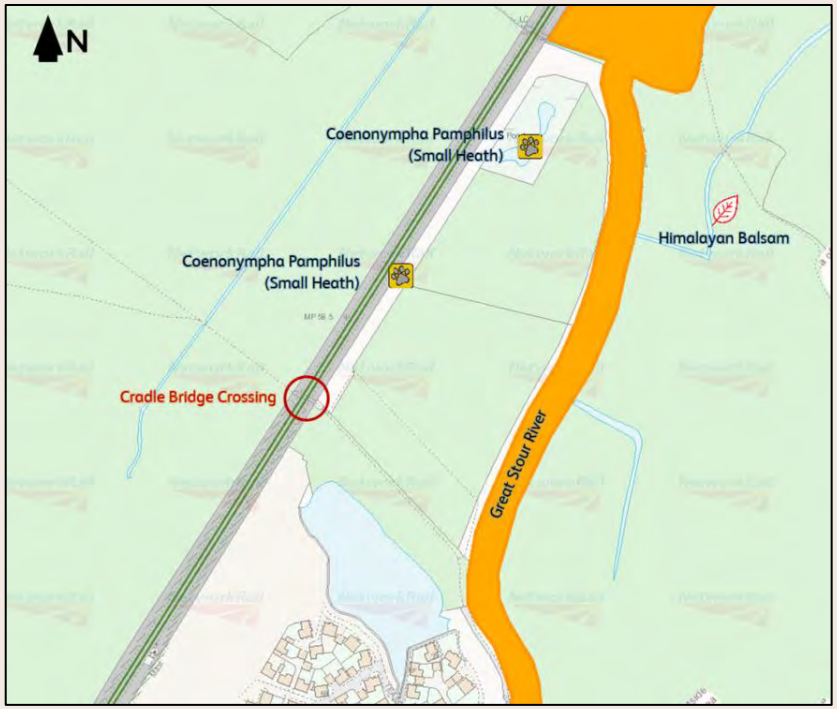


Figure 9 – Designated sites and Habitats in close proximity of the crossing.

Flooding risk

Geo-RINM identifies the area just towards east of the level crossings location as having a high risk of flooding, as shown below in Figure 10.

The bridge lies in Flood zone 1 for planning, the area to the southeast associated with the Great Stour River lies in Flood zone 2 (**orange**) and 3 (**red**) for planning.

Figure 10 – Flood risk map from Geo-RINM.

Around the housing development sites there are ponds noted. Land drainage, ponds and ditches from adjacent land which generate water run-off and have flooding potential should be addressed by the housing development on each side of the railway.

Site History

The history of the site and the surrounding area is as follows. In 1896, the area to the northwest of the railway line was largely farmland and the area to the south-east was a mixture of woodland and farmland, with 1 No. at-grade foot crossing at the current location and another at the high mileage. The Great Stour River was noted as lying to the east of the railway line. In 1926, additional smaller brooks / channels were noted on the map and were indicated as passing under the railway line to the northeast of the proposed bridge location. In 1958,

a small works opened to the northwest of the railway line. By 1990, the works had closed, and a small aggregate quarry was operating adjacent to the railway line to the south-east. By 2003, this quarry had closed and by 2018 work was taking place to construct the current Conningbrook Lakes housing development that is on the former quarry site today.

Geology and Mining

According to BGS data, the proposed site is underlain by head deposits (CLAY and SILT) underlaid by the Folkstone formation (SANDSTONE). A previous ground investigation was undertaken in January 2012 for the first phase of the new housing development, Conningbrook Lakes (500m to the south of the proposed bridge).

This ground investigation encountered the Folkstone formation at a depth of 4 to 6m and overlain by a mixture of alluvium and river terrace gravels to the north and head to the south of the Conningbrook Lakes site.

A surface level quarry for aggregates was located to the southeast of the proposed footbridge site. The specific dates of operation of the quarry are unknown. The site is in a landfill referral area but is not in a mining referral area. This stretch of railway has been identified as being at risk of migration of landfill gases.

Track Gauging Requirements

Gauging is to be compliant with the RSSB standard GIRT7073 where the minimum clearance between vehicle and any asset is stated as 100mm. Horizontal offsets from running edge to assets are stated within Network Rail standard NR/L3/TRK/2049/MOD07 where an offset of 1.625m is desirable.

Electrification & Plant Requirements

There are a number of Network Rail operational critical Electrification & Plant (E&P) assets in the area concerned (non-exhaustive):

- 33kV High Voltage traction power distribution and pilot cables connecting with the nearby HV grid supply and other NR traction power substations in the area.
- E&P optical fibre cables linking the traction power locations and the electrical control rooms – part of traction power equipment protection and control systems.
- Signalling power distribution cables for supplying with the lineside signalling equipment.
- 750V DC electrification system for providing traction power to electric trains – including conductor rails (third rails) and DC traction cables.

Signalling Requirements

The Cradle Bridge Footpath crossing, which is the proposed site for the new bridge, is located on the Up / Down Canterbury (ACR) at approximately 58m 37ch. The ALCRM report states that the preferred option is for the crossing to be replaced, which is being undertaken by this project, and as such will be subject to closure prior to the bridge installation works. The closure should follow the process set out in NR/L2/SIG/30019 – Process for Closing or Downgrading Public Level Crossings in consultation with the local level crossing manager. Cognisance should be given to the staging of the works to ensure that crossing users are fully aware of the alternative crossing routes until such time as the bridge construction is completed.

Connectivity

Desire Lines

The orientation of the new footbridge should best compliment the desire lines of users crossing the bridge for their onward journey. While on the north the only existing direction is perpendicularly away from the railway, routes on the south offer three directions, including a parallel route along the tracks both ways. The northern route leads toward the to-be-closed Bolleaux Crossing and will form part of the new approx. 700m long diversion route. With the Housing Estate and lakes to the south, it is, however, assumed that most people will connect towards this direction, especially with the new development on the northern side of the tracks coming soon.

With the predominately flat surroundings, the bridge will be visible from far views across fields in the current context, aiding in wayfinding and locating the crossing point. With a more built-up environment and new trees on the north, the crossing will be less visible and may need signposting.

Accessibility

Network Rail has undertaken a separate Diversity Impact Assessment (DIA) which has concluded that a stepped-only footbridge is suitable for this site. Network Rail's rationale for this is that the current crossing is not accessible, as it includes stiles and steps up the railway embankment to be reached. The path leading to the crossing from the southern housing estate has not been upgraded so can be challenging to navigate by lesser-able bodied people or with pushchairs. A stepped-only footbridge would therefore be an appropriate upgrade to the crossing to increase safety for users at this time.

Figure 11 - Footpath / Cycle Lane network

Figure 12 - Cradle Bridge Crossing

However, taking into consideration the new school that is part of the planned development, the user requirements and frequency is likely to change, making an accessible bridge desirable and more appropriate for the future.

A ramped bridge will require very long access ramps to reach the required clearance height of the bridge above the tracks, which in turn entails a lot of space to ensure the ramps are compliant with standards. They can also be very strenuous to use when used to achieve a significant height difference, such as here, resulting in a limited enhancement to accessibility. This may therefore not be a suitable option for this location, as also outlined in the accompanying DIA report.

The modular design of the stepped Flow bridge allows for a passive provision for lifts, which can be added at a later point by replacing one of the deck modules and adding a lift on either side. Though the remote location and limited access for maintenance or in emergency cases may not outweigh the accessibility improvements, it is important to include the option should the necessity to enhance the crossing arise with the new development. Not having an accessible crossing significantly lengthens the journey between the southern housing estate and the new northern school, placing those who cannot use the bridge at a disadvantage. Further work to the paths leading to the crossing would also be required in this case.

Alignment Options – Approach

Span

The modular design of the flow bridge offers a limited number of Layout options, S- or C- shape, with an adjustable span in 0.5m increments. Considering the required clearance envelope a 20m span stepped-only Flow bridge is suggested as best fit for the location. This will place the bridge stairs at the top edge of the railway embankment. Additional steps will be required on the north side, where a ramp or groundwork adjustments would suffice on the southern approach to meet the bottom of the bridge stairs.

The proposed alignments have been assessed primarily on their continuity of existing and new routes, their adaptability for the new development and their integration into the landscape. A ☑ is valued as positive, whereas ! marks an aspect for caution, as the proposal either creates a negative impact or requires special consideration during the next design stage to ensure a positive effect of the footbridge.

The powerline adjacent to the railway will be too close to any structure built over the tracks and will need to be diverted or put underground in sections, independent of which alignment is chosen.

Alignment 1

S-Shape Alignment

An S-shape alignment would enhance the connectivity between the two developments on either side, bringing the southern end of the stairs close to the housing estate. The natural continuation of the route on the northern side directs people toward the footpath and new park, thereby discouraging unofficial footpaths being created between the tracks and the planned school.

However, the southern approach puts the users along the diverted route from the to-be-closed crossing at a disadvantage and requires a great amount of clearing, as the alignment coincides with existing trees and densely overgrown areas.

Directness of the route

Impact on the existing trees and vegetation

Utilisation and continuation of existing paths

Adaptability to future developments

N

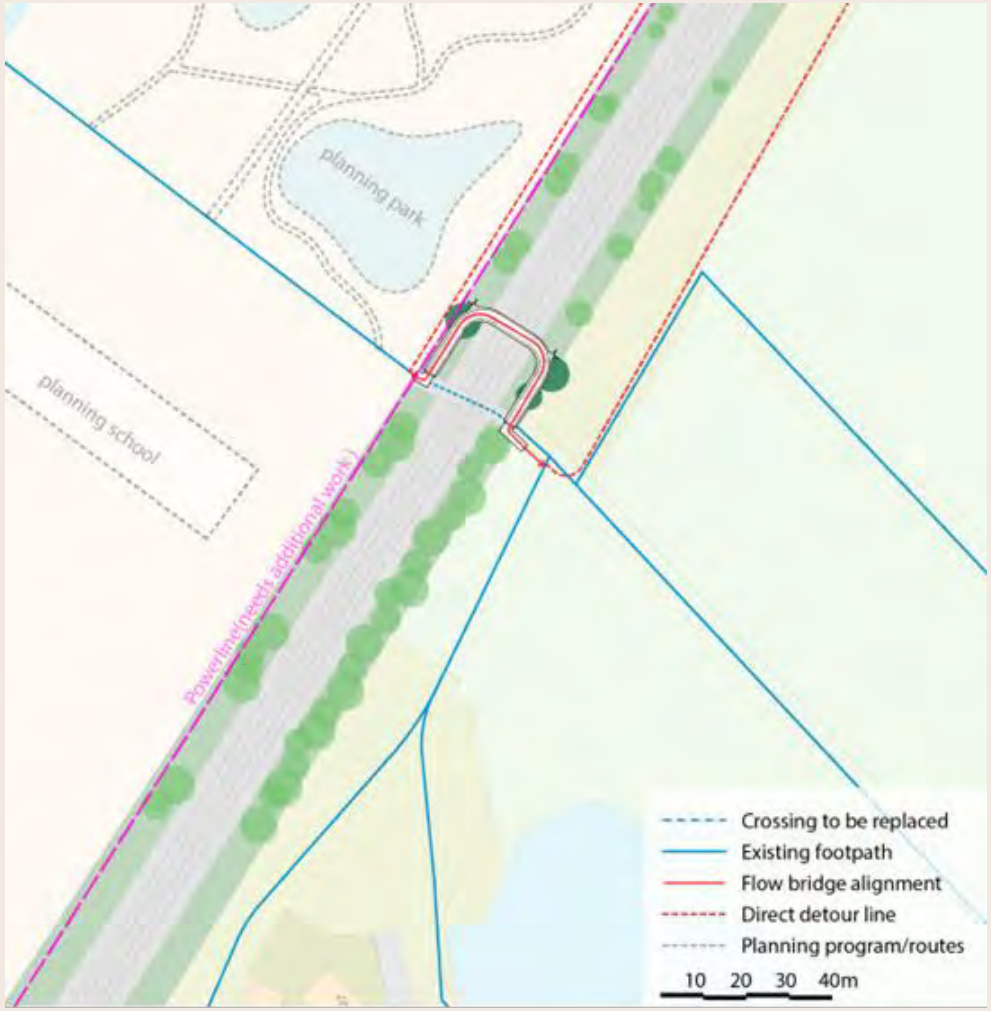
Alignment 2

C-Shape Alignment

A C-shape alignment will maximise the continuation and use of the existing footpaths, it will also accommodate the future development on the northern area whilst providing a more evened detour distance between the two sides from the to-be-closed crossing.

The C-shaped form also echoes the axial and linear form of the site and will have less impact on existing trees and vegetation.

Directness of the route	☑
Impact on the existing trees and vegetation	☐
Utilisation and continuation of existing paths	☑
Adaptability to future developments	☐



Recommended Alignment

C-Shape Alignment

A C-shape alignment will be of the most benefit in the currently existing context, as it has less impact on surrounding vegetation and future route diversions.

Lifts could be added to either alignment at a later stage, though they should be taken into consideration during the early stages of design, as they may affect the precise location and span arrangement to allow appropriate access to the lifts. Great care must be taken to ensure they are visible and safe to use.

Additional surveys for underground utilities may require adjustments to the proposed alignment as well.

While it is feasible to construct a stepped-only Flow bridge at this location, and suitable for the current environment, we consider a stepped-only crossing will become unsuitable once the sites are developed. We encourage the consideration of the impact of the bridge on the future development and suggest further investigation of the implementation of an accessible crossing / allowance for adding lifts in the future.

It should be noted that the DIA for this site notes that lifts may not be practicable at this site and thus this may not be deemed an appropriate solution to create a step-free structure in the future.

Option Description

The proposed option from this feasibility is shown in Drawing 186814-NRD-1706-ACR-DRG-ECV-000002. This option has been determined following a design workshop on 23rd October 2024 involving Knight Architects and Network Rail Engineering Services Design Delivery personnel.

Civils and Structures Commentary

It should be noted that all geometry stated in this section is based off point cloud and AIS data. A full topographical survey shall be required to validate the site levels and layout.

The proposed option shows a 'C' shape layout for the bridge. The superstructure is shown to be 20m in span (from / to the centre of the staircase spine on both sides). This span has been considered to ensure the bridge sits outside the 'hazard zone' (defined as per GCGN5612 and UK NA for BS EN 1991-1-7 as an area within 4,500mm of the nearest running edge) and is in line with the outlined span constraints for the Flow bridge which stipulate the span is in multiples of 500mm. Due to the length of the bridge, the existing boundary fence shall require locally repositioning, and land purchases shall be required on both sides of the railway to facilitate the new bridge, thus potentially adding additional cost to the overall scheme. It should be noted there is scope to reduce the overall span of the footbridge by allowing structural elements to sit within the 'hazard zone'. The position of any vertical supporting elements in relation to the track will need to be taken in consideration, to understand the risk from derailed trains impact. If a vertical support is located within a denominated 'hazard zone', the risk of impact from derailed trains shall be assessed in accordance with Appendix F of UIC 777-2R, which gives guidance on the risk assessment for Class B structures. This should be considered by designers at future design stages should there be a desire to shorten the overall span.

The bridge is shown to have a vertical clearance of 5,500mm from rail to soffit in line with the clearances stipulated in the Form A design for the proposed Mk2 Flow bridge.

The Superstructure is shown to be a stepped only footbridge to replace the existing stepped crossing at Cradle Bridge Crossing. The structure is not considered to be suitable to accommodate the future installation of ramps. Whilst lifts are potentially able to be installed in the future, the DIA for this site 186814-NRD-1700-ACR-REP-EHF-000001 states that lifts are not a reasonable solution at this site given the remote nature of the lifts in the event of breakdown and the potential for these to be misused. Consequently, it may not be considered that this Flow Bridge solution would be suitable for the future installation of a step-free bridge should this be deemed required.

The proposed footbridge will interface with the existing 11kV overhead power cables (UK Power Network) which run parallel to the Down side of the railway. As part of the works, these would require repositioning to allow the bridge to be installed. The proposed footbridge will also interface with the 21-inch diameter cast iron buried water main (South East water) at the Up side pier. To facilitate the installation of the bridge, the water main will

require local diversion and / or protection during construction activities as agreed with South East water. There may be scope to avoid this by reducing the clearance from the running edge as described above. It is not envisaged there will be any interface with existing drainage systems on the railway infrastructure.

On approach to the bridge minor changes shall be required to the approach footpaths to allow access to staircase level. On the Down side of the bridge, steps shall be required at 90^{o} to the main bridge staircase due to the level difference from footpath level to bridge level. On the Up side minor changes shall be required to the approach path.

Environmental and Ecological Commentary

Coenonympha Pamphilus butterflies commonly known as Small Heath is found in the vicinity of the bridge as well as the proposed new walking routes from Bolleaux crossing to the new bridge. Trees around the crossing to the north east where the bridge will be situated shall require removal. Any tree felling / vegetation clearance activities that need to be undertaken should be done outside bird nesting season.

Geotechnical Commentary

The proposed footbridge site is 'at grade', as such there are no earthwork assets on either side of the railway. The track level is up to approximately 1.4m higher than adjacent land. It is not anticipated that any railway earthwork slopes will be affected by the bridge construction.

Ground investigation has not been undertaken at the bridge location. The superficial Head deposits were recorded as being up to 5m thick in the BGS soil thickness model and the 2012 housing development ground investigation. Head deposits have the potential to include localized compressible organic lenses, giving rise to compressibility and uneven settlement hazards. Superficial deposits around the current artificial lakes at the Conningbrook Lakes development, east of the site, were likely excavated to extract the gravels beneath. However, the 2012 ground investigation indicates that an offset of 15m from the railway line was applied during the operation of the quarry by Bretts Aggregates, thus un-dug / unworked material is likely present here. The underlying bedrock of the Folkstone formation (Sandstone) was recorded in local BGS boreholes as medium dense sand at 2mbgl, to very dense at up to 10mbgl depth. The depth to groundwater ranged from 0.9mbgl to 4.8mbgl.

Ground investigation is required to investigate the ground and groundwater conditions to determine whether shallow or deep foundations are required. Rapid Root ™ foundations founded within the head deposits or within the underlying bedrock where weathered to a sand may be appropriate, depending on loading and ground conditions. To determine the foundation solution, the following geotechnical hazards need to be investigated by the ground investigation: Thickness and composition of superficial soils; depth to and strength of bedrock; groundwater conditions; infilled ground associated with former quarry; plasticity of clay deposits (shrink/swell); buried services as well as groundwater and ground gas monitoring. At this

stage it is suggested that ground investigation comprises two cable percussive boreholes on each side of the railway. Rotary coring of the bedrock may be required, depending on ground conditions encountered.

Track Commentary

The existing track along the *ELR:* ACR line comprises of two tracks, the Down and Up Branch line. Within the area of the proposed footbridge the existing track alignment horizontally is straight and vertically falls at an approximate gradient of 1:260 from Ashford Station. No works to the track alignment or componentry is required.

The proposed horizontal offset from running rail to the nearest point of the proposed footbridge is 4,500mm, a direct result of the considerations given regarding derailment risk. This offset is greater than the minimum desirable offset as defined within NR/L3/TRK/2049/MOD07 at 1,625mm, therefore the proposed clearance is greater the desirable structure gauge offset and can be defined as providing sufficient horizontal structural gauge clearance.

Third rail is located within this area therefore the proposed soffit height of the footbridge could be set lower than would be required for an OLE system. If passive provision for OLE is not required, it may be possible to reduce the soffit height of the footbridge to 4,640mm as defined within NR/L3/TRK/2049/MOD07. NR/L3/TRK/2049/MOD07 defines the desired soffit height of 5.100m for new construction with OLE. The proposed height is set at 5,500mm and should be reviewed at the next design stage as part of the value engineering exercise to ensure the correct soffit height for the footbridge is chosen. All soffit heights stated above would provide sufficient vertical structural gauge clearance. Any increases that are required to soffit heights at future design stages can be accommodated by the use of steel stools positioned at the cruciform support of the Flow Bridge.

Signalling Commentary

The nearest Signalling asset to the proposed bridge location is around 400m away and as such is not affected in any way by the new structure. Any cable route which runs through the worksite will need to be identified to ensure it is not disturbed by any works to deliver the bridge or by the subsequent final position. It is not expected that further Signalling input will be required however this cannot be ruled out at this stage, should any further interfaces to the Signalling system be identified. Should any signal sighting be required this shall be required through a Signal Sighting Chairman who would be procured separately through the project and thus would add further cost to the project. The local signalling asset owner should be consulted to determine their acceptance of the new bridge in relation to any signalling assets before any additional work is remitted at added cost to the project.

Electrification & Plant Commentary

Highlighted interfaces between E&P assets and the proposed Flow bridge works are as follow (non-exhaustive):

a) According to records, NR 33kV HV Feeder F1095 and pilot cables – between Willesborough and Wye substations – are buried under Cradle Bridge Crossing and on a surface cable route along the Down cess.
b) According to records, the E&P optical fibre cable – between Wye Substation and Kennington GSM-R Site – is located in the existing S&T route along the Up cess.
c) The signalling power cables are likely to be in the existing S&T route along the Up cess. However, this could not be confirmed at this stage.
d) Based on desktop observation, 750V DC conductor rails are located along the 6-foot area. At Cradle Bridge Crossing, a gap of the conductor rails was created, and the DC traction cables (continuity cables) are likely to be buried under the crossing decking and the 6-foot area electrically linking the two sections of conductor rails across the gap.
e) All E&P assets and their positions / alignments are subject to verification on site. The proposed Flow bridge is unlikely to directly affect these assets, however it may be necessary to protect these assets during the construction stage.
f) Any works affecting the existing NR 33kV HV feeder and 750V DC electrification system may require electrical isolations / switch-outs during construction stage. It will be subject to approval by NR HV Office or isolation planning.
g) Kennington Track Paralleling (TP) Hut – *ELR:* ACR, Mileage: 58m 13ch on the Down cess – is an existing traction power location nearby. Its main maintenance access (including the Local Control Panel (LCP) for isolation purposes of the DC electrification system) is at the existing access point off Willesborough / Kennington Road Bridge (Structure No. 1864). Although Cradle Bridge Crossing is not the main access for the TP hut, track access provisions to the Down cess should be considered at the crossing as the alternative access point for this traction power location.
h) Electromagnetic Compatibility (EMC) and Earthing & Bonding (E&B) requirements shall be considered as part of the next design stage.
i) Note that the interface with the existing third party's overhead electricity distribution lines (assumed to be part of UK Power Networks) outside the Down side boundary fence is not part of the scope of this E&P commentary. However, any changes / diversions of the DNO distribution lines will need to be assessed at the next design stage in order to determine the interfaces with the NR E&P assets.
j) Impacts to existing non-traction and non-operational critical LV power supplies have not been assessed and will need to be reviewed at the next design stage. In addition, any new/modified LV power supply (including lighting) for the proposed Flow bridge will need to be assessed as part of the next design stage. Note that the commentary on E&P assets will be subject to review if there is a change to the parameters of the proposed Flow bridge.

Constructability Commentary

The Flow bridge design has been developed in the thinking to provide a modular construction solution, which would give greater benefits to the construction phase and drive the cost installation down. Due to the light FRP material nature, the spine and bridge deck components let itself for an easier installation, with the utilization of smaller cranes at the site. For the Conningbrook site, we envisaged the following programme activities:

Site survey

Prior to undertake any site construction activities, topographical, service identification and ground investigation survey, gas monitoring will be carried out to inform the permanent and temporary works design. Environmental surveys (PEA) will confirm any potential ecology constraints at the site (invasive species, birds and other) to be catered and planned for.

Permanent & Temporary works Designs / Planning

Once the design will have reach full maturity, it is envisaged that a prior approval planning application will be required to the Local Authority, due to the permitted development category of the railway corridor. Once granted and conditions accepted, the implementation works will be able to start.

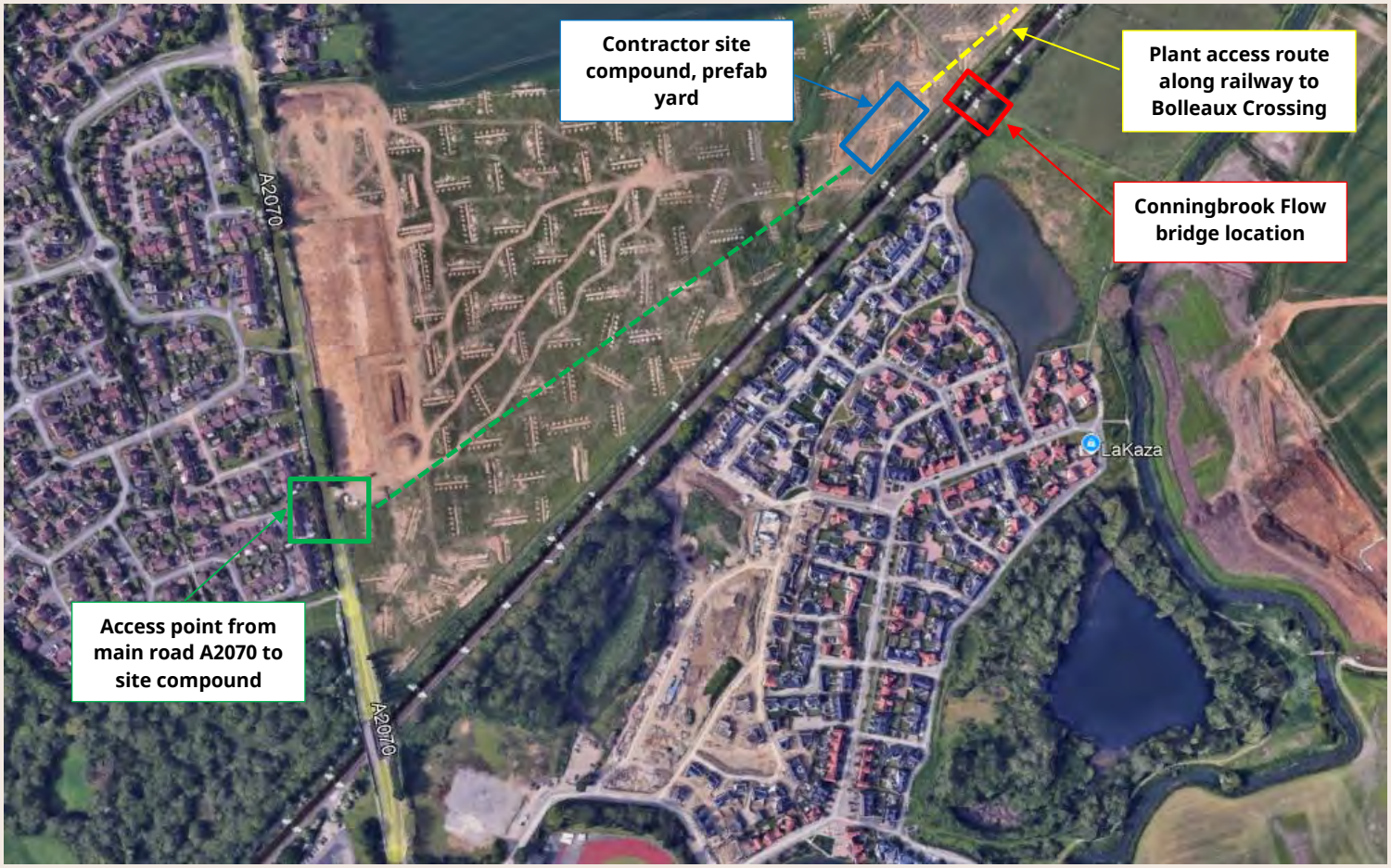
The detailed design will be developed to minimize the need for land purchase and diversion of the 21" water main owned by South-East water on the east side of the railway corridor, which will require to rationalize the main bridge span length required.

Service protection and diversion works

Early engagement with South-East water will be required, due to the close proximity of their assets to the bridge foundation and to establish control measures / protection to their assets, due to the interface with the site activities (additional loading applied onto the water main from excavator, crane…).
A temporary works design will be compiled and submitted to South-East water for their review and approval, prior to start any site activities.
For the The 11Kv Overhead Line, a service diversion will be required. UK Power Networks will be approached, to obtain a C3/C4 quotation to ascertain cost and timescale required to undertake the service diversion.

Enabling works / Site Establishment

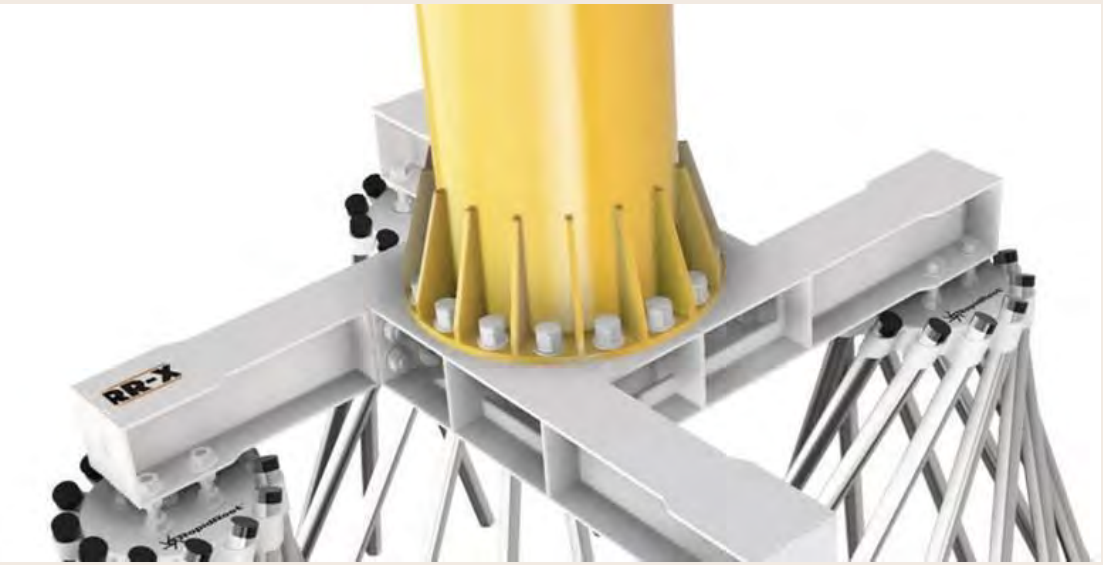
Once planning and service diversion dates confirmed, the enabling works will start, which will include to establish temporary access route to the crossings from the A2070, site compound and prefabrication yard, Conningbrook track crossing closure, temporary diversion route in place to Bolleaux crossing and de-vegetation works (refer to map next page).



Indicative site establishment and access route for the construction phase

Substructure works

It is assumed at this stage that the proposed Rapidroot foundation system will be able to be installed for the Conningbrook site, which will depend on the ground conditions and product performance. It will be de-risk at detailed design, as ground investigation report will be available to confirm ground suitability (refer to next page).



Rapidroot system

Rapidroot system installation photo

Earthwork

The foundation installed; the ground level will be re-shaped locally due to the level difference.

Superstructure works

For the bridge installation, the railway line will be taken under possession and the third rail isolated, so operatives and plant can be operated safely. We have planned the bridge construction to be undertaken as follow:

- 1st Saturday nightshift – install bridge piers and spine,
- Mid-week dayshift – install stair deck units and glazing panels onto pier sections (ALO working),
- Mid-week dayshift – prefabricate main bridge span lineside into yard,
- 2nd Saturday nightshift – install main bridge span and glazing panels onto the spine,
- Mid-week dayshift – install handrail system,

Lifting operation will be undertaken with a mobile crane and road rail vehicle, with associated alloy tower for working at height.

Flow Bridge Mark 1 installation photo – Spine

Flow Bridge Mark 1 installation photo – Stair FRP units

Ancillary Civil & Accommodation works

At the bridge landing, additional steps and handrail system will be installed. Lineside railway fence and permanent path diversion will then be put in place.

Finishing works / Hand-back

Finishing works, as topsoil spread, grass seeding and close out any defects will be undertaken. Once the Conningbrook Flow bridge will be open to public, the Bolleaux track crossing will be fully decommissioned and fencing / vegetation clearance completed.

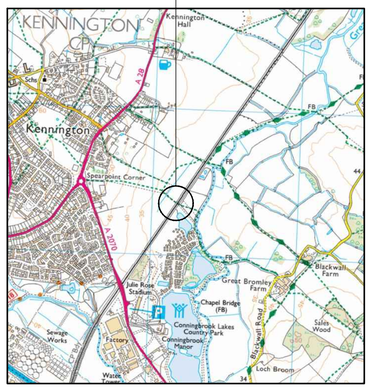
Demobilisation

It will bring the project to completion, which will allow removal of the site compound and ground reinstatement. We envisage that the total construction period will be setting between 6-8 weeks duration.

Option Drawings

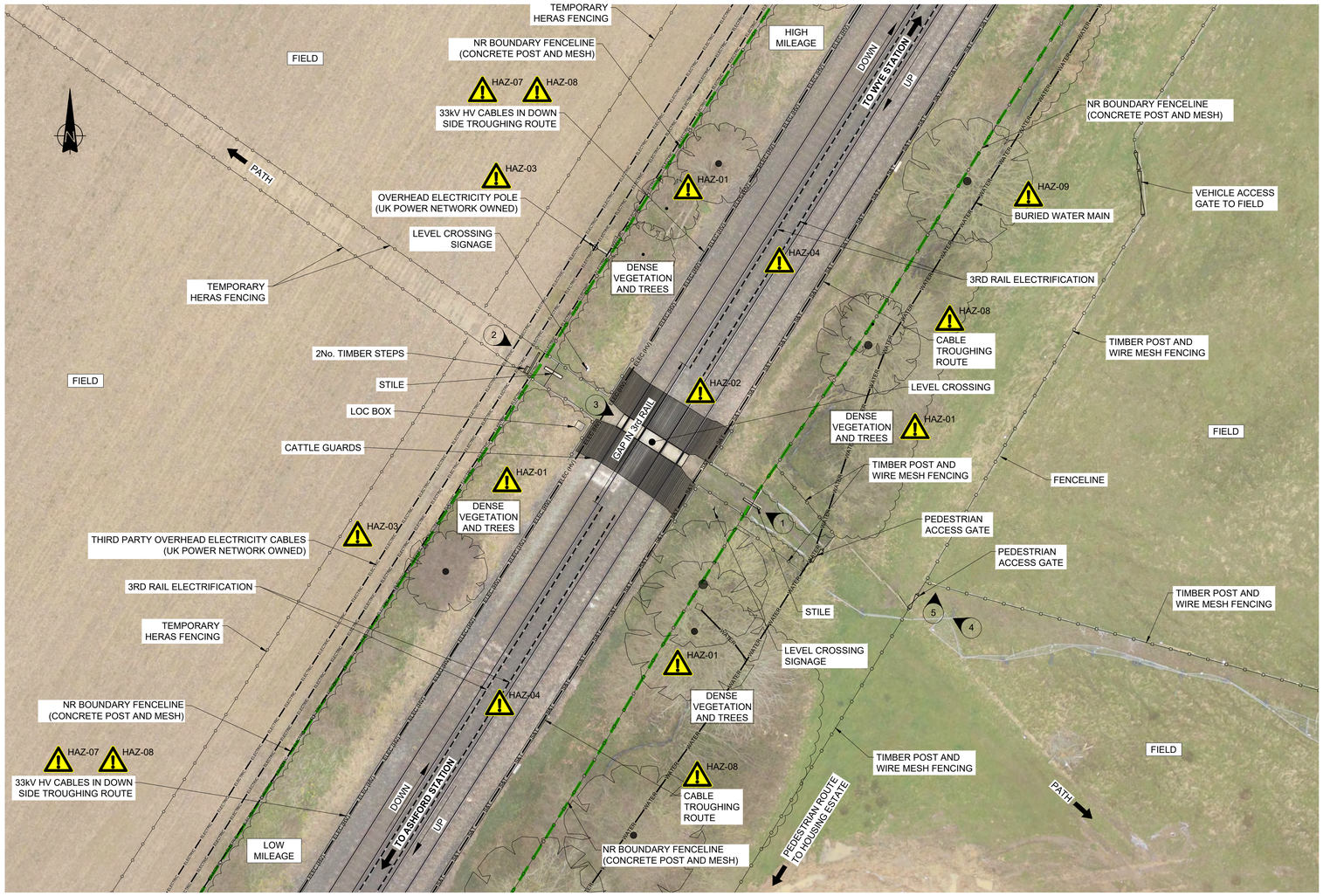
186814-NRD-1706-ACR-DRG-ECV-000001
186814-NRD-1706-ACR-DRG-ECV-000002

ELR : ACR
GRID REF : TR 0317 4435
MILEAGE : 58m 0804yds



LOCATION PLAN

BIRDS EYE VIEW LOOKING NORTH EAST TOWARDS HIGH MILEAGE



PLAN
SCALE 1:200

PHOTO 1: PEDESTRIAN STILE TO UPSIDE

PHOTO 2: PEDESTRIAN STILE TO DOWNSIDE SHOWING STEPPED ACCESS

PHOTO 3: LEVEL CROSSING FROM DOWNSIDE

PHOTO 4: PEDESTRIAN ACCESS GATES TO UPSIDE

PHOTO 5: LAND TO UPSIDE LOOKING FROM PEDESTRIAN ACCESS GATE

Legend/Notes

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS STATED OTHERWISE.
2. DO NOT SCALE FROM THIS DRAWING.
3. THIS DRAWING IS TO BE PRINTED IN COLOUR.
4. THIS DRAWING IS BASED ON AVAILABLE NETWORK RAIL RECORD INFORMATION, INCLUDING POINT CLOUD INFORMATION, AIS DATA, AERIAL IMAGERY AND TOPOGRAPHICAL SURVEYS FOR ADJACENT PROPOSED HOUSING DEVELOPMENTS.

SCOPE OF WORK:

- INSTALLATION OF NEW FRP FLOW BRIDGE

DRAWING LIST:

186814-NRD-1706-ACR-DRG-ECV-

000001 - EXISTING GENERAL ARRANGEMENT
000002 - PROPOSED GENERAL ARRANGEMENT

KEY:

- NETWORK RAIL OWNERSHIP BOUNDARY
- DC (3rd RAIL) ELECTRIFICATION
- OVERHEAD ELECTRIC CABLE
- CABLE TROUGHING ROUTE
- 33kV HV CABLES
- BURIED WATER MAIN
- FENCING
- TEMPORARY FENCING (HERAS)
- PHOTO MARKER

IMPORTANT CDM / H&S NOTE

THE DESIGNERS WOULD DRAW THE READER'S ATTENTION TO THE KEY RESIDUAL HEALTH AND SAFETY RISKS THAT HAVE NOT BEEN ELIMINATED FROM THE DESIGN, SHOWN ON THIS DRAWING, BY THE DESIGN PROCESS.

DRA REF:	SIGNIFICANT DESIGNERS IDENTIFIED HAZARDS
HAZ-01	DENSE VEGETATION AND TREES
HAZ-02	LACK OF FULL TOPOGRAPHICAL SURVEY
HAZ-03	OVERHEAD ELECTRICITY CABLE
HAZ-04	DC (THIRD RAIL) ELECTRIFICATION
HAZ-07	HV CABLE
HAZ-08	CABLE TROUGHING ROUTES
HAZ-09	BURIED WATER MAIN

FOR MORE DETAILS ON THE HIGHLIGHTED HAZARDS REFER TO THE DESIGN RISK ASSESSMENT FOR THIS PROJECT
"EVERYDAY" LOW RISK HAZARDS AND THOSE HAZARDS WHICH SHOULD BE OBVIOUS TO A COMPETENT CONTRACTOR HAVE NOT BEEN INDICATED ON THIS DRAWING. SHOULD ANY ADDITIONAL HAZARDS BE IDENTIFIED DURING THE COURSE OF THE WORKS THE CONTRACTOR SHALL NOTIFY ALL RELEVANT MEMBERS OF THE PROJECT TEAM.

0 4 8 12 16 20m
SCALE 1:200

REV	DATE	DESCRIPTION OF REVISIONS	DRAWN	CHK'D	APPR'D
P03	22/11/2024	ISSUE TO CLIENT	RD	JO	SG
P02	07/11/2024	DRAFT ISSUE	RD	MM	JO
P01	31/10/2024	DRAFT ISSUE FOR COMMENTS	LE	JO	JO

STATUS: FEASIBILITY

DESIGNERS

Network Rail Engineering Services Part of Route Services
Manchester Square One, 4 Travis Street, Manchester, M1 2NY
Tel: 0161 880 3936 Web: www.networkrail.co.uk

PROJECT: FLOWBRIDGE FEASIBILITY - CONNINGBROOK PARK

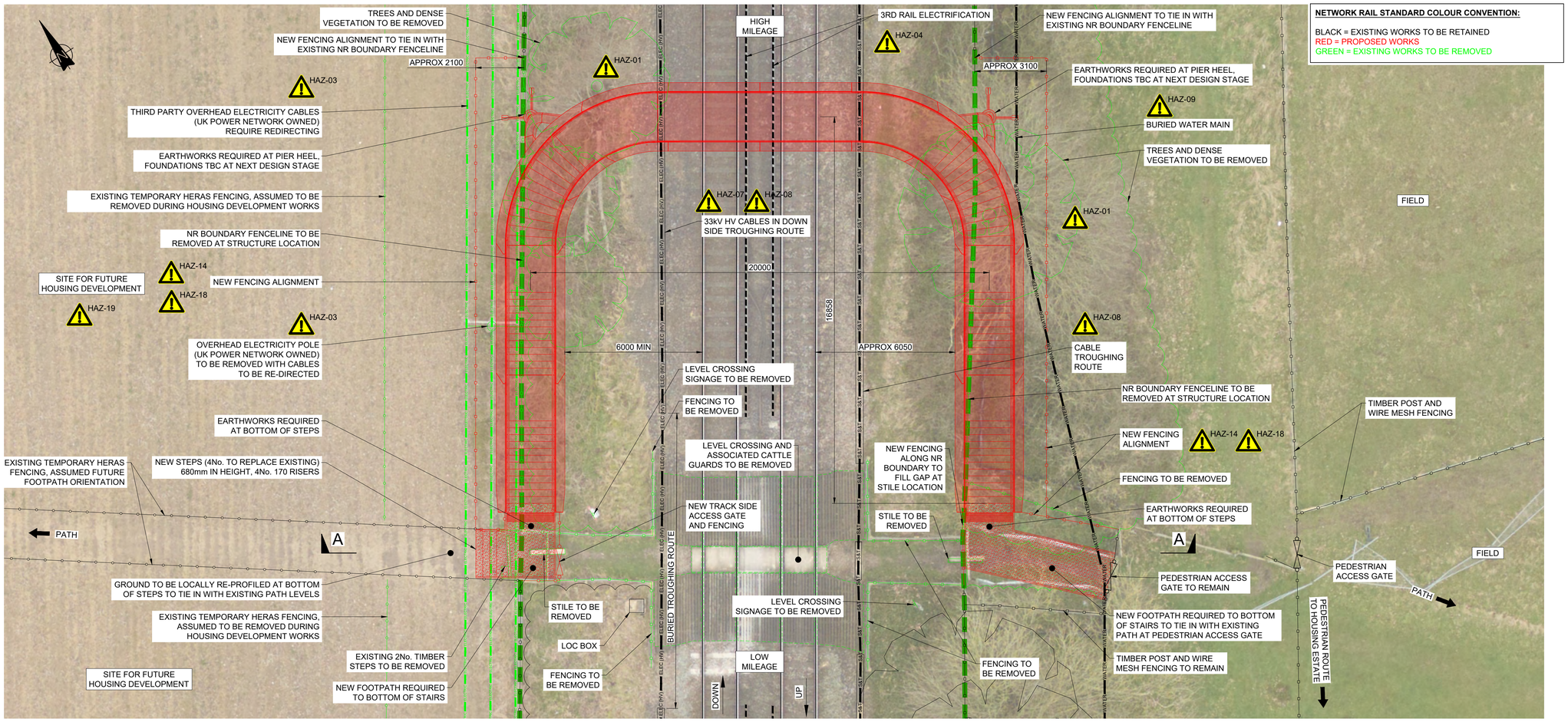
DRAWING TITLE: EXISTING GENERAL ARRANGEMENT

DESIGNED	L. TAYLOR	SIGNED	Date 22/11/2024
DRAWN	L. EVANS	SIGNED	Date 22/11/2024
CHECKED	J. OLLERHEAD	SIGNED	Date 22/11/2024
APPROVED	S. GOMEZ	SIGNED	Date 22/11/2024

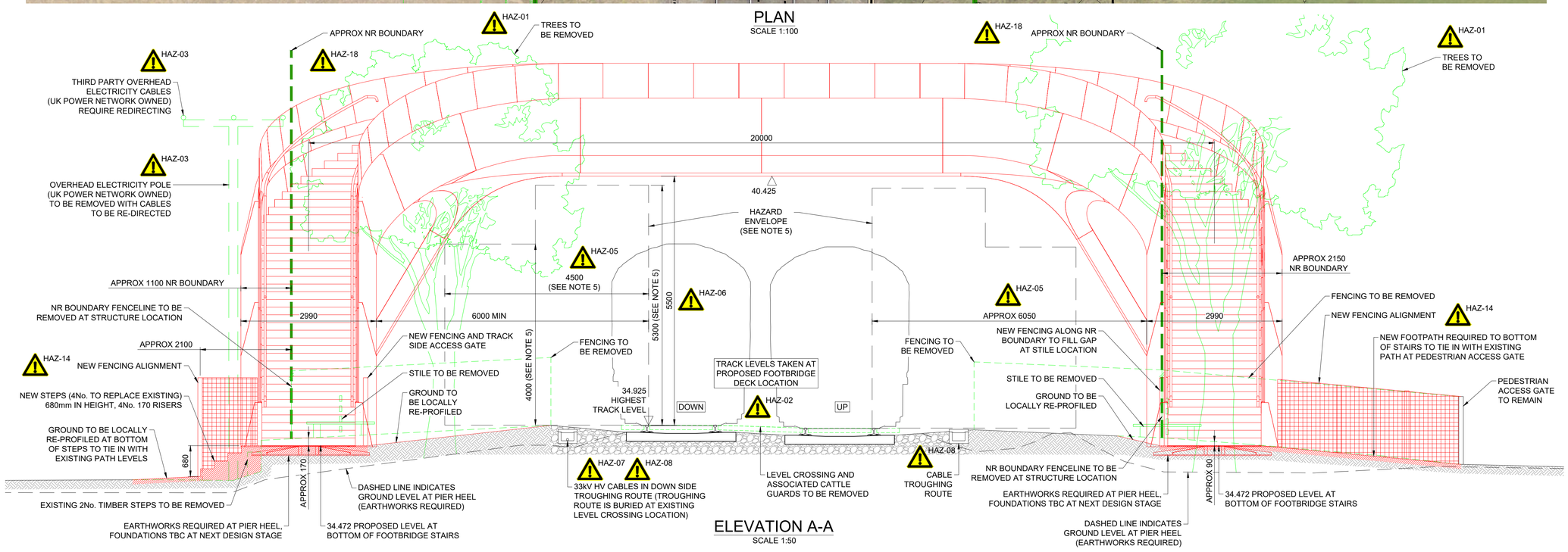
SCALE (@ A1 SHEET SIZE = 841 x 594): AS SHOWN
ELR: ACR
MILEAGE: 58 miles 0804 yards

DRAWING NUMBER: 186814-NRD-1706-ACR-DRG-ECV-000001
REVISION: P03

Sheet Size A1 594 x 841



PLAN
SCALE 1:100



ELEVATION A-A
SCALE 1:50

NETWORK RAIL STANDARD COLOUR CONVENTION:

BLACK = EXISTING WORKS TO BE RETAINED
RED = PROPOSED WORKS
GREEN = EXISTING WORKS TO BE REMOVED

Legend/Notes

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5. DETAILS OF THE SHAPE AND DIMENSIONS OF THE HAZARD ENVELOPE CAN BE FOUND IN THE FEASIBILITY REPORT.
6. FOUNDATION SOLUTION TO BE CONFIRMED AT NEXT DESIGN STAGE SUBJECT TO GROUND INVESTIGATION SURVEYS.

KEY:

- LOCATION OF PROPOSED BRIDGE
- NETWORK RAIL OWNERSHIP BOUNDARY
- DC (3rd RAIL) ELECTRIFICATION
- ELECTRIC — OVERHEAD ELECTRIC CABLE
- S&T — S&T — CABLE TROUGHING ROUTE
- ELEC (HV) — 33kV HV CABLES
- WATER — WATER — BURIED WATER MAIN
- FENCING
- TEMPORARY FENCING (HERAS)

IMPORTANT CDM / H&S NOTE

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HAZ-05	TRAIN DERAILMENT
HAZ-06	GAUGE CLEARANCE
HAZ-07	HV CABLES
HAZ-08	CABLE TROUGHING ROUTES
HAZ-09	BURIED WATER MAIN
HAZ-14	TRESPASS
HAZ-18	LAND PURCHASE
HAZ-19	LINESIDE NEIGHBOURS

FOR MORE DETAILS ON THE HIGHLIGHTED HAZARDS REFER TO THE DESIGN RISK ASSESSMENT FOR THIS PROJECT
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0 2 4 6 8 10m
SCALE 1:100

0 1 2 3 4 5m
SCALE 1:50

REV	DATE	DESCRIPTION OF REVISIONS	DRAWN	CHK'D	APPR'D
P03	22/11/2024	ISSUE TO CLIENT	RD	JO	SG
P02	07/11/2024	DRAFT ISSUE	RD	MM	JO
P01	31/10/2024	DRAFT ISSUE FOR COMMENTS	LE	JO	JO

STATUS
FEASIBILITY

DESIGNERS
Network Rail Engineering Services
Part of Route Services.

Manchester Square One, 4 Travis Street, Manchester, M1 2NY
Tel: 0161 880 3936 Web: www.networkrail.co.uk

PROJECT:
FLOWBRIDGE FEASIBILITY - CONNINGBROOK PARK

DRAWING TITLE:
PROPOSED GENERAL ARRANGEMENT

DESIGNED	L. TAYLOR	SIGNED	Date 22/11/2024
DRAWN	L. EVANS	SIGNED	Date 22/11/2024
CHECKED	J. OLLERHEAD	SIGNED	Date 22/11/2024
APPROVED	S. GOMEZ	SIGNED	Date 22/11/2024

SCALE (@ A1 SHEET SIZE = 841 x 594) AS SHOWN | ELR ACR | MILEAGE 58 miles 0804 yards

DRAWING NUMBER 186814-NRD-1706-ACR-DRG-ECV-000002 | REVISION P03

Sheet Size A1 594 x 841

Option Visualisations


Looking Northwest, approaching from
the southeast side of the railway


Looking Southeast, approaching from
the northwest side of the railway

Estimation for future costs

Conningbrook Flow Bridge - Cost Estimate			
Item Ref	Description	Cost Estimate GBP £	Comments
1	**ES4 Stage – Approval In Principle**	£ 96,800	Including surveys (approximately £30k)
2	**ES5 Stage – Detailed Design**	£121,000	
3	**ES6-7 Stage – Construction & Hand-back**	£1,126,961,73	
	Total Estimated Cost	**£1,344,761.70**	
4	**Exclusions**		
4.01	Land Purchase	TBC	(If required)
4.02	Proposed new paths – Conningbrook to Bolleaux	TBC	By others (Housing Developer or Council funded)
4.03	11kV Overhead Line Diversion (UK Power Networks)	TBC	C3/C4 Quotation to be obtained
4.04	21" Southeast Water main Diversion	TBC	C3/C4 Quotation to be obtained
4.05	Power Supply for sensors / Lighting / CCTV provision	TBC	C3/C4 Quotation to be obtained + Design / Installation cost

Designers Risk Assessment

186814-NRD-1706-ACR-RSA-ECV-000001

Design Risk Assessment

DESIGN RISK ASSESSMENT	Project Ref: 186814 (Oracle)	Project Title:	**Conningbrook Flow Bridge**	Doc ref: Version:	186814-NRD-1700-ACR-RSA-ECV-000001
Design Stage: ES2		Status:		Version:	01
		Prepared by: Sign:	L Taylor	Checked by: Sign:	J Ollerhead
		Date:	22/11/2024	Date:	22/11/2024
		Approved by: Sign:	S Gomez	These signatures cover items between 01 and 21.	
		Date:	22/11/2024	Signatures are filed for items up to 21.	

All=All; A=Architecture; B=Buildings; C=Civils; D=Drainage; Eo=E&P OLE; El=E&P LV; E3=E&P 3rd rail; G=Geotech; L=Level Xings; M=M&E; O=Operations; S=Sig'g; Te=Telecoms; Tr=Track; Z=Other

Design Risk Assessment

Discipline(s)	Ref	Risk description	Risk consequence	Phase Construction / Operation / Mtce / Demolition	Mitigation measures The reason for providing no mitigation must be explained. Eliminate = E Reduce = R	Residual Risk Reduced or Eliminated or Not Changed,	Residual risk - and - **Method of communicating mitigation measures and residual risk** Inform = I	Responsibility for control of risk (beyond this design stage) Control = C	Notes (Including assumptions, dependencies and constraints)
C, Z	01	**Dense Vegetation** Bridge clashes with existing vegetation.	Vegetation to be removed leading to an adverse impact on local ecology e.g. nesting birds.	C	Bridge positioned so deck is to the north east of the crossing as opposed to the south west to minimise the impact on vegetation. Designer notes works to remove vegetation are undertaken outside bird nesting season. Preliminary Ecological Appraisal to be undertaken to establish any unforeseen ecology issues, invasive species requiring removal / treatment or fence zone affected. At this stage no further mitigations are possible.	R	No Ecological appraisal has been undertaken by an ecologist at this stage. Area of vegetation to be removed demonstrated on Drawing 186814-NRD-1706-ACR-DRG-ECV-000002. De-vegetation works should be outside bird nesting season.	Designer at next design stage.	Z = Ecology

C, Z	02	**Third Party Overhead Electricity Distribution Lines** Electricity distribution system (not related to NR traction power distribution and electrification systems) will be affected by the new bridge.	Electric shock / electrocution to bridge users due to new standing surfaces being close to power distribution cables leading to serious injury or fatality. Plant clashes with cables during construction leading to damage to infrastructure and / or serious injury or fatality.	C, O	New bridge is shown to intersect with the cables therefore requiring them to be relocated / diverted. Liaison with asset owner (UKPN) will be required for relocation / diversion requirements. A C3 / C4 quotation for the diversion works should be sought. Report notes that there is scope at future design stages to reduce the length of the bridge span. This may still require the cables to be relocated / diverted due to the close proximity they will have with the bridge – subject to electrical clearance checks. An exclusion zone would need to be established due to plant interface should cables remain close to site. Goal posts, signage as well as appropriate safety documentation would also be required.	R	Cables requiring relocation / diversion which may lead to increased project scope / costs / programme. Additional stakeholder management with the DNO may increase project complexity. Potential for power supply to low voltage elements may be required as part of the project which will lead to additional costs. Cables demonstrated on Drawing 186814-NRD-1706-ACR-DRG-ECV-000002.	Project Team Designer at next design stage.	Z = UK Power Networks Notification period for the diversion works (thought to be 12-16 weeks potential leading time).
All	03	**Lack of Full Topographical Survey** No topographical survey for the railway available at this design stage.	Incorrect level / geometry information leading to misleading drawings. This can lead to an increase in scope and thus costs due to additional / more onerous works being required.	C	Drawings based off available AIS and point cloud data for the site and cross checked against Geo-RINM and on-site observations.	NC	Full topographical survey required at next design stage.	Designer at next design stage.	
E3	04	**DC Electrification** NR DC electrification system (including conductor rails /	Damage to Network Rail infrastructure during construction leading to	C	Based on the preliminary design, the bridge is unlikely to impact the DC conductor rails and DC	R	Surveys have not been undertaken at this design stage and thus accurate positioning of	Designer at next design stage. Contractor.	It is assumed that the bridge design will consider the risks associated with

Design Risk Assessment

Discipline(s)	Ref	Risk description	Risk consequence	Phase Construction / Operation / Mtce / Demolition	Mitigation measures The reason for providing no mitigation must be explained. Eliminate = E Reduce = R	Residual Risk Reduced or Eliminated or Not Changed,	Residual risk - and - **Method of communicating mitigation measures and residual risk** Inform = I	Responsibility for control of risk (beyond this design stage) Control = C	Notes (Including assumptions, dependencies and constraints)
		third rails and DC traction cables) may be affected by the new bridge.	disruption to railway and / or serious injury or fatality.		traction cables – subject to verification on site. To avoid possible damages, the assets may need to be protected during the construction stage. Isolation shall be required during possession works so workforce can cross and work on the track safely.		infrastructure not possible at this design stage. Protection of the assets may be subject to temporary works design and approval. Electrification demonstrated on Drawing 186814-NRD-1706-ACR-DRG-ECV-000002.		projectiles / objects from the bridge which may damage the DC electrification system. Any works affecting the 750V DC electrification system may require electrical isolations during construction stage.
C, Tr	05	**Train Derailment** Bridge collapsing as a result of a train derailment.	Trains derailing and colliding with the bridge causing the collapse of the structure leading to serious injury or fatality.	O	Hazard zone in line with NR/L2/CIV/020, GCGN5612 and UK NA for BS EN 1991-1-7 has been considered with no structural elements positioned within this area.	R	Future scope to reduce the hazard zone offset from the running edge. Hazard zone demonstrated on Drawing 186814-NRD-1706-ACR-DRG-ECV-000002.	Designer at next design stage.	

Design Risk Assessment

Discipline(s)	Ref	Risk description	Risk consequence	Phase Construction / Operation / Mtce / Demolition	Mitigation measures The reason for providing no mitigation must be explained. Eliminate = E Reduce = R	Residual Risk Reduced or Eliminated or Not Changed,	Residual risk - and - **Method of communicating mitigation measures and residual risk** Inform = I	Responsibility for control of risk (beyond this design stage) Control = C	Notes (Including assumptions, dependencies and constraints)
C, Tr	06	**Gauge Clearance** Trains colliding with bridge.	Trains colliding with the bridge causing the collapse of the structure leading to serious injury or fatality.	O	Bridge is sized to allow for sufficient clearance for gauge profile for this line and in line with minimum soffit clearances stipulated in the Form A for the Standard Design.	R	Bridge has a clearance of 5.5 from running edge to soffit. Clearance to soffit from running edge demonstrated on Drawing 186814-NRD-1706-ACR-DRG-ECV-000002.	Designer at next design stage.	
E3	07	**HV Cables** NR 33kV HV traction power distribution and pilot cables may be affected by the new bridge.	Damage to Network Rail infrastructure during construction leading to disruption to railway and / or serious injury or fatality.	C	Based on the preliminary design, the bridge is unlikely to impact the NR HV feeder cables – subject to verification on site. To avoid possible damages, the assets may need to be protected during the construction stage.	R	Surveys have not been undertaken at this design stage and thus accurate positioning of infrastructure not possible at this design stage. Protection of the assets may be subject to temporary works design and approval. Cable route demonstrated on Drawing 186814-NRD-1706-ACR-DRG-ECV-000002.	Designer at next design stage. Contractor.	Any works affecting the existing NR 33kV HV feeder may require electrical isolations / switch-outs during construction stage.

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E3, S, Te	08	**Cable Troughing** NR E&P and S&T cable routes may be affected by the new bridge.	Damage to Network Rail infrastructure during construction leading to disruption to railway and / or serious injury or fatality. Slip and trip hazards during construction.	C	Any known cable routes are shown on design drawings. To avoid possible damages, the assets may need to be protected during the construction stage.	R	Surveys have not been undertaken at this design stage and thus accurate positioning of infrastructure not possible at this design stage. Protection of the assets may be subject to temporary works design and approval. Cable route demonstrated on Drawing 186814-NRD-1706-ACR-DRG-ECV-000002.	Designer at next design stage. Contractor.	It is assumed that the bridge design will consider the risks associated with projectiles / objects from the bridge which may damage the cable trough routes.

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C, Z	09	**Buried Water Main** Buried water main shown to interface with proposed flow bridge footing.	Interface leading to damage during construction or increased scope to move as part of project.	C	Use of rapid root system to minimise risk of damage on site to water main. Temporary works will be required to protect the pipe during construction from works and access road. A C3 / C4 quotation for the diversion works should be sought.	R	Interface highlighted in drawing and in report. Potential for the bridge footing to be moved closer to the track / orientation amended / location amended and thus reduce the risk of interface. Surveys in the form of trial pits to accurately locate the water main are recommended. Route of buried water main demonstrated on Drawing 186814-NRD-1706-ACR-DRG-ECV-000002.	Designer at next design stage.	Z = South East Water Notification period for the diversion works (thought to be 12-16 weeks potential leading time).

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A, C	09	**Accessibility** Stepped footbridge precludes persons with reduced mobility from using the crossing.	Discrimination against persons based on their protected characteristics as defined in the Equality Act 2010 leading to reputational damage.	O	Diversity Impact Assessment undertaken to review the works and determine if they would have a negative impact on users. DIA noted that the existing crossing was not suitable for persons with reduced mobility however due to the adjacent areas scheduled for development future proofing the crossing to allow enhancement for step free access should be considered.	R	Future changes to demographics in the local area could lead to an increased case to enhance the site and provide step-free access at the crossing.	Project Team Client	
A	10	**Aesthetics** Bridge having an adverse visual impact on the area.	Bridge adversely impacting the local aesthetic leading to opposition from Local Authority and residents.	O	Design has been reviewed from an architectural standpoint and visualisations provided to allow a greater understanding at design stage as to the visual impact on the area.	NC	Relevant planning approvals / reviews to take place at future design stages.	Designer at next design stage.	

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A, Z	11	**Anti-social behaviour** Bridge providing a secluded environment that could attract anti-social behaviour / act as a deterrent for prospective users.	Anti-social behaviour becoming prevalent at the site leading to crime. Persons feeling unable to use structure due to fear of entering the crossing.	O	Flow bridge features glazed parapets allowing persons to be viewed from areas adjacent to the railway. Curved corners also allow sightlines across the bridge. Lighting / CCTV coverage should be considered with power supply / telecoms network connection investigated in line with Local Authority and Developer.	R	Future changes to the adjacent land use could lead to security requirements at site changing.	Project Team	Z = Developer and Local Authority
C, G, Tr	12	**Track Stability** Track becoming unstable due to ground works around bridge.	Track becoming unstable leading to track faults causing disruption to services and / or derailments.	C	Track monitoring to be undertaken to ensure track alignment is not undermined. NR/L2/CIV/177 trigger levels to be adopted if / when required.	E	Track monitoring required during construction.	Contractor	
C, S	13	**Signal Interface** Bridge affecting signal sighting.	Bridge affecting the sighting of signals leading to disruption to services.	O	A review of signal interface has been undertaken and the position of the bridge is such that no impact on signalling is envisaged.	R	A further review of signal impact should take place at future design stages.	Designer at next design stage.	

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C	14	**Trespass** Persons trespassing onto the railway where bridge is situated.	Persons accessing the railway corridor beyond the Network Rail boundary causing disruption to services and / or serious injury or fatality.	O	New boundary fences are proposed as part of the works.	NC	A review of the boundary measures at the site should be undertaken as part of the works to develop the site due to changes to the adjacent land use.	Network Rail Asset Team Project Team Client	
C	15	**Public Right of Way** Public rights of way being diverted leading to opposition from Local Authority.	Rejection of closure of AU17 crossing and diversion of AU22 footpath over the railway.	O	No impact on the proposed diversion paths already proposed between AU17 and AU22 parallel to the railway.	R	Local Authority approval shall still be required.	Project Team	
C	16	**Additional Maintenance Liability** Additional structural asset to be inherited.	Additional maintenance and operational costs.	O, M	Bridge features steps only and doesn't include lifts which would present additional operational and maintenance requirements. Bridge features remote condition monitoring to assist with maintenance over design life.	R	New structures asset shall be installed. Removal of a crossing asset.	Network Rail Asset Teams	

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Tr	17	**Objects on line** Construction works near the tracks and working over the tracks leading to objects falling / striking the tracks. Objects falling onto the railway during operations by the public	Defected track componentry, derailment by construction plant striking train, assets leading to serious injury / fatality.	C, O	Contractor to ensure sufficient protection of the existing track assets during construction is in place. Protection measures to be within the contractor's method statement. Proposed bridge parapet height to help deter objects from being thrown over by the public. Lighting and CCTV to also be considered. ALO plan as well as other safety documentation to be provided by contractor.	R	Contractor to inspect track componentry before handback of the railway. Routine track patrolling within the area to identify possible defected componentry. ALO management, monitoring by the contractor during the works (plant exclusion zone required).	Contractor Network Rail Asset Team Maintenance	

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All	18	**Land Purchase** Land required to be purchased as part of the scheme.	Additional land required to facilitate the bridge in the permanent case. Risk of excessive costs to procure land.	C	Bridge shown as minimum width to ensure outside hazard zone from track. Report notes the potential to reduce this overall span and thus reduce / eliminate permanent land purchases.	R	Extent of land purchase shown on drawings. Potential to remove this risk at later design stages. Lack of topographical information at this stage reduces designers' ability to quantify exact amount of land required.	Project Team	

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All	19	**Lineside Neighbours** Disruption to lineside neighbours from construction activity in the form or noise and light pollution as well as dust.	Disruption to lineside neighbours leading to reputational damage and increased risk of on-site hostility from neighbours.	C	Maximise day shift and Monday to Friday working days. Modular construction used to reduce construction period. Use of silent generator, use of baffle soundproofing wall around working area, use of electric powered tools. Night shift working – temporary lighting to be directed away from houses. Briefing to operatives on noise management.	R	Active communication to neighbourhood on work undertaken, letter drop, and potential disruption during the construction period.	Contractor	
G	20	**Lack of Ground Investigations** Lack of Ground Investigations informing the geotechnical and foundation design.	Insufficient Ground information leading to assumptions which could be incorrect at this stage. Risk of increased scope of works leading to increased costs.	C	Ground Investigations required are listed in the geotechnical section of the report.	NC	Weaker ground conditions affecting the rapid root standard design solution is possible. Potential for landfill gas and contaminated ground (WAC test required).	Designer at next design stage	

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C, G	21	**Flooding** Flooding to the site causing damage to structure.	Flooding from adjacent land onto the railway causing damage to the structure leading to significant future maintenance and repair costs.	O, M	Flood maps have been reviewed which highlight minimal risk to bridge. Developer to ensure drainage of proposed hosing estate to not have a detrimental impact on the railway.	NC	Further review of flood risk to take place at next design stage.	Designer at next design stage.