A12 Chelmsford to A120 widening scheme

TR010060

9.69 Paynes Lane Technical Note

April 2023

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning
(Examination Procedure) Rules 2010

A12 Chelmsford to A120 widening scheme

Development Consent Order 202[ ]

9.69 Paynes Lane Technical Note

Regulation Number	Rule 8(1)(k)
Planning Inspectorate Scheme Reference	TR010060
Application Document Reference	TR010060/EXAM/9.69
Author	A12 Project Team and National Highways

Version	**Date**	**Status of Version**
Rev 1	12th June 2023	Final for Deadline 6

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1 Introduction

1.1.1 This technical note relates to an application (the Application) made by National Highways (the Applicant) to the Planning Inspectorate acting on behalf of the Secretary of State (SoS) under section 37 of the Planning Act 2008 for a Development Consent Order (DCO).

1.1.2 DMRB CG300 “Technical Approval of Highway Structures” requires that a Structures Options Report (SOR) is submitted to the Technical Approval Authority (TAA) to summarise the development process for each of the structure proposals, identifying all significant influences on the form of structure proposed and reasons for rejecting other structural forms. The purpose of this technical note is to summarise the SOR and provide further information in relation to the design development, options assessed and subsequently selected for the proposed WCH bridge at Paynes Lane. This technical note also includes details on the Applicant’s proposed approach to future engagement with Chelmsford City Council (CCC) in relation to Paynes Lane detailed design.

1.1.3 This technical note builds on the information provided in the A12 Chelmsford to A120 Widening Scheme DCO submission documents, responses to Relevant Representations [PDA-004] and Local Impact Reports [REP3-017 - REP3-021] and contents of the Statement of Common Ground between the Applicant and CCC [REP4-043].

2 Considerations, constraints and assumptions

2.1 Land use considerations

2.1.1 The Great Eastern railway line passes under the north span of the proposed bridge, with the proposed Beaulieu Park and Network Rail development located approximately 90m to the west of the north end of the bridge.

2.1.2 The northern half of the footprint of the bridge is within the boundary of Greater Beaulieu Park, which was approved in March 2014, providing a train station and business park.

2.1.3 Private residential properties reside along Payne's Lane immediately to the south of the proposed bridge.

2.2 Environmental considerations

2.2.1 Footprint of the proposed bridge is located within B21 – Boreham Farmland Plateau local landscape character area.

2.2.2 An area of deciduous woodland approximately 150m south west of the bridge is classified as a Priority Habitat.

2.2.3 Vegetation along the A12 and rail line verges and surrounding agricultural fields provide habitats for protected species such as badgers, bats, breeding birds and reptiles.

2.3 Site constraints

2.3.1 Existing overhead cables clash with the proposed northern footbridge ramps. Overhead cables are to be diverted prior to construction.

2.3.2 Utilities running parallel to the A12 and Great Eastern Mainline under the proposed bridge.

2.3.3 The A12 will remain partially open during construction so work will take place adjacent to live traffic.

2.3.4 The maximum span for the proposed bridge is approximately 54m. A summary of approximate span ranges suitable for the various forms of structure is given in Table 2.1.

Table 2.1 Table 1: Span ranges for different types of construction

Construction Type	Span Range (m)	Initial suitability for site
Truss	15 to 60	✔
Vierendeel girder	15 to 45	X
Twin steel girders	10 to 25	X
Steel girders + steel floor plate	10 to 30	X
Steel box girder	20 to 60	✔

Composite beams	10 to 50	✔
Arches	25 upwards	✔
Cable stayed bridge	40 upwards	✔
Suspension bridge	70 upwards	X

2.3.5 Certain forms of structure were dismissed from this process, simply by inspection, due to factors such as the span arrangements, ramp lengths, cost, embodied carbon, aesthetic or construction risk. See Section 3 for discounted options.

2.4 Assumptions

2.4.1 A list of assumptions was used to identify suitable options and discount unsuitable structure options.

- The deck cross-section over the structure is 4.5m.
- The carriageway cross-sections beneath the bridge are in accordance with the requirements of CD 127.
- The maximum span for Paynes Lane Footbridge is approximately 54m.
- The headroom requirements of the footbridge are in accordance with CD 127 over the carriageway and NR/L3/CIV/020 over the Great Eastern Mainline.
- For ease of maintenance and benefits to the whole life cost, all steel plate options are assumed to be weathering steel pending outcome of in-situ testing.
- Utilities affected by the proposed footbridge will be diverted or relocated as required.
- The design life of the proposed bridge will be 120 years.

3 Discounted options (Bridge)

3.1.1 To avoid the need for high whole life cost, maintenance and additional traffic management phases in the central reserve of the A12 with the associated traffic delay, piers in the central reserve should be avoided whenever practicable to do so. This results in a single span structure over the A12 with a span greater than 50m. Constraints with regard to the installation of the bridge structure over the A12 may be generally manageable, but when installing over the electrified railway, limited available time during railway possessions needs to be considered. The time available will be significantly shortened by the safe systems of work required to both gain possession of the railway and then to isolate the overhead electrification.

3.1.2 Structural forms that were not taken forward for further consideration in the options appraisal process included:

3.2 Steel Composite girder construction

3.2.1 Deep girders would be topped with a concrete deck above which a 1.8m parapet would be required due to the equestrian requirement. Over the railway this would need to be solid. Due to the narrow width of the structure, there would be a very limited cantilever of the deck over the beams, resulting in a very 'heavy' looking structure. Additionally, as the deck sits on top of the beam, the crossing will be approximately 2m higher leading to an additional 100m plus of ramps.

Plate 3.1 Example of a steel composite girder footbridge

3.3 Precast concrete beams

3.3.1 These would also have a deck sat on top of them, so having the same issues with extended ramp lengths. Commercially available lengths in the UK are at a maximum between 30and 40m, so well short of the 50m plus span available.

Plate 3.2 Example of a steel precast concrete beam footbridge

3.4 Post tensioned concrete beams

3.4.1 These would also have a deck sat on top of them, so having the same issues with extended ramp lengths. These would be a very bespoke design and would not lend themselves to the installation over an operational railway or trunk road process due to the weight and in situ construction with significant wet trades brought to site.

Plate 3.3 Example of a post-tensioned concrete beam footbridge

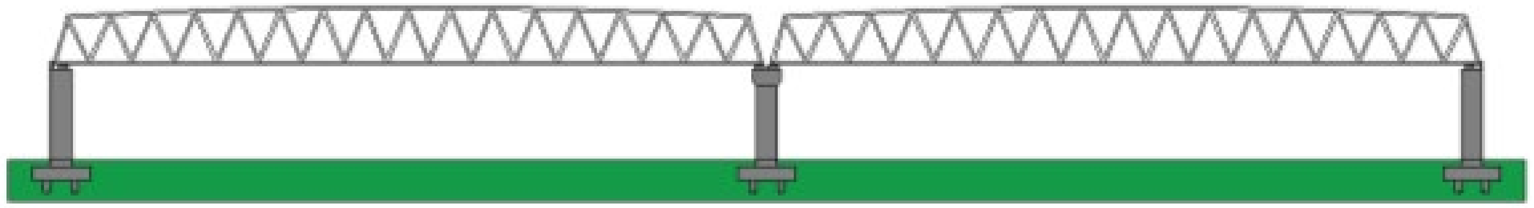
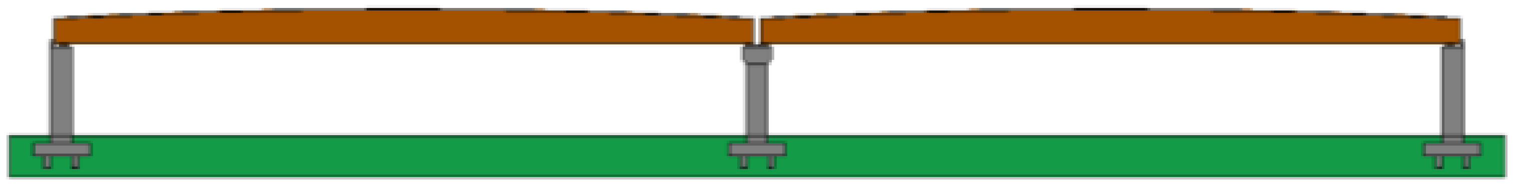
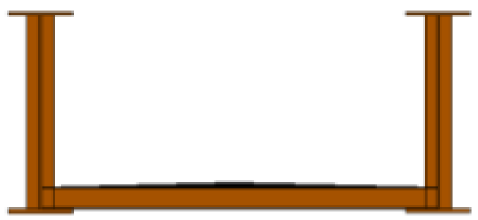
4 Options assessed (Bridge)

4.1 Overview of options

4.1.1 Four options were considered in response to the site specific considerations:

- Option 1: Warren Truss.
- Option 2: Half through steel I girders.
- Option 3: Vierendeel Truss.
- Option 4: Composite weathering steel box girder with reinforced concrete deck slab.

Table 4.1 Options assessed (Bridge)

Opt.	Description	Span Arrangement	Structure Type	Substructure Type	Elevation and cross-section
1	**Warren Truss** - This is the preferred option. A relatively light solution, it can be lifted either in one unit into place or parts can be rapidly bolted together making it suitable for installation over road or railway with limited disruption. These structures if not well designed can look utilitarian, but with good design, particularly integrating the main spans into the ramps and landscaping design, together with sympathetic paint schemes the aesthetic value can be enhanced. Whilst trusses can be fabricated from weathering steel, weathering steel is only available in plate, not RHS or CHS. Therefore, each member required has itself to be fabricated, often by hand, significantly adding to fabrication and testing costs. This is why trusses are usually painted steel.	53.5m, 47.7m No skew	Steel Warren Truss formed of multiple hollow section members with a steel deck plate.	Piers: Reinforced concrete column piers, supported on pad foundations.	 **Elevation**  **Cross-section**
2	**Through Girder** - A technically appropriate solution, however these structures can look very stark as they require deep beams. Examples include a bridleway crossing of the A34 near Chieveley (refer to Figure 5). Due to the beams and weight if the deck between, these structures would either need to be constructed insitu, or launched over the railway and A12. The size of the members would likely require the use of very large cranes. Due to the weight of steel, these would be a costly solution. Alternatively, this form of structure could be constructed adjacent to the A12 and	53.5m, 47.7m No skew	Weathering steel longitudinally tapered I girders and steel cross girders with weathering steel beam and plate deck.	Piers: Reinforced concrete column piers, supported on pad foundations.	 **Elevation**  **Cross-section**

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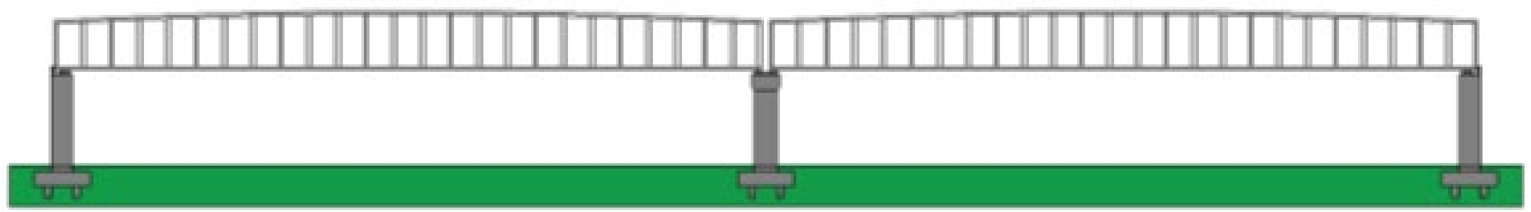
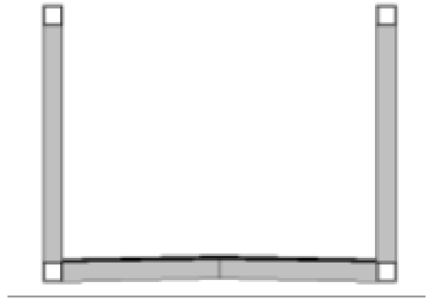
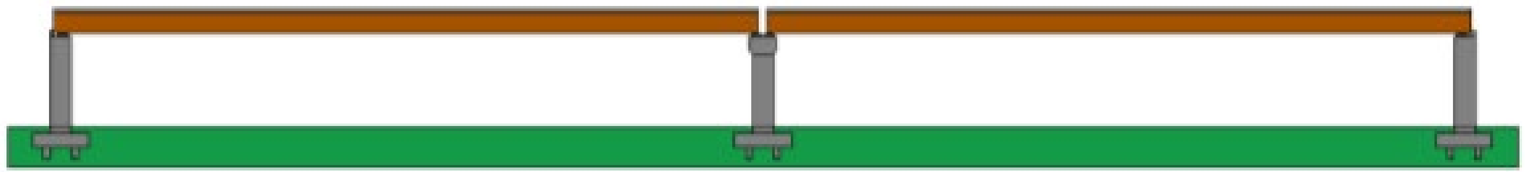
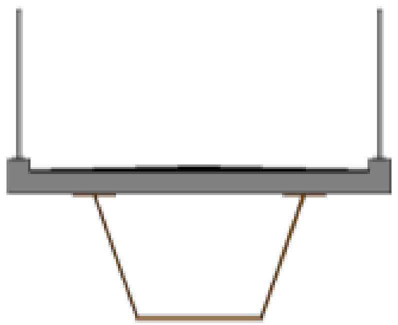
	launched over the road and then railway. Whilst these structures lend themselves to the solid infill requirement over the railway, if constructed from weathering steel, internal panels would be required to prevent people rubbing against the rusty finish.				
3	**Vierendeel Girder** – Vierendeel girders have no diagonal members and rely on a combination of axial load and bending to carry loads. The stiffness of the girder depends on the stiffness of the horizontal and vertical members. As a consequence, they are much heavier, for a given span, than a warren truss. For large spans, such as at Paynes Lane, the Vierendeel girder will probably be too flexible.	53.5m, 47.7m No skew	Steel Vierendeel Truss formed of multiple hollow section members with a steel deck plate.	Piers: Reinforced concrete column piers, supported on pad foundations.	 **Elevation**  **Cross-section**
4	**Steel Composite box girder** - Whilst installation of the box would be relatively straightforward an insitu deck pour would be required over the railway and A12. This form of structure would require significant temporary work, which could be installed with the box, but would need removal once the deck concrete has set, so therefore requiring addition rail possessions. Alternatively, these structures could be jacked into position, but the associated temporary works are significant.	101.2 m No skew	Weathering steel box girder composite with reinforced concrete deck slab.	Piers: Reinforced concrete column piers, supported on pad foundations.	 **Elevation**  **Cross-section**

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5 Preferred option (Bridge)

5.1.1 Warren Truss (Option 1) is the preferred option due it being the lightest structure, with the angled symmetrical truss formation providing the most visually pleasing structure. It will comprise a two-span simply supported Warren Truss formed of multiple welded hollow section members supported on reinforced concrete column piers.

5.2 Reasons for selection

Visual impact

5.2.1 The light and weight-saving Warren Truss bridge is the preferred solution as it provides a smaller footprint for the bridge.

5.2.2 The steel equilateral triangles create an almost ‘see-through’ type aesthetic which camouflages the structure within the surrounding environment, reducing the visual impact of the footbridge across Boreham farmland plateau LCA and Boreham House listed building.

5.2.3 Trusses also have the advantage that pedestrian parapets can be incorporated within the structural envelope, without requiring additional posts and fittings. This is particularly important at this location as the parapets will be 1.8m high for equestrian use which could have a detrimental effect on the visual impact and aesthetics of other forms of footbridge.

Structural efficiency

5.2.4 This steel truss structure is lighter than other steel or steel concrete composite options which reduces foundation loads and gives it the lowest embodied carbon.

Cost – Affordability and Value for money

5.2.5 Lowest whole life cost due to having the lowest overall steel tonnage.

Health and safety

5.2.6 The steel elements would be fabricated off site reducing site activities, however significant on-site lifting would be required.

Construction

5.2.7 It will comprise a two-span simply supported Warren Truss formed of multiple welded hollow section members supported on reinforced concrete column piers. This form of construction will provide an efficient solution with a low deck thickness which optimises the height of the piers to achieve the required headroom. This steel truss structure is lighter than other steel or steel concrete composite options which reduces foundation loads and gives it the lowest embodied carbon.

Minimise adverse impact on environment

5.2.8 A truss structure is an efficient use of steel which minimises the total steel tonnage compared to non-truss options.

5.2.9 When the bridge is demolished in the future, steel is considered to be a more sustainable material as a much higher percentage can be recycled compared to concrete, although concrete can be "down-cycled".

5.2.10 Steel beams offer a wide range of strengthening options in the future if needed.

6 Example images

Plate 6.1 Example warren truss structure (1)

Plate 6.2 Example warren truss structure (2)

Plate 6.3 Example warren truss structure (3)

Plate 6.4 A13 (Painted green)

Plate 6.5 A39 (Painted white)

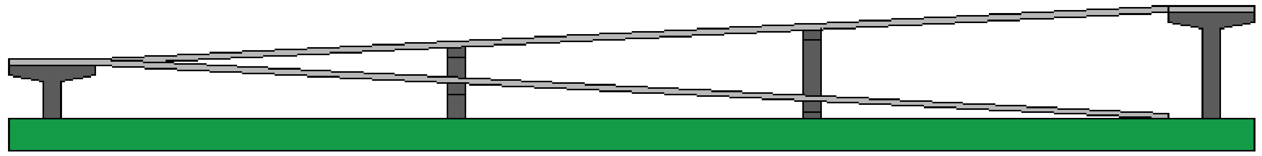
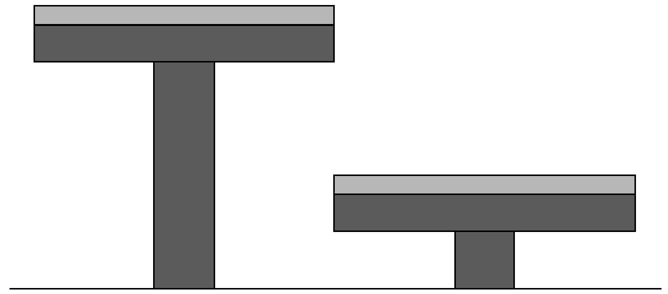
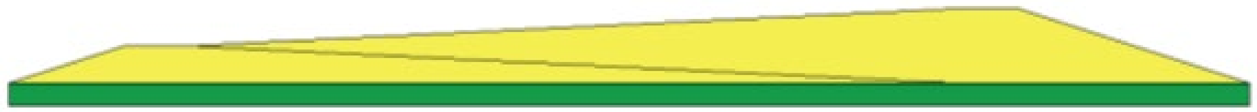
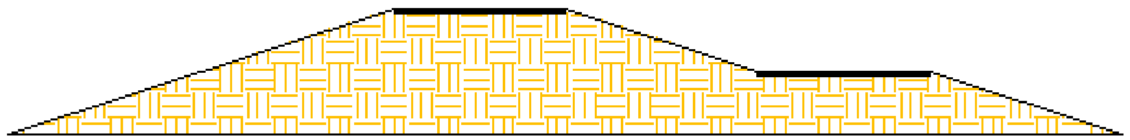
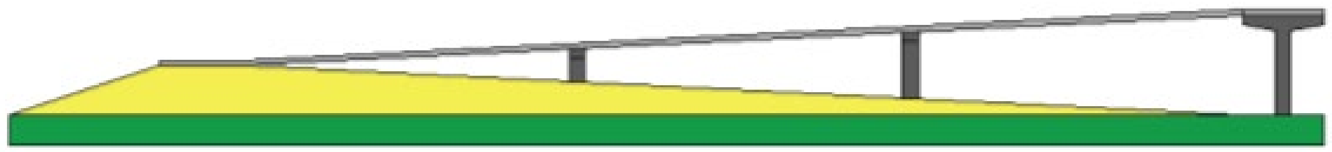
7 Options assessed (Ramp)

7.1 Overview of options

7.1.1 Four ramp options were also considered:

- Option A: Multi-span steel ramps.
- Option B: Earthwork ramps.
- Option C (i): Multi span steel ramp and earthwork ramp combination (not applicable for Paynes Lane Bridgenorth ramp or Marks Tey Bridge).
- Option C (ii): Multi span steel ramp and concrete ramp combination (only applicable for Paynes Lane Bridgenorth ramp).
- Option D: Reinforced soil retaining wall ramps with concrete facing panels

Table 7.1 Options assessed (Ramp)

Opt.	Description	Span Arrangement	Structure Type	Substructure Type	Elevation and cross-section
A	Multi span steel ramps	Multi span ~16.7m spans	Steel ramp deck formed of steel hollow section members with a steel deck plate	Piers: Reinforced concrete column piers, supported on spread footing foundations.	 **Elevation**  **Cross-section**
B	Earthwork ramps	n/a	n/a	Earthwork embankments	 **Elevation**  **Cross-section**
C	Multi span steel ramp and earthwork ramp combination	Multi span ~16.7m spans	Steel ramp deck formed of steel hollow section members with a steel deck plate with an earthwork embankment forming the lower ramp.	Piers: Reinforced concrete column piers, supported on spread footing foundations. Earthwork embankment	 **Elevation**

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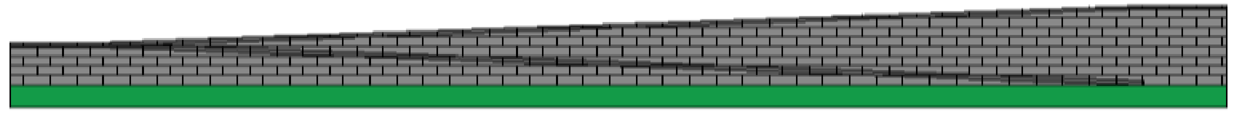
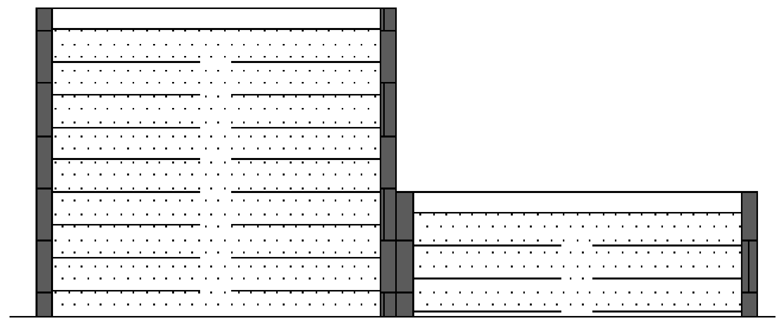
					 **Cross-section**
D	Reinforced soil retaining wall ramps with concrete facing panels	n/a	n/a	Reinforced soil vertical retaining walls with concrete facing panels	 **Elevation**  **Cross-section**

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8 Discounted options (Ramp)

8.1 Option A (Multi span steel ramp)

8.1.1 Option A is not preferred as the lower ramp would require maintenance of the ramp deck and piers at a low level below head height, which creates a space with restricted access. Therefore, this option has been discounted due to greater maintenance requirements, increased maintenance difficulty and greater health and safety risk during maintenance compared to other options.

8.2 Option B (Earth work ramp)

8.2.1 Option B is not considered the preferred option as the height of the abutments mean an extremely large volume of material would be required to provide earthwork embankments for all ramps. This makes this option less cost effective and would add significantly to the overall programme. Additionally, due to the batter required at the sides of the embankments, typically 1 in 3, the ramps would need to battered to allow for this at each switchback, in turn making the overall footprint of the ramps much larger than necessary with multi-span steel. The total footprint for the earthwork ramps is approximately 2500 m^2 at each abutment. This would extend beyond the redline boundary at the south side making this option unfeasible.

8.3 Option D (reinforced soil retaining wall)

8.3.1 Option D is not considered the preferred option as this option would have the longest programme duration due to the highly involved nature of laying reinforcement straps and compacting the fill at each layer of soil reinforcement. This option also requires a large volume of graded material due to the height of the abutments and large number of concrete facing panels making it more expensive.

9 Preferred option (Ramp)

9.1.1 Option C is the recommended ramp option and comprises a series of multi span steel hollow section deck supported on reinforced concrete piers on pad foundations forming the upper ramps. The lower ramp comprises an earthwork embankment.

9.2 Reasons for selection

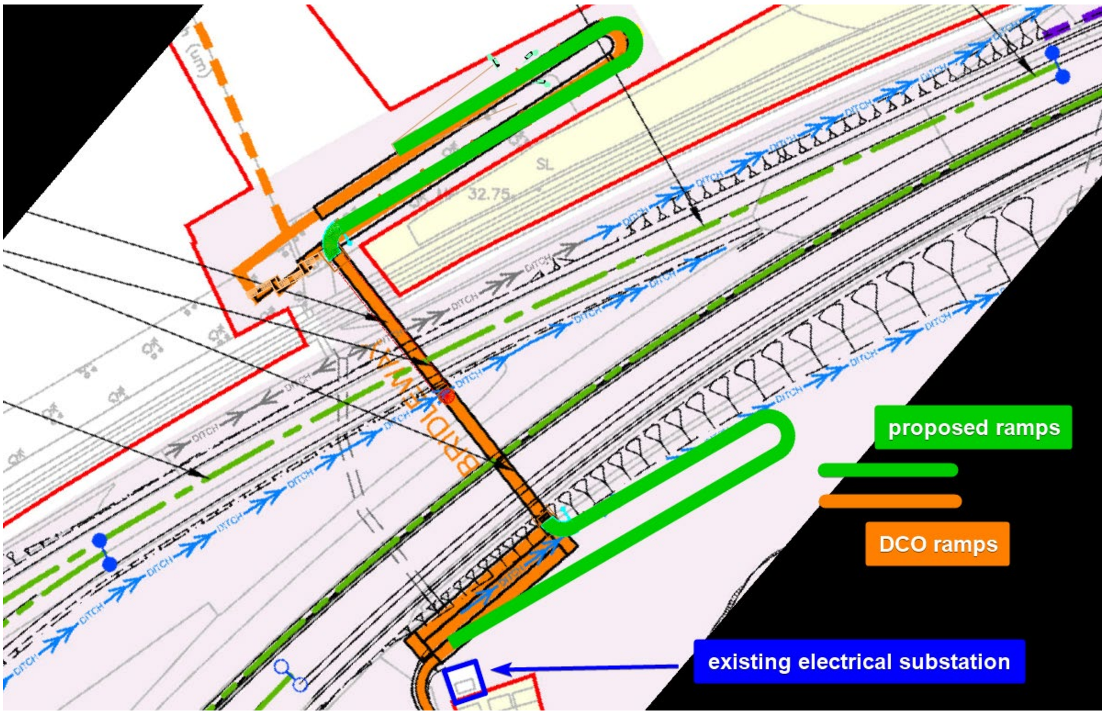
9.2.1 This form of construction for the ramps provides an efficient solution that benefits from the advantages of a multi span elevated ramp and an earthwork ramp. The elevated steel ramps utilise a cost effective and relatively low volume of material where the ramp is at high level. The earthwork lower ramp benefits from a lower cost material where the earthwork volume is relatively low and removes the need for maintenance of the steel ramp deck and piers where the ramp would be below head height, which is beneficial from a health & safety and practical perspective.

9.3 Post-submission amendments

9.3.1 As a result of consultation with Essex County Council (ECC) and CCC, the Applicant has made a commitment to implement up to 5m radius on Paynes Lane.

9.3.2 Additionally, the Applicant is considering a southern ramp alignment in the detailed design which reduces the amount of foldbacks in a similar fashion to the northern ramp alignment (see Plate 9.1).

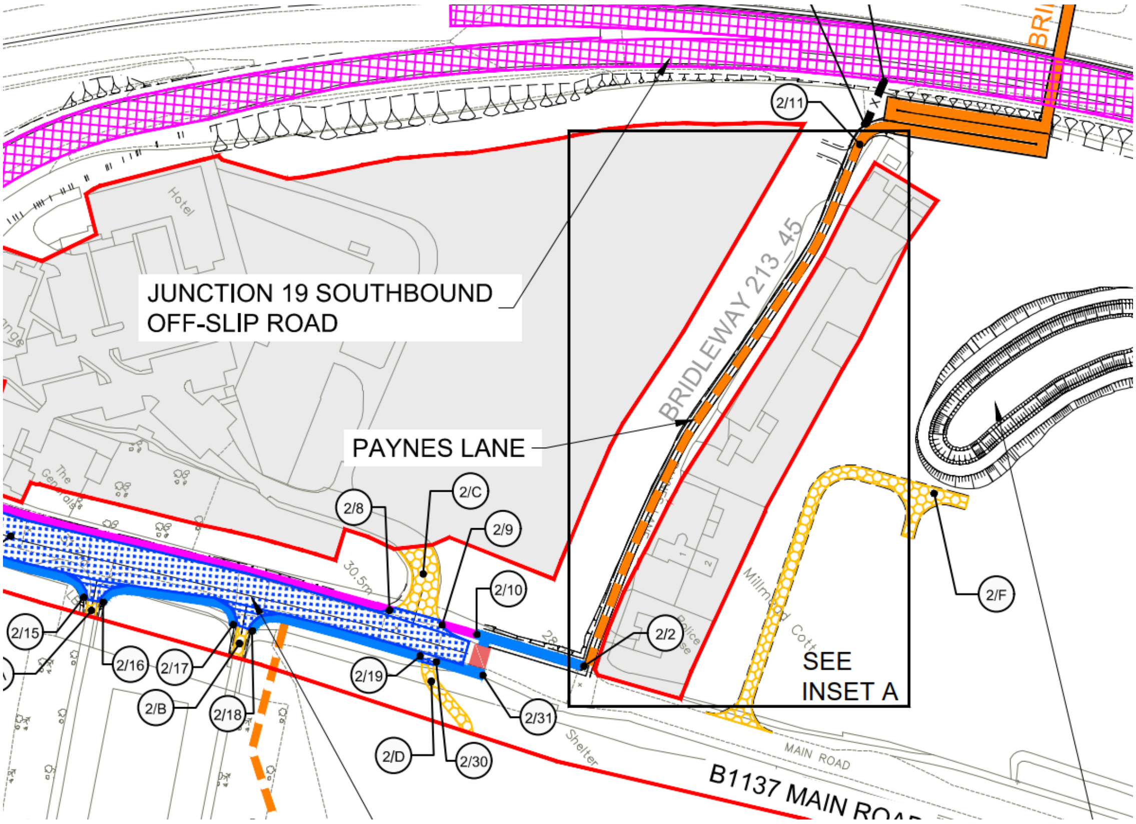
Plate 9.1 Updated ramp design (Paynes Lane)



11 Connecting to surrounding infrastructure

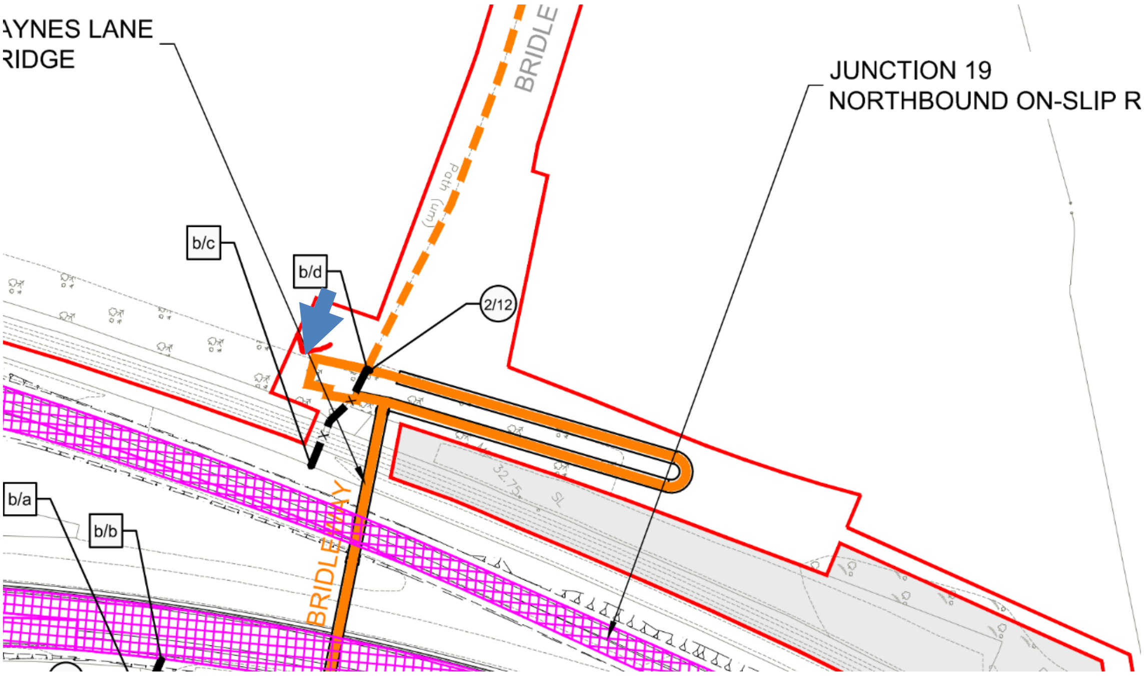
11.1.1 On the southern (Boreham) side, the extent of works is to provide a ramp that ties in to the existing Paynes Lane with bound surface from the ramp to the B1137. There is currently a significant length of Paynes Lane beyond the first few houses which is not formally surfaced. The Applicant is proposing to connect this to the ramp with a bound surface material fit for cycling and horse-riding. Sheet 2 of the Streets, rights of way and access plans shows physical works between 2/2 and 2/11 to allow for this (see Plate 11.1).

Plate 11.1 Southern ramp connection



11.1.2 On the northern side, the ramp will connect to the existing bridleway at 2/12, and a new cycle route (at the blue arrow) proposed as part of the Greater Beaulieu Park development.

Plate 11.2 Northern ramp connection



12 Maintenance

12.1.1 National Highways will be the asset owner of Paynes Lane structure, and therefore responsible for the maintenance of the structure and associated ramps.

12.1.2 Essex County Council as the Local Highway Authority will be responsible for the maintenance of the footpaths to the north and south of Paynes Lane ramps.

13 Further engagement & next steps

13.1.1 The Applicant has engaged with CCC several times both pre and post-submission of the DCO application to hear and address concerns regarding the functionality and aesthetics of the proposed structure.

13.1.2 As a result of the most recent engagement, CCC sent a list of elements they wish to be consulted on in the future. These are set out in Table 10.1 alongside the Applicant's response and proposed next steps.

Table 13.1 Further engagement & next steps

CCC requested engagement	National Highways response	Next steps
Colour of the Beans, Ramps, Columns (colour of the Structure)	Paynes Lane will need to be coherent with the rest of the footbridges on the proposed scheme, as the proposed scheme is providing a family of structures which will provide a consistency along the route.	Further engagement with CCC and ECC to agree collaborative approach.
The style of Lighting on the bridge and ramps	The proposed scheme proposes inset lighting within the parapets which is a sympathetic solution.	Further engagement to understanding CCC aspirations for lighting.
The form of the columns for the bridge and the ramps	Form and shape of the bridge piers will be informed by the structural and geometric constraints of the bridge. Intention is to provide an earthworks embankment to the lower sections of the ramp which will support planting which would likely screen the piers. Therefore, NH consider that the structural and construction factors would outweigh the visual.	The Applicant to share proposed designs to inform further discussions. The Applicant has provided indicative design proposals (See Appendix A: 3D Visualisations).

The layout of the steel used on the bridge (square, round, H)	The Applicant considers that rectangular hollow sections would form the majority of the structural members due to fabrication efficiencies.	The Applicant to share drawings of proposed structural detailing for comments which would be considered where reasonably practicable.
The installation of Local Art on the bridge or Ramps	The Applicant would propose any installation of Local art be off the structure due to the maintenance implications here.	The Applicant is content for CCC to propose, install and maintain Local Art off the structure/ramps (and on footpaths only), upon the completion of the proposed scheme construction.
The type and colour of surface on the ramps and bridge, considering it's a bridleway (asphalt, Resin bond, etc)	Surfacing on the proposed Payne's lane bridge deck will be specialised rubber matting designed for equestrian use with waterproofing system beneath.	Further engagement with CCC on the colouring of the surface, however, note that this may be limited by availability.
The style and material of the parapets on the bridge and on the ramps (vertical, diagonal, round or square)	Options will be limited due to the need to comply with Network Rail requirements.	The Applicant to share proposed designs to inform further discussions.
Details of the landscape around the ramps to be agreed (to be built upon the materials Pallet)	As per LV16 of the Environmental Management Plan (EMP) [APP-184], the relevant Planning Authority will be consulted on the landscaping as detailed in The Landscape and Ecology Management Plan (LEMP) [APP-193].	As per LV16 of the Environmental Management Plan (EMP) [APP-184], the relevant Planning Authority will be consulted on the landscaping as detailed in The Landscape and Ecology Management Plan (LEMP) [APP-193].

14 Summary

14.1.1 The Paynes Lane bridge is proposed to use the Warren Truss type of structure which is coherent with the other footbridges on the proposed scheme providing a family of structures along the A12 route.

14.1.2 The light and weight-saving Warren Truss bridge is the preferred solution as it provides a smaller footprint for the bridge. The steel equilateral triangles create an almost 'see-through' type aesthetic which camouflages the structure within the surrounding environment, reducing the visual impact of the footbridge across Boreham farmland plateau and Boreham House listed building.

14.1.3 Bridge span requirements are set by the clearance envelope of the undercrossing facility and legislative requirements. The bridge is affected by key-specific constraints such as the Great Eastern railway line, existing A12 carriageway and the proposed Beaulieu Park and Network Rail station development located approximately 90 m from the north end of the bridge. A truss was selected as the preferred option as it minimizes construction depth, thereby reducing the length of the approach ramps, facilitates off-siting and accelerated construction, minimizes maintenance interventions and provides a light and graceful appearance. The Warren Truss presented is particularly effective as all the diagonals have been set at the same angle and verticals have been omitted which reduces visual confusion.

14.1.4 The Applicant will continue to engage with CCC throughout examination and detailed design regarding detailed design elements discussed in Table 10.1.

Appendix A: 3D Visualisations

Plate 14.1 3D Visualisation looking north

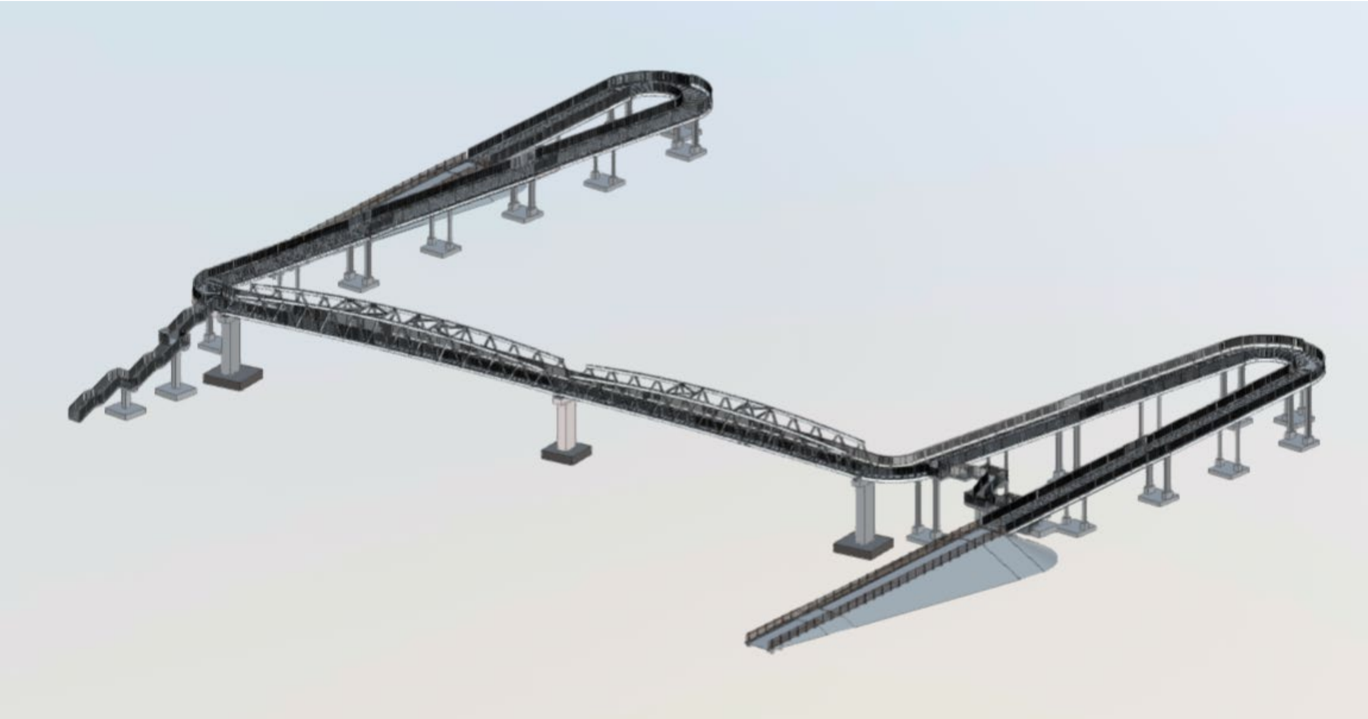


Plate 14.2 3D Visualisation looking south

Plate 14.3 3D Visualisation of northern ramp/stairs

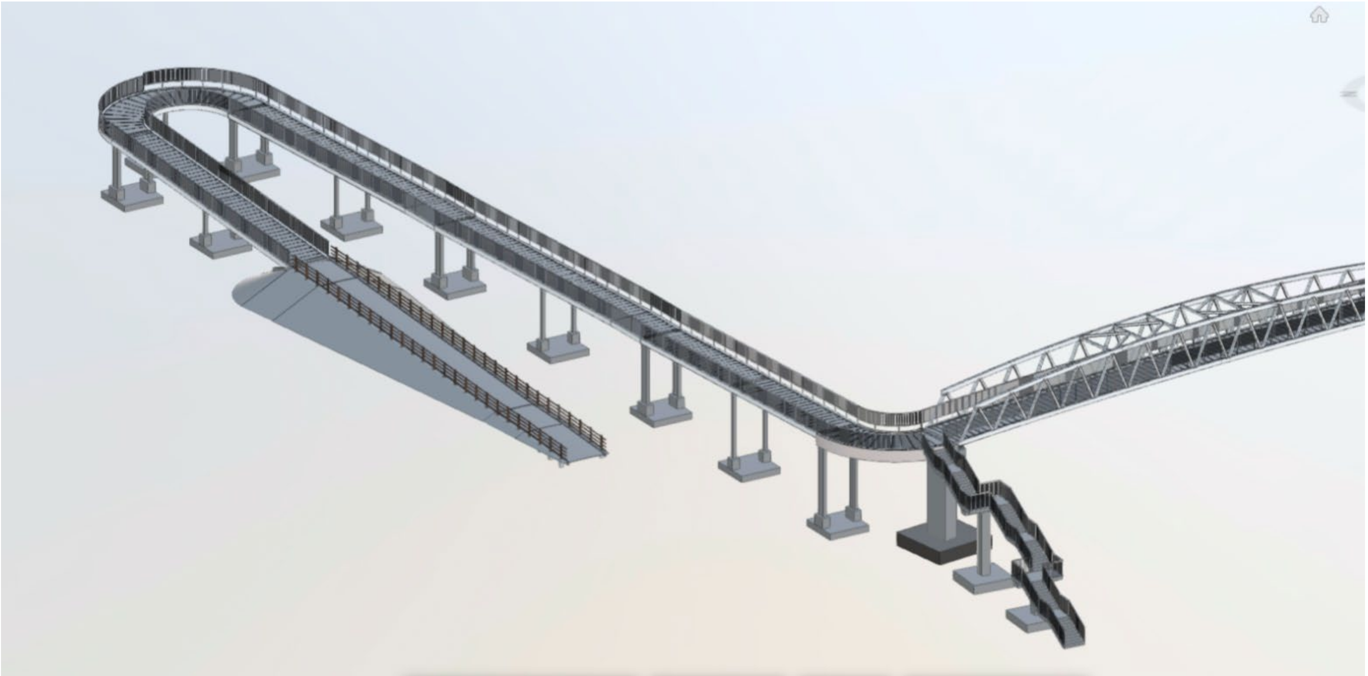


Plate 14.4 3D Visualisation of bridge pier

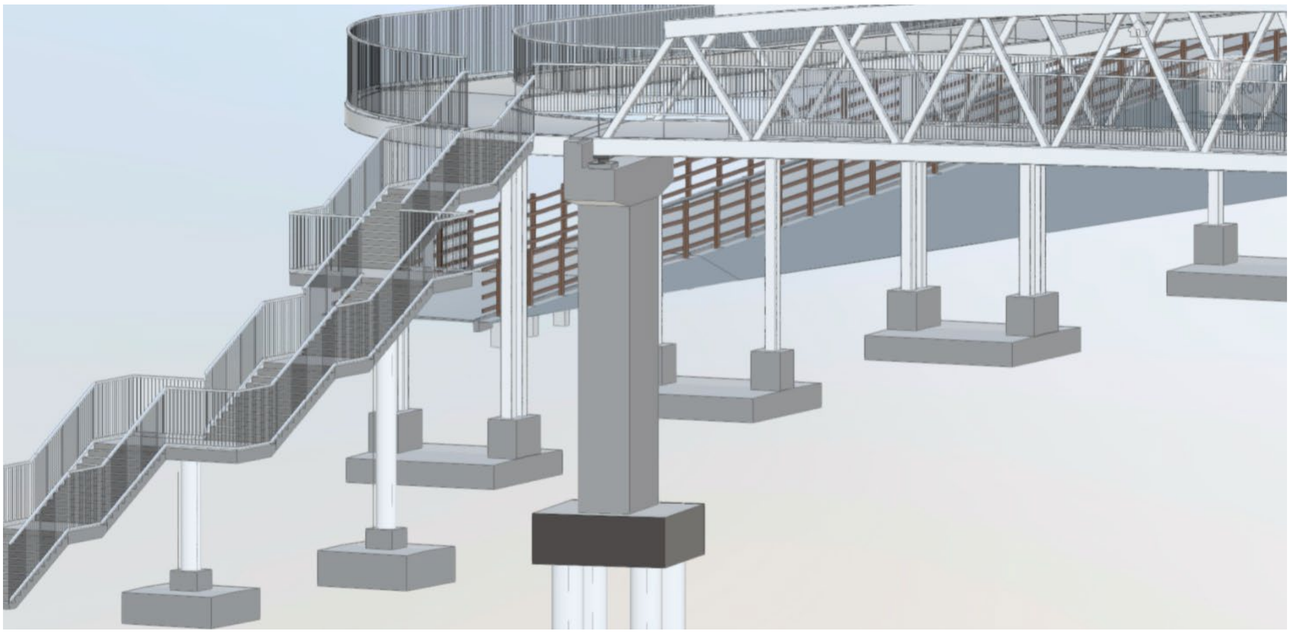


Plate 14.5 3D Visualisation of bridge pier