

EM Highway Services Limited

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Area 1 Green Bridges

Interim Feasibility

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EM Highway Services Limited

Ash House
Falcon Road
Exeter
EX2 4LB

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1 Introduction

Green bridges (or ecoducts) are structures designed to facilitate the easy and safe crossing of main roads by wildlife and non-motorised users. They are topped with deep soil, rather than a metalled surface, in order to enable soft landscaping and the planting of vegetation if required.

The first structures of this type were constructed in France during the 1950s. Since then several EU countries including the Netherlands, Switzerland, Germany, as well as the USA and Canada, have used various styles of green bridge to reduce the conflict between wildlife and roads. Despite the tried and tested use of these structures, they have been relatively slow to catch on in the UK with only a handful having ever been constructed, such as the structure over the Lamberhurst bypass on the National Trust's Scotney Castle property (see figure 1.1 & 1.2 below).

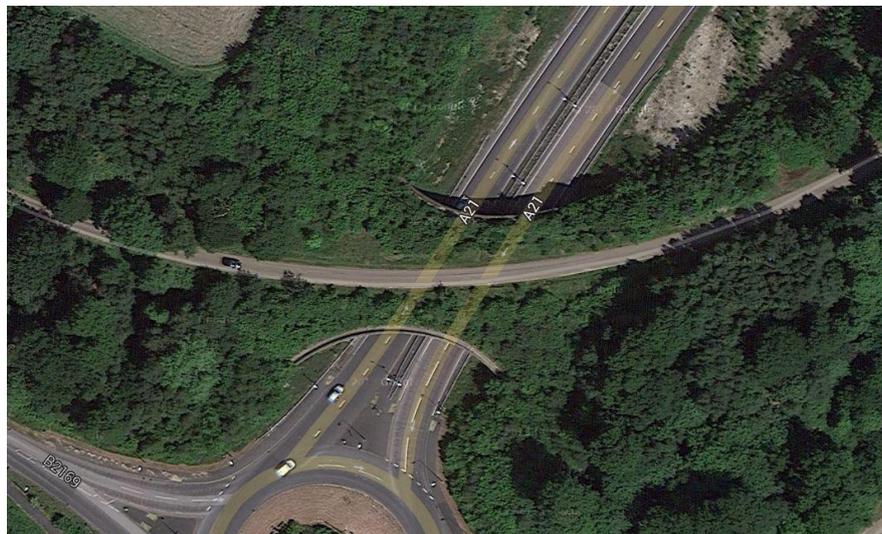


Figure 1.1: Aerial view - Green Bridge over the Lamberhurst bypass, Kent.



Figure 1.2: Street view - Green Bridge over the Lamberhurst bypass, Kent.

1.1 Haldon Hill - Background

The Haldon Hills are a ridge of high ground situated between the River Exe and the River Teign which runs north from Teignmouth for approximately 24km until it ends just south of Crediton at the River Yeo.

The ridge reaches its highest point (250 metres), just south of Exeter. This is where the A38 dissects the ridge in two (see figure 1.3 below).



Figure 1.3: Haldon Hill Location Map

1.1.1 Deer Vehicle Collisions (DVCs)

In Area 1 DVCs have increased in the past three years by 30% with 80 deer hit by traffic in 2012-13. The figure is the highest recorded in Area 1 so far, however many collisions may go unreported.

Such deer related traffic accidents have a considerable impact:

- they present one of the main causes of mortality among wild populations of deer
- they pose a major animal welfare issue, because a high proportion of deer which are hit by cars are not killed outright: many have to be put down at the roadside, while others escape to die later of their injuries.
- they pose a safety hazard to road users, and lead to substantial damage to cars and numerous human injuries as well as a number of human fatalities each year.

It is a longstanding and increasing issue because of the lack of safe passages across the road causing injury to humans and animals and causing damage to property. Other common wildlife species killed by moving traffic include badgers and foxes.

In June 2012 Fallow deer were filmed running along the verge of the eastbound carriageway at Haldon Hill in daylight (see figure 1.4 below). This is a common sight.



Figure 1.4: Fallow Deer at Haldon Hill

On average there are between 13 and 27 DVCs at Haldon every year (see map below, taken from the *Area 1 Deer and Existing Trunk Roads Structures Study: 2010*).

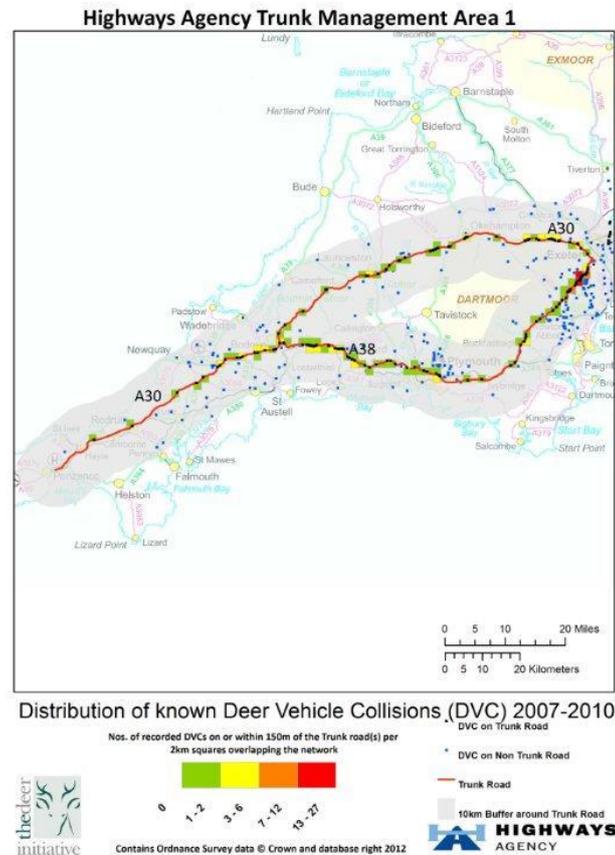


Figure 1.5: Distribution of Deer Collisions in Area 1

The map above (figure 1.5) demonstrates that Haldon Hill (coloured red) is a hot spot for DVC's with more collisions than anywhere else on the Area 1 network. In fact, when compared with similar maps for other regions Haldon is identified as a hot spot nationally.

A green bridge at Haldon Hill will have a positive effect on the number of DVCs that take place on the A380 as well as other county roads surrounding Haldon.

The Haldon Forest has been designated as a SSSI because it supports an exceptional assemblage of breeding birds of prey, including several rare species, a nationally important population of breeding nightjar and rich communities of invertebrates, especially butterflies. In addition, the site incorporates two pockets of lowland heathland, a nationally-scarce and threatened wildlife habitat (see Table 1.1 below taken from Haldon's Strategic Nature Area profile).

Table 1.1: Haldon's Strategic Nature Area Species list

Important species or species assemblage	Status
Bell heather, cross leaved heather and bristle bent.	
Heathland insects.	
Breeding nightjar (3% of British population) and birds of prey in Haldon Forest SSSI: honey buzzard, goshawk, hobby, sparrowhawk, buzzard, kestrel.	Amber list (honey buzzard, kestrel)
Butterflies in managed woodland rides of Haldon forest e.g. high brown fritillary, marsh fritillary and on heathland areas e.g. silver studded blue.	S.41 (high brown fritillary, marsh fritillary, silver-studded blue) DBAP (marsh fritillary)
Dragonflies recorded in ponds throughout Haldon forest (16 species).	
Diverse moth fauna in Haldon forest (277 species of macro moth recorded) including: Brindled beauty, rosy minor, dot moth, dotted carpet, pale pinion, beautiful brocade	S.41 (brindled beauty, rosy minor, dot moth) Nationally notable (dotted carpet, beautiful brocade)
Wetland plant communities with bog mosses, bog asphodel, devil's bit scabious, round-leaved sundew, pale butterwort.	
Bog bush-cricket	Nationally notable
Viviparous lizard, adder and slow worm	S.41
Greater & lesser horseshoe bat	S.41 DBAP (Greater horseshoe)
Dormouse	S.41, DBAP

The figure 1.6 below demonstrates how the A38 cuts this SSSI in two. Creating a manmade barrier for many of the species listed above.

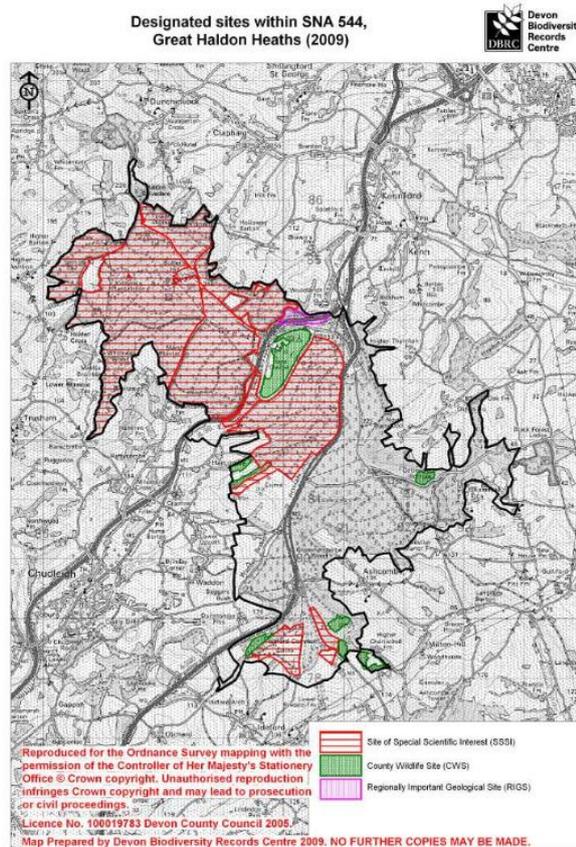


Figure 1.6: Haldon Hill Site of Special Scientific Interest (SSSI)

1.1.2 Haldon Forest Park – Forestry Commission

Haldon Forest Park is partly owned and managed by the Forestry Commission (FC). The number of visitors to Haldon Forest Park participating in active recreation, such as walking, running, cycling (21 miles off-road trail) and horse-riding, has reached 250,000 visitors per year.

The figure 1.7 below shows the area of woodland managed by the FC. Currently only a small proportion of this (to the north of the A38) is open to visitors. The area of woodland to the south of the A38, known as the Harcombe block, is currently isolated and under used due to problems with access.

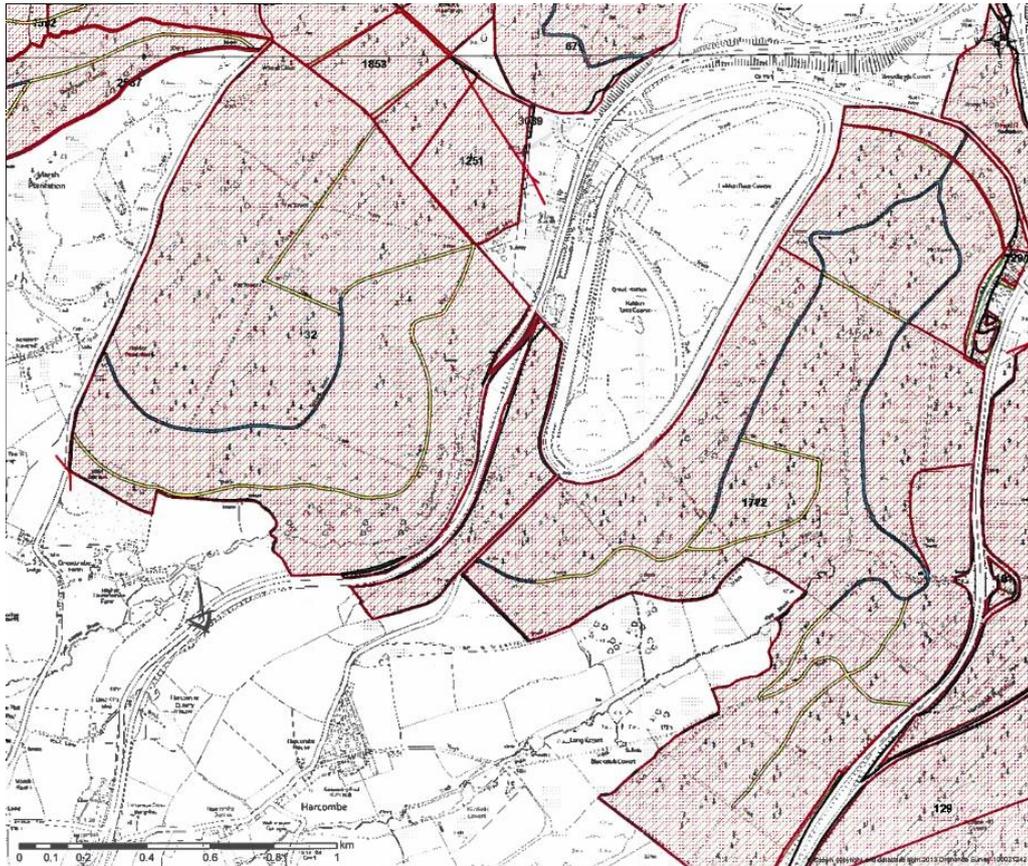


Figure 1.7: FC Managed land at Haldon Hill

1.2 Saltram - Background

Saltram overlooks the River Plym and is set in a rolling landscape park that provides precious green space on the eastern outskirts of Plymouth (see figure 1.8 below).

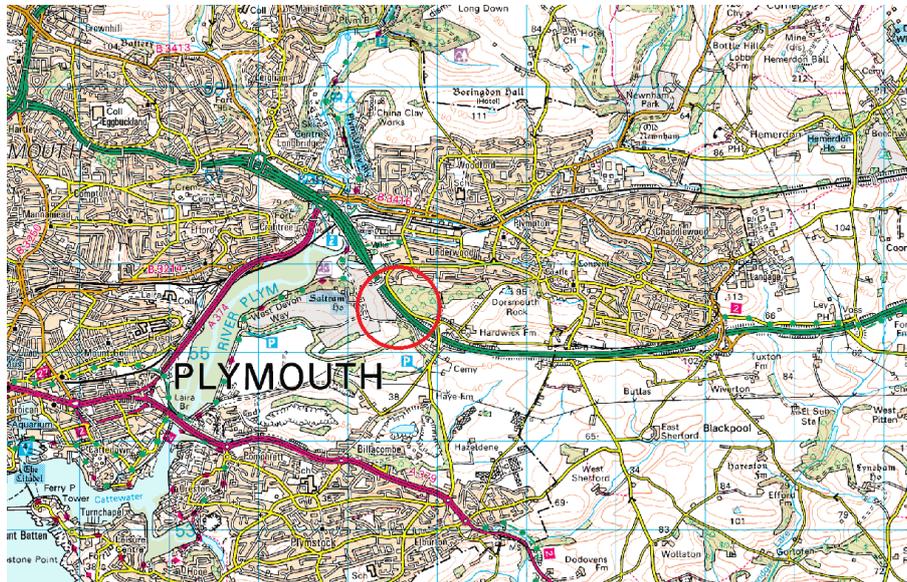


Figure 1.8: Saltram location map

1.2.1 Saltram House – National Trust Property

Saltram came to the National Trust in 1957. It is a Grade 1 historic house, in a Grade 11* Registered Park and Garden with many other listed buildings on the estate and the house contains one of the most important collections of contents owned by the National Trust. The main Saltram Estate and part of Hardwick Wood are owned inalienably by the National Trust.

In the late 1960's the A38 trunk road was installed from the east of Devon where the M5 ends to enable access to Cornwall. The new A38 sliced through the National Trust owned Saltram Estate cutting through a historic carriage ride which connected Hardwick Woods to the main estate and causing all historic and physical connections between the main Saltram Estate and Hardwick Woods to be lost.

The access to the main parkland is now through the historic Merafield Gated entrance and via a modern concrete structured bridge over the A38, whilst the small bisected area of the estate, Hardwick Wood, had to be accessed entirely separately via a secondary road, known as Hays Road.

Plans for a green bridge at Saltram House were first drawn up by the National Trust & PCC in the Saltram House Master Plan (see figure 1.9 below – location of green bridge circled in red).

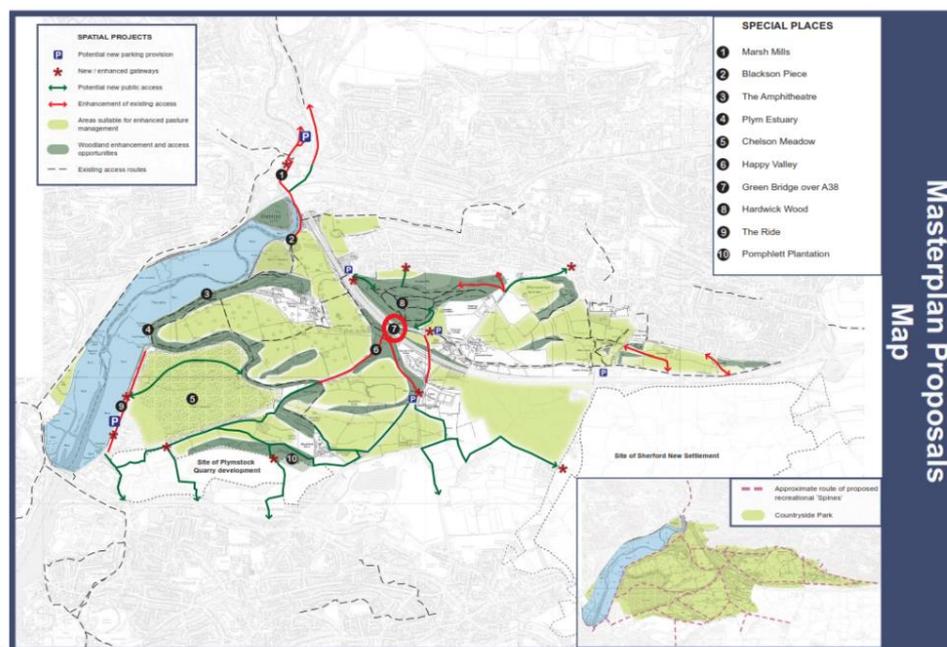


Figure 1.9: location of green bridge in the Saltram House Master Plan

This location was chosen because it is on the alignment of the historic driveway into the estate and it would be ideal for non-motorised users accessing Hardwick Woods, which was isolated from the rest of the estate when the A38 was constructed. Currently footpaths and tracks end as they reach the A38 and there is no safe way of crossing.

The main Saltram Estate is now visited by some 230,000 vehicles a year. Including further pedestrian visitors, Saltram receives approximately 700,000 people a year visiting. Due to space constraints, it is only possible to provide for 175 car parking spaces.

Studies have shown that 89% of the visitors to the National Trust property at Saltram are from within 14 miles. Currently access for non-motorised is extremely limited mainly due to the construction of the A38. On busy days visitors to this historic estate are turned away due to the limited parking.

1.2.2 Plymouths Green Infrastructure

In anticipation of the growth that Plymouth will undergo in the next decade, Plymouth City Council (PCC) have created a Green Infrastructure Plan. This plan sets out a blueprint for the management of existing spaces, the creation of future spaces, how the landscape will be linked and how it will be used by the local population.



A key objective for the management of the Countryside Park is to provide new opportunities for public recreation and enjoyment and the development of a network of high quality recreational routes. As the area changes in light of new developments, opportunities will be created to improve the cohesiveness of the Countryside Park, the connectivity between the distinct areas and visitor orientation and experience. This will help foster a new identity for the Park.

The developments at Sherford and at Plymstock Quarry will significantly change the character of the area. Demand for recreational opportunity and access to (and through) the countryside will significantly increase as communities who live within walking and cycling distance of the Countryside Park increase.

One of the key opportunities identified by the Master Plan was to encourage visitors to fully explore the Countryside Park by removing and /or improving actual or perceived physical barriers (e.g. the A38). This would enable people to move freely around the Park and reconnect with less visited areas.

The A38 is a very significant barrier in achieving this aim and a green bridge is possibly the only way to achieve the reconnection of the two parts of the historic estate to enable access and exploration. Without the bridge this aim of an accessibly Park will only ever be achieved in part.



2 Haldon Hill

The aim of this project is ultimately reduce the number of DVCs in Area 1 by encouraging deer to use green bridge structures rather than cross the live carriageway, improve connectivity between the two sections of the SSSI for many rare and notable species and bring huge social and economic benefits to the local population brought about by the increased capacity of the Haldon Forest Park for leisure activities.

This scheme would be in partnership with the Forestry Commission (FC). Creating a new green bridge with pedestrian and cycle access reconnecting Haldon Hill Forest, ridge and the SSSI would help to remove the physical barrier created by the A38 for both people and wildlife.

An initial consultation meeting has been held with the Forestry Commission who provided a statement of support to help with the compilation of this document.

2.1 Potential Benefits

This bridge will provide improved access and free movement for people and wildlife. Local residents and recreational users can walk and cycle through the landscape and improve their wellbeing. The bridge will reconnect people with the surrounding landscape.

A green bridge at Haldon could realise the following benefits:

2.1.1 Social Benefits

The proposed green bridge connects two of the main FC blocks on the ridge, with the Harcombe block currently being isolated due to the barriers of the A38 and A380 and therefore under-utilised for public access and recreation.

Currently horse riders, walkers and cyclists wanting to pass from the main Haldon Hub forest block to the Harcombe forest block need to pass under the A38 and negotiate the hazardous roundabout associated with the A38 eastern slip road; combined with the anti-social behaviour of the council car park and traveller's camp this road does not make for a friendly family recreation experience. The construction of a green bridge crossing makes it possible for an exciting new Haldon Ridge Trail to be established linking the Haldon Belvedere (Lawrence Castle) at the north with Mamhead Obelisk to the south.

2.1.2 Economic Benefits

In addition to timber production the primary revenue generated at Haldon is through recreation activity and associated businesses.

The success of the Haldon Forest Park project has been achieved in barely eight years, growing from a redundant yard to a thriving activity centre situated within 3,500 acres of forest. The recreation activity provides jobs for three full-time FC staff (+2 seasonal) and

eight regular volunteers. The four business partners (Go Ape, Ridge Café, cycle hire and Segways) employ 11 full time staff, plus many more seasonal workers.

It is anticipated that the proposed green bridge would further benefit income and jobs through the increased opportunities for activities and events; these could be allocated space within Harcombe woodland, but still be connected to the main visitor hub by existing off-road forest tracks, a distance of only 2km.

Historically Harcombe has been the woodland block where horse-riding has been encouraged on 10 miles of permissive trail and ¼ mile gallop; any improved links to surrounding rights of way will further benefit local riding stables and riders.

In addition, the green bridge could mutually benefit the FC and Haldon Racecourse camping and caravanning by connecting overnight accommodation with outdoor recreation activities. Other neighbouring businesses could also benefit from the connectivity (e.g. Haldon Forest Diner).

As discussed in section 1.1.1, there are between 13 and 27 DVCs per year on the A38 at Haldon. The creation of a green bridge would reduce the delay to traffic due to a reduction in these collisions. The reduction in deer casualties would also benefit the FC whose wildlife ranger is often involved in tracking down and despatching injured deer.

There is also the potential for economic benefits for the HA associated with close partnership working with organisation such as the Forestry Commission (i.e. positive press coverage).

2.1.3 *Environmental benefits*

One of the key benefits of the Green Bridge would be to create sustainable transport links, both along the ridge and across the ridge - between local communities Kennford and Chudleigh, where the cycle network is currently not well connected.

A safe wildlife crossing will not only reduce the number of protected species being killed by traffic and help the HA meet its environmental and Biodiversity Action Plan goals, but also create opportunities for extending existing open space SSSI habitats. This will be achieved through heathland restoration, grazing and ride-widening to create additional habitat for valuable butterfly and ground nesting bird species.

The study and maintenance of the large central reservation of the A38 at Haldon Hill, with its thriving dormouse population has always proved difficult, even more so now EM Highways has introduced their zero carriageway crossing policy. The green bridge at Haldon will allow easy, safe access to the central reservation in order to continue and maximise these activities.

2.2 Key constraints

2.2.1 Land Ownership

The land on either side of the A38 is occupied on a leasehold basis by FC for forestry purposes only. The development of the bridge and the creation of recreation access through the leasehold land will require a variation of the FC lease necessitating the cooperation of the freeholder. Although there has been an informal acknowledgement of the proposal from the freeholder and an expression of interest it is likely that detailed negotiations and possible land transfers will be needed to achieve the development and the outcome of this at this stage cannot be guaranteed. The figure 2.1 below demonstrates FC land that is either leasehold or freehold.

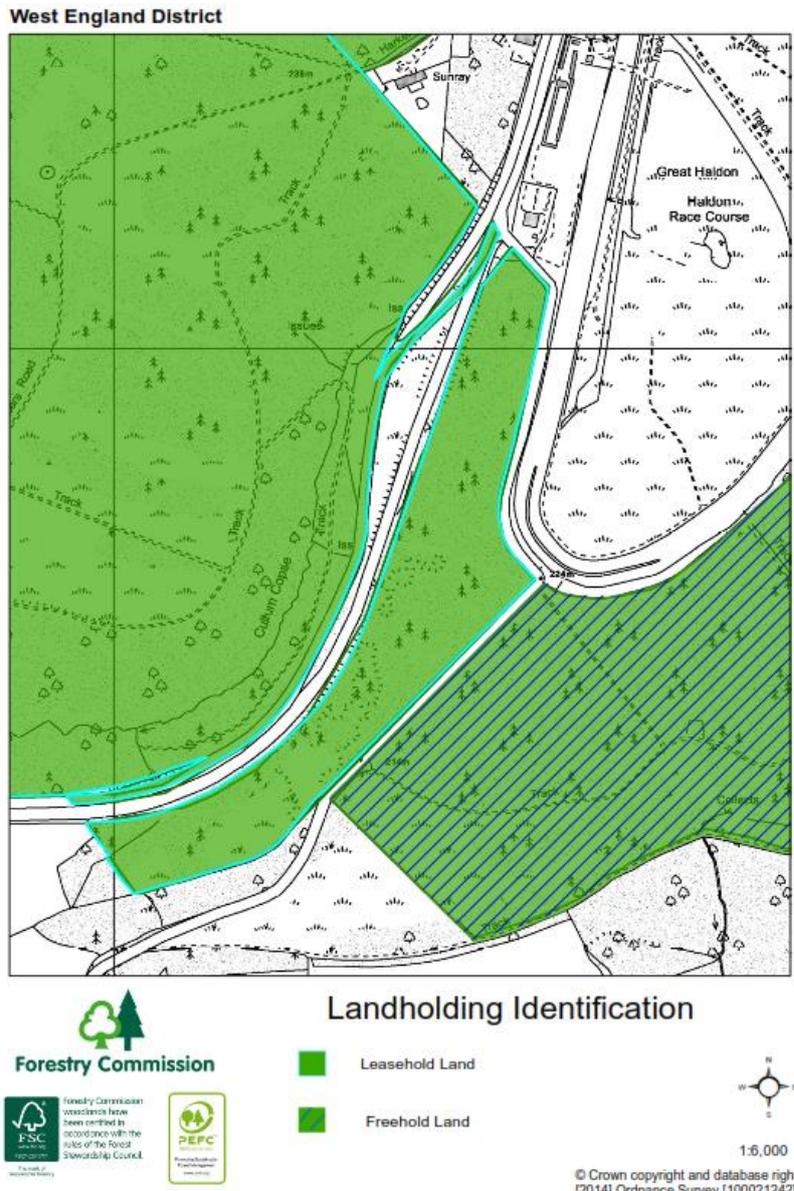


Figure 2.1: FC land leasehold or freehold

2.2.2 Environmental Constraints

Table 2.1 below outlines the key environmental constraints at Haldon that will need to be taken into consideration and investigated further as part of a full environmental assessment. The dormouse population in the central reservation at Haldon will be a key environmental constraint.

Table 2.1: Key environmental constraints at Haldon

Proposed Location	Nearest MP	AQ/Noise Sensitive Receptors	Cultural Heritage within 300m	Designated Sites	Species Records within 2km	Habitats	Invasives within 2km
Haldon 1	105/2	Haldon Forest SSSI, Exeter Racecourse, few residential properties within 1km.	None	<p>Within 30km of the South Hams Bat SAC, just outside of a sustenance zone and very close to radio tracked flight paths/strategic flyway</p> <p>Haldon Forest SSSI adjacent to soft estate on both carriageways.</p>	<p>Dormouse</p> <p>Slow Worm</p> <p>Common Lizard</p> <p>Badger</p> <p>Orchids</p> <p>Common Toad</p> <p>Known DM and GCN area</p>	<p>Within soft estate: Heath and Moorland, Woodland, Scrub. Species rich grassland at 105/3 (within central res)</p>	<p>Giant Hogweed</p>

				Ancient Woodland within 2km but not within 1km			
Haldon 2	105/6	Haldon Forest SSSI, Exeter Racecourse, few residential properties within 1km.	None	<p>Within 30km of the South Hams Bat SAC, just outside of a sustenance zone and very close to radio tracked flight paths/strategic flyway</p> <p>Haldon Forest SSSI adjacent to soft estate on both carriageways.</p> <p>Ancient Woodland within 2km but not within 1km</p>	<p>Dormouse</p> <p>Slow Worm</p> <p>Common Lizard</p> <p>Badger</p> <p>Orchids</p> <p>Common Toad</p> <p>Known DM and GCN area</p>	<p>Within soft estate: Heath and Moorland, Woodland, Scrub, Species Rich Grassland, Open Grassland</p>	
Haldon 3	107/0	Haldon Forest SSSI, Exeter Racecourse, few residential properties within 1km.	None	<p>Within 30km of the South Hams Bat SAC</p> <p>Haldon Forest SSSI approximately 100m north of eastbound soft estate.</p> <p>Ancient Woodland within 2km but not within 1km</p>	<p>Dormouse</p> <p>Slow Worm</p> <p>Common Lizard</p> <p>Badger</p> <p>Known DM and GCN</p>	<p>Within soft estate: Woodland, Scrub, Species Rich Grassland, Open Grassland, Waterbody/Marsh and Wet Grassland</p>	

2.3 Preferred Locations

The A38 was originally constructed in a deep cutting where it crossed the ridge at Haldon Hill. This resulted in the forest and woodland that extends from approximately 5 kms west of the A38 to approximately 9kms south of the A38 / A380 bridge at Telegraph Hill being severed.

This tract of woodland is divided into several smaller areas by the A38, the A380 and by a small number of minor county roads.

The provision of a new bridge over the A38 will enable the section of woodland segregated by the A38 to the west and the A380 to the east to be connected to the main recreational area west of the A38.

The land encompassed by the race course is fenced and gated and therefore forms a barrier to the free passage of wild life. The new crossing point of the A38 will therefore need to be located either to the north of the race course or to the south.

2.3.1 General Considerations

Sites for Green Bridges will be selected to maximise the potential for the existing topography and ground contours to allow the new structure to blend into the landscape.

The aerial photographs produced as part of the flown Lidar survey undertaken in Area 1 together with contour ordnance survey plans were reviewed to allow an initial selection of a small number of sites.

The Lidar survey provided information for a width of approximately 100m centred about the carriageway.

The survey data was then analysed to produce a long section at the preferred locations.

These long sections were then extended by use of ordnance survey contour plans to produce an approximate profile that can be used to review the bridge type best suited to the site.

Figures 2.2 and 2.3 below demonstrate the locations of the sites identified for further investigation as part of this interim feasibility study.

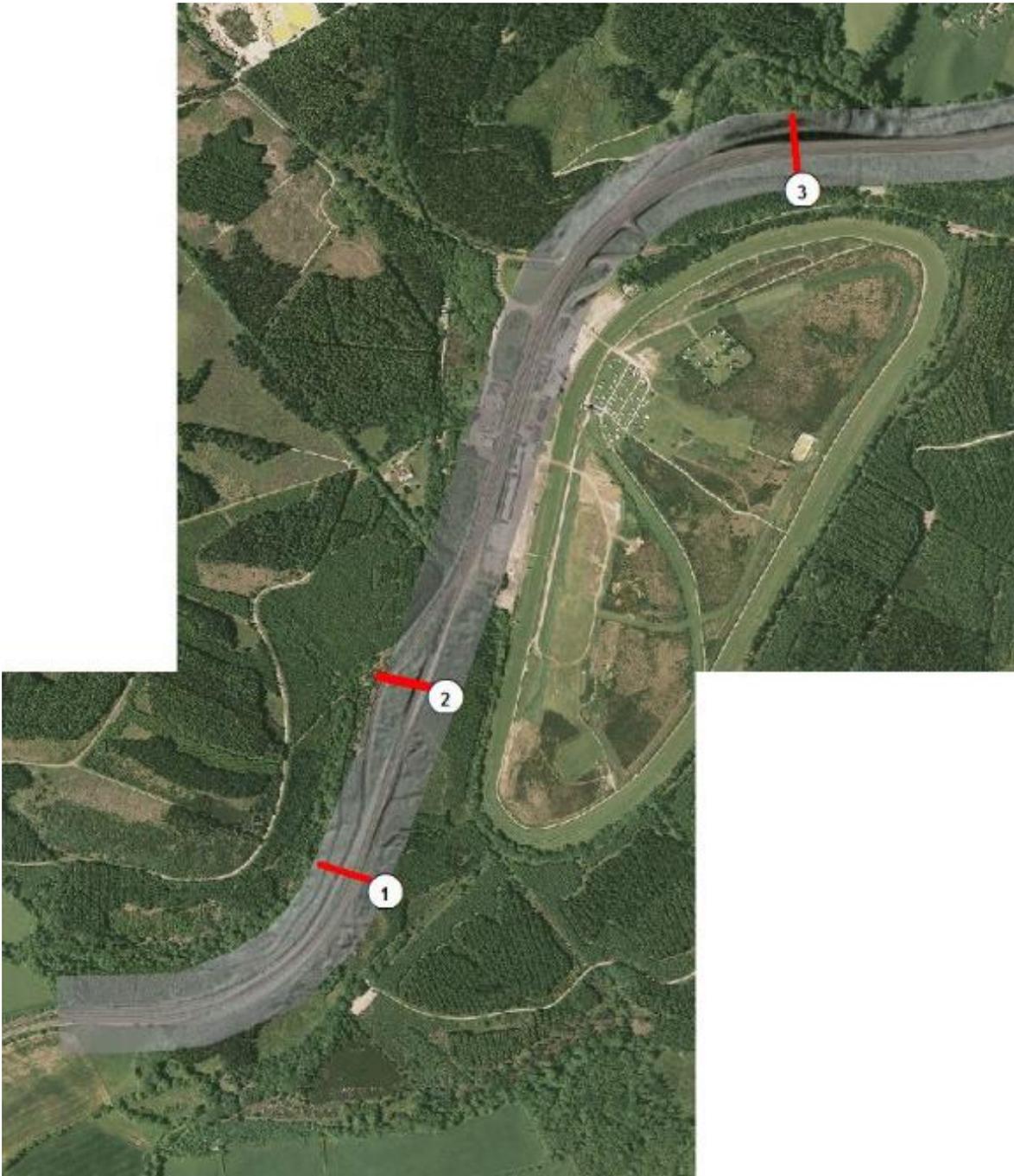


Figure 2.2: Location of identified sites (Aerial view from Lidar data)

2.3.2 Site 1

Site 1 is located to the south of the race course where the A38 is a dual two lane split level highway with both the northbound and southbound carriageways benched into the hill side by approximately 3 metres.

Site 1 is located to connect to an existing track that runs approximately east / west.

Immediately west of the A38 the ground falls away to cross an existing access track and a small stream in the bottom of a natural valley before climbing up the steep sided valley.

To the east of the site the land slopes up to a small plateau before descending down into a valley with a small stream (see figure 2.4 below).

The access track may need to be bridged to maintain the existing access arrangements and the stream will also need to be bridged.

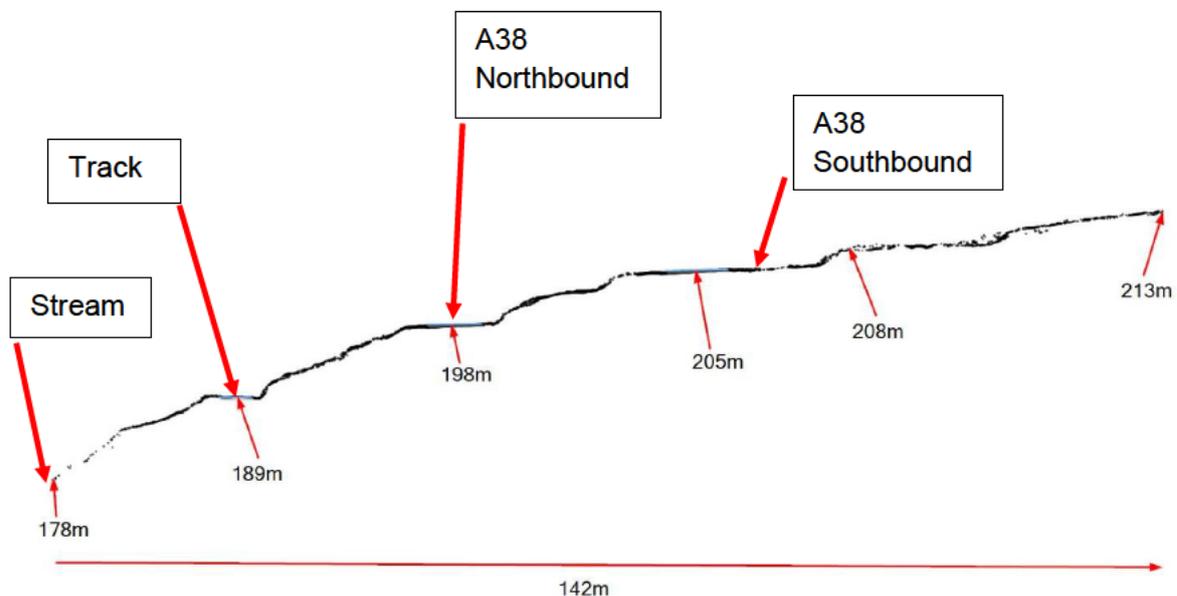


Figure 2.4: Haldon Site 1 Lidar Long section

2.3.3 Site 2

Site 2 is located approximately 300m north of site 1 where the A38 is a dual two lane split level highway with both the northbound and southbound carriageways located within a shallow cutting of approximately 3 to 4 m depth. This section of the A38 has a wide central reserve approximately 45m wide (see figure 2.5 below).

The land to the west of the A38 forms a small plateau that gently slopes up to a track that runs approximately north / south along the ridge line.

The land to the east is gently sloping to a small road approximately 100m east of the A38 southbound carriageway.

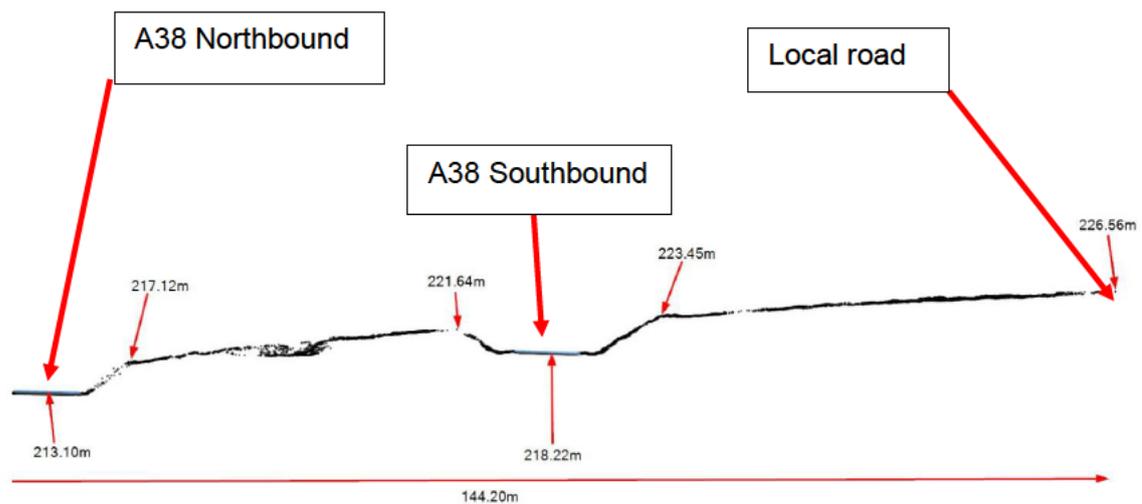


Figure 2.5: Haldon Site 2 Lidar Long section

2.3.4 Site 3

Site 3 is located to the northern end of the race course where the A38 is a dual two lane carriageway located in a section of cutting approximately 15m deep (see figure 2.6 below).

At this point the A38 runs approximately east / west.

Immediately to the south of the A38 is the county road that connects the A380 at Haldon Chalets to the A38 at Belvedere Cross.

Immediately north of the A38 is the Old Exeter Road that connects the A38 at Belvedere Cross to the A380 at the bottom of Telegraph Hill.

Both of these county roads will form a significant barrier to the free flow of animals between the two sections of woodland.

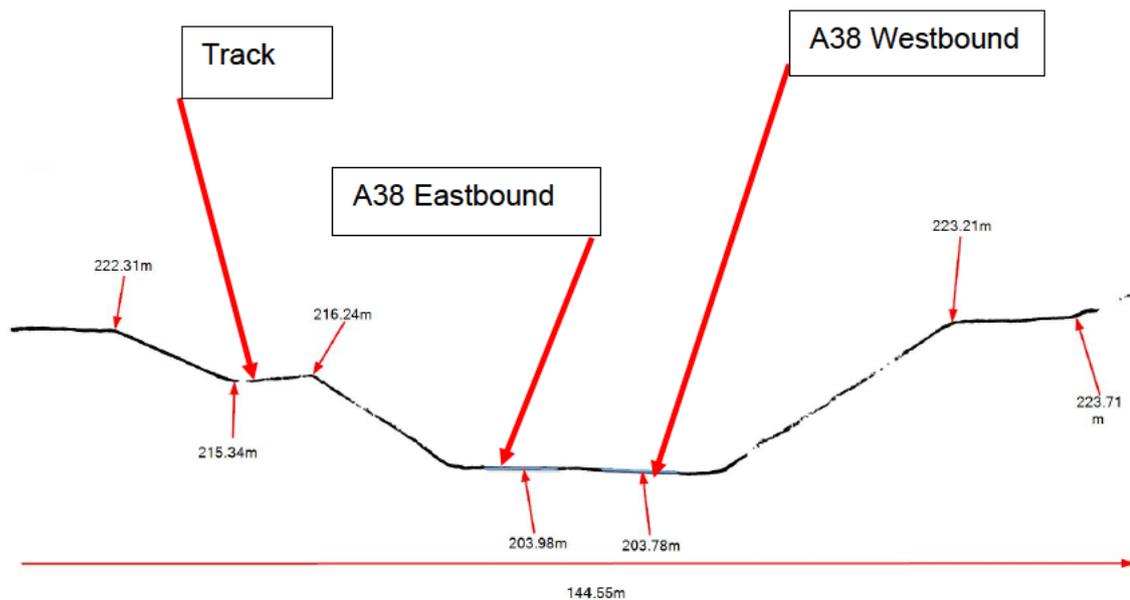


Figure 2.6: Haldon Site 3 Lidar Long section

2.4 Preferred Bridge Configuration

Green Bridges are intended to connect areas of natural landscape to facilitate the safe passage of wild animals over the trunk road.

As such their main purpose is to retain a significant depth of fill material that will be used for the planting of vegetation that will provide cover and food for the animals. The depth of fill required will be in excess of 1.5m to allow for adequate root growth to ensure that the small trees and shrubs etc. remain in a stable condition as they grow.

Highways structures are currently designed for a 120 year life expectancy.

There are two primary materials that can be used for the construction of highway structures, steel and concrete.

Steel bridges, including steel composite structures, may not be suitable for green bridges because of the high moisture content that will be within the retained fill. The water within the fill material will be in contact with the structure which in time will cause accelerated corrosion of the structural steel.

Concrete structures would include in-situ and precast construction methods. In-situ construction methods can largely be discounted because of the very high level of delay and disruption to the traffic on the A38 over a prolonged period of time. Precast construction methods will include the use of precast pre-stressed concrete beams and precast reinforced concrete arch structures.

The reinforcement within the concrete can be treated with a corrosion inhibitor, the concrete can be designed to be waterproof and the upper concrete surface can be treated with a waterproof membrane. Thereby minimising the opportunity for moisture to penetrate the structure and cause corrosion of the reinforcement.

Precast pre-stressed concrete beam type structures can be designed with an in-situ concrete top slab that will provide additional protection to the pre-cast beams. The in-situ top slab can be designed to be predominately in compression under the effects of the imposed self-weight and soil loads which will compensate for any surface cracking of the in-situ concrete caused when it cures. Precast pre-stressed beams are suitable for spans from 9m up to 50m.

Precast concrete segmental arch structures can be designed such that the concrete is in compression therefore a thinner section size can be utilised for a given span. Precast concrete arch structures, such as the Bebo Arch system, are suitable for spans from 3.0m up to 31.0m and can retain up to a 100m of over fill.

The minimum vertical clearance above the A38 shall be set at 5.5m for preliminary design purposes. For precast beam structures a span to depth ratio of 1 to 20 shall be assumed for single span structures and a ratio of 1 to 25 for multi span structures.

2.4.1 Site 1

The nominal carriageway width has been assumed to be 7.3m plus 1.0m hard strips on each side. The verges shall be assumed to be a minimum of 2.5m resulting in a minimum clear span of 14.3m.

In order to produce an open aspect to the structure a Bebo T80 arch has been selected. The T80 has a clear span of 24.38m. The end supports will therefore be set back approximately 5m behind the back of the verge.

The existing site falls from a level of 213m to 178m (35m) over a distance of 142m a gradient of approximately 1 in 4.

In order to accommodate the additional height required over the northbound A38 the gradient would either need to be locally steepened to 1 in 2 or else approximately 12m of fill material would need to be placed in the valley bottom.

The former option would make this site very difficult to be used by pedestrians and cyclists. The latter option would have significant environmental and cost implications for locally infilling the valley. The revised gradient would be similar to the natural ground profile, this may be considered to be too steep for pedestrian and disabled access (see figure 2.7 below).

2.4.2 Site 2

At this location the southbound carriageway of the A38 is in a localised cutting approximately 4m deep and the northbound carriageway is in a cutting approximately 3m deep. The natural ground levels fall from east to west with an average gradient of approximately 1 in 14.

At this location the northbound and southbound carriageways are approximately 45m apart, the area between the carriageways is a wild life habitat that is difficult to access.

A Bebo T80 arch has been selected for this site, this will give the appearance of the arch springing from the top of the adjacent cutting.

The slender dimensions of the arch structure will allow the bridge to blend into the ground profile with minimal earthworks required on the approach tracks.

The earthworks between the two arches could be shaped to allow access to the central reserve area for future maintenance operations (see figure 2.8 below).



Figure 2.7: Haldon Site 1



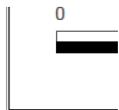


Figure 2.8: Haldon Site 2



2.4.3 Site 3

At this location the eastbound and westbound carriageways are in close proximity to each other with a standard central reserve width. There is therefore insufficient space for a central support and the A38 will need to be crossed in a single span.

At this location the A38 is in a cutting approximately 20m deep.

Three options have been considered at this location.

Option A

A T102 Bebo arch will provide a 31m clear span with the abutments set at the back of the verges.

The finished ground profile over the structure could be shaped to provide the minimum required depth of fill over the structure that connects to the top of the cutting on the south side and either to the top of the cutting or to the track level part way up the cutting on the northern side.

The depth of retained fill will vary from approximately 1.5m to a maximum of 7.5m.

Based on an assumed clear width of 20m over the structure, a 1 in 2 side slope for the retained fill and a minimum of 1.0m wide maintenance access track adjacent to the parapet edge beam the overall length of the structure will vary from a minimum of 29m to a maximum of 53m (see figure 2.9 below).

Option B

A two span over bridge with a main span of 40m and a side span of 20m could connect the top of the cutting on the southern side to the access track at mid-cutting height on the northern side.

This would provide a vertical clearance of approximately 10m over the A38 (see figure 2.10 below).

Option C

A three span over bridge with spans of 22.5m, 35.0m and 30.5m, from south to north, could connect the top of the cutting on the southern side to the top of the cutting on the northern side and maintain a nominal vertical clearance over the access track.

The vertical clearance over the A38 would be approximately 14m (see figure 2.11 below).

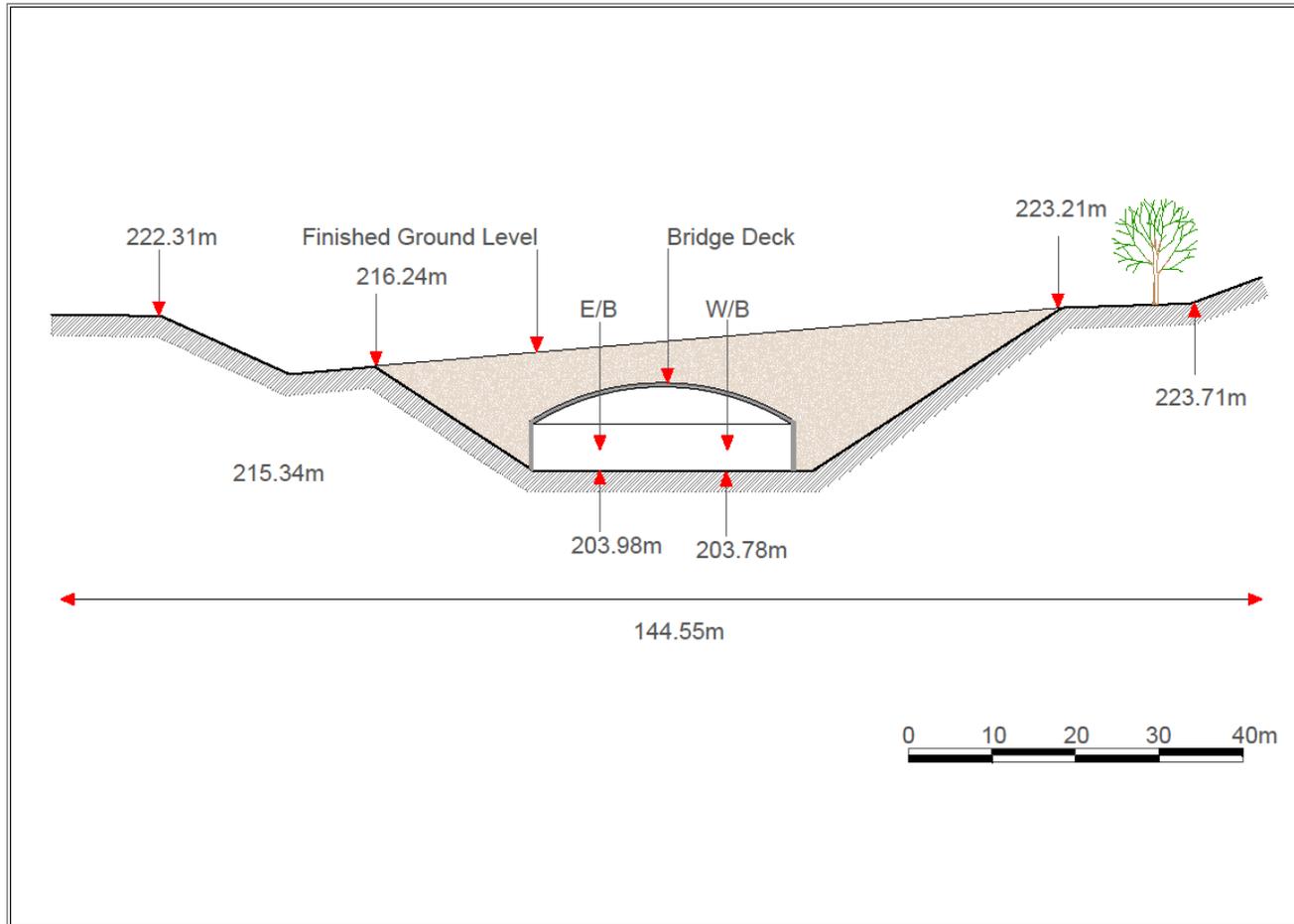


Figure 2.9: Haldon Site 3 Alternative A



Figure 2.10: Haldon Site 3 Alternative B



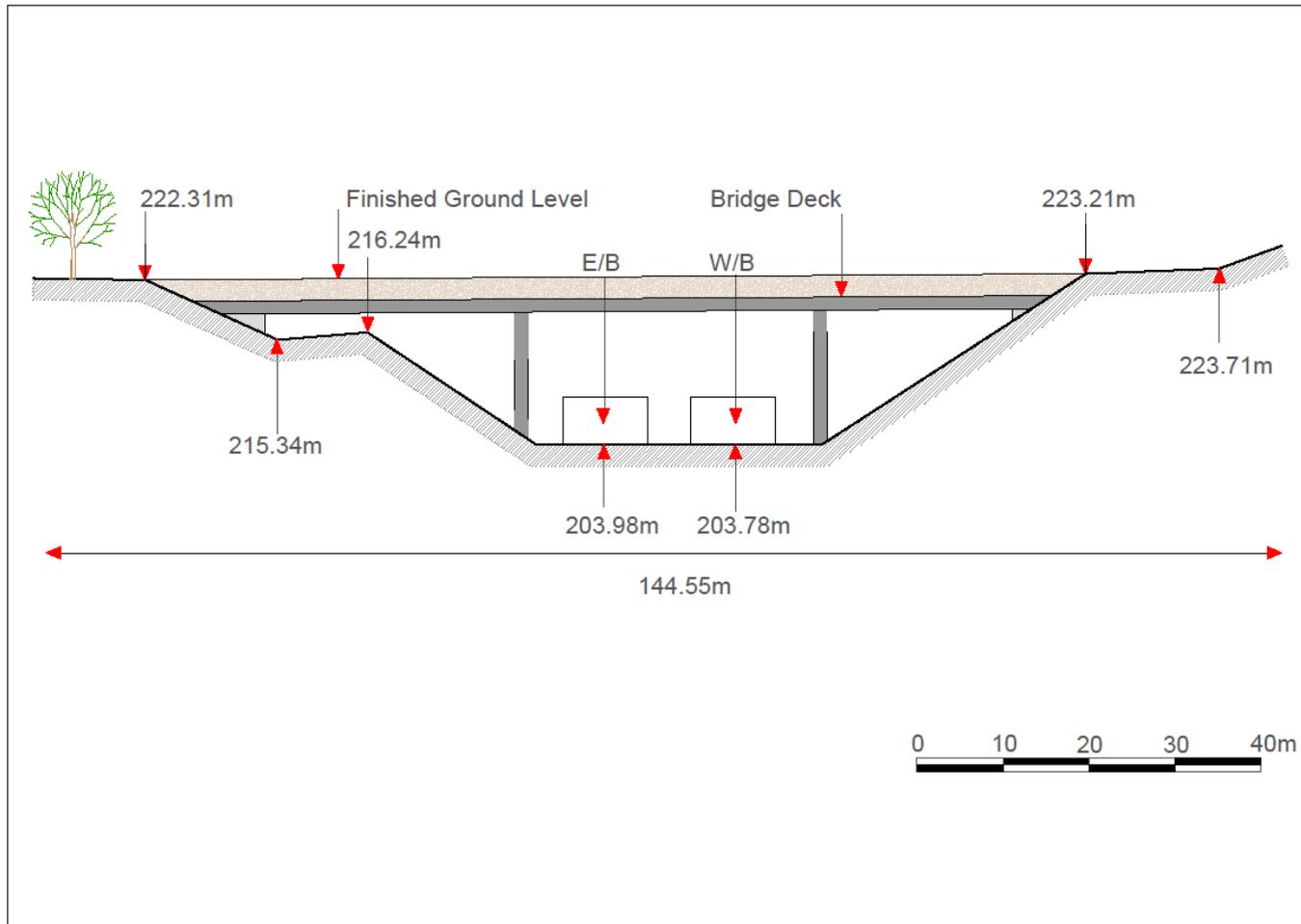


Figure 2.11: Haldon Site 3 Alternative C

2.4.4 Recommendation

Based on the Lidar long sections and the preliminary bridge configuration it is recommended that Site 2 should be considered for a more detailed topographic survey and the preliminary design be developed to provide sufficient detailed drawings etc. for consultation with third parties.

2.5 Potential Planting Regime

Figure 2.12 below outlines the potential planting regime for the green bridge at Haldon.

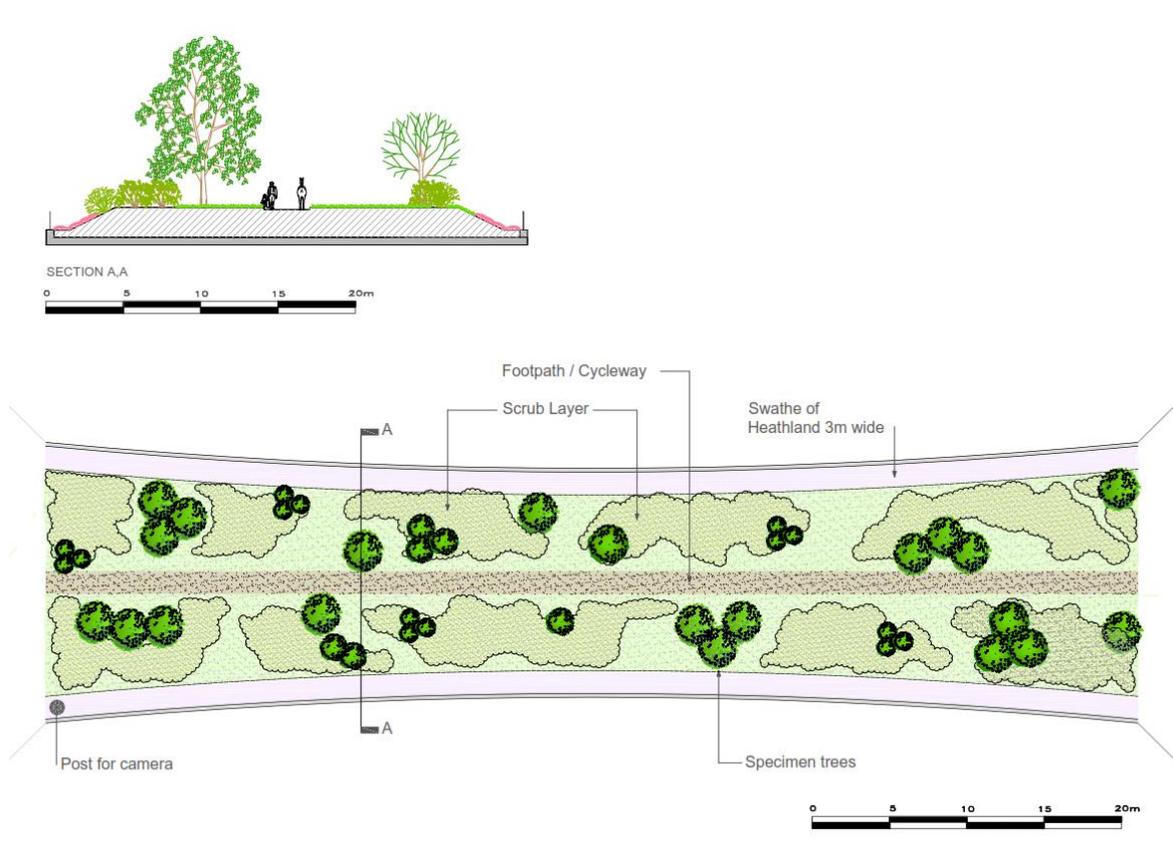


Figure 2.12: Haldon Potential Planting Regime

Landscape Strategy

The planting will provide visual and habitat connectivity to create links to existing habitats to the north and south of the A38. As well as providing wildlife habitat within the green bridges this will reduce the potential for fatalities of species such as deer and will encourage the broadening of habitat. In addition the bridge will provide a green pedestrian and cycle link across the A38.

Species choice to strengthen and complement existing retained woodland and encourage species diversity, typical species may include:

Woodland:

- *Acer campestre* (Field Maple)
- *Crataegus monogyna* (Hawthorn)
- *Ilex aquifolium* (Holly)
- *Quercus robur* (Oak)

Scrub:

- *Corylus avellana* (Hazel)
- *Crataegus monogyna* (Hawthorn)
- *Euonymus europaeus* (Spindle)
- *Ilex aquifolium* (Holly)
- *Rosa canina* (Dog Rose)
- *Sambucus nigra* (Elder)

Heathland:

- *Erica tetralix* (Heather)
- *Erica cinerea* (Heather)
- *Vaccinium myrtillus* (Murtleberry)

3 Saltram

The introduction of a Green bridge would reinstate the historic connection between the Saltram Estate and Hardwick Wood. This would bring heritage, biodiversity and access improvements to the area. It would achieve an aspiration desired by the public as well as the landowners involved in this very public and popular space by enabling a more pleasant entrance into Saltram. It would also allow the dispersal of the Saltram Estate visitors over a wider area to help future proof the estate given the expected increase in visitor numbers and make a visit to Saltram an altogether more enjoyable experience. The green bridge would give local people an alternative to driving into Saltram and onto Plymouth and reduce the number of cars arriving at the Estate.

This scheme would be in partnership with The National Trust, Plymouth City Council and Natural England all of whom endorse and support the opportunity to restore the lost connection between the main Saltram parkland and Hardwick Woods.

An initial consultation meeting has been held with the National Trust and Plymouth City Council who provided a statement of support to help with the compilation of this document.

3.1 Potential Benefits

This bridge will provide improved access and free movement for people and wildlife. Local residents and recreational users can walk and cycle through the landscape and improve their wellbeing. The bridge will reconnect people with the surrounding landscape.

A green bridge at Saltram could realise the following benefits:

3.1.1 Social benefits

Working in partnership with Plymouth City Council and Natural England, the National Trust engaged LUC to undertake a public exercise to determine what people valued about Saltram and what could be done to enhance their experience. This was particularly in light of the existing visitor numbers and the expected increase due to the development of the adjoining Plymstock Quarry (some 1500 houses) and Sherford (some 5000 houses).

There was a strong demand by the public to ensure that walks, cycling, connectivity to nature and protection of the heritage would all be sustained. The reinstatement of the lost connection to Hardwick Wood was picked out as a project which many people who live locally would truly value, not only to enable physical access between the two green spaces, but also restoration of historic views, historic carriage routes and an opportunity to enjoy a different type of nature, Hardwick Wood being the only large area of woodland left in the area. The current tenants of the Trust owned Hardwick Wood, the Woodland Trust, supported the outcome and endorsed how this would enable more people to enjoy Hardwick Wood in its entirety.

In anticipation of the growth that Plymouth will undergo in the next decade, PCC have created a Green Infrastructure Plan. This plan sets out a blueprint for the management of existing spaces, the creation of future spaces, how the landscape will be linked and how it will be used by the local population.

The Governments Planning Policy Statement 12 (*Creating Strong Safe and Prosperous Communities through Local Spatial Planning*), defines green infrastructure as:

“Green infrastructure is a network of multi-functional green space, both new and existing, both rural and urban, which supports the natural and ecological processes and is integral to the health and quality of life of sustainable communities”

The A38 and access across it, presents a major constraint for this plan. The creation of a green bridge at Saltram will help achieve the objectives set out within this plan and have huge social benefits to the communities living to the east of Plymouth.

If non-motorised access to Plymouth and Saltram House is greatly improved it could potentially reduce the vehicle numbers on the A38.

3.1.2 Economic benefits

The National Trust undertakes an annual survey of the visitors who come to Saltram to assess their opinion of their experience. The results are compared to the surveys of all the other National Trust properties participating and a score is rated against the average level of visitors stating they have had a very enjoyable experience. Without exception, the arrival at Saltram is rated as below average for a National Trust property. Furthermore, visitor welcome staff receive constant complaints about the access into Saltram. Clearly, the current vehicle bridge over the A38 which is used as one of the main routes into the site, is having an unsightly impact on this most important and highly graded of heritage assets and a new walking access route through woodland would significantly improve peoples' perception of Saltram.

Anyone trying to walk into the estate has to cope with the noise and pollution caused by the heavily used A38 as they are directly exposed to it when crossing the current concrete bridge. Vehicles and pedestrians using the bridge frequently pause on the bridge to view the traffic movements below causing traffic jams and frustrations amongst other drivers on the bridge attempting to access the estate.

Additionally, this same route is used by cyclists commuting quickly through Saltram to Plymouth or for pleasure purposes. The new green route into Plymouth would encourage more commuters to cycle, easing the pressure on road and public transport networks.

The Saltram Estate is still a working farm. Cattle and other farm vehicles have to use the only existing access in to Saltram over the A38, sharing this access with the van and lorry service vehicles supporting the Saltram business operation. There is a constant conflict of user type, pace of movement and passing space in this pinch-point access point to Saltram.

It is predicted that the creation of a green bridge will result in increased visitor numbers to the estate, generating more income for the National Trust and the associated businesses. The visitor experience will be greatly enhanced, resolving the main negative issue raised in past visitor surveys. This will result in repeat visits boosting the economic benefits further.

3.1.3 Environmental benefits

The area already supports a diverse range of habitats including ancient woodland, flower-rich grasslands, mud flats, and a network of hedgerows.

The Saltram Countryside Park is very rich in biodiversity and there are opportunities to increase the wildlife value across the site. Currently there are six County Wildlife Sites (designated for its veteran trees, rich ancient woodland flora, the insect life that depends on them and for the presence of bats), and one Regionally Important Geological Site within the Saltram Countryside Park boundary. The site also includes areas of Ancient Woodland at Saltram Wood, Wixenford Bottom, Sellars Acres and Hardwick Wood. The majority is currently in a Higher Level Stewardship scheme, which reflects the significance of the biodiversity found on site.

The Park also supports significant numbers of protected and notable species. In particular the Park supports a large diversity of bat species, some 12 of the 17 species of bat found in Great Britain including both lesser and greater horseshoe use the site for roosting (including maternity roosts) commuting and foraging.

The A38 is a significant barrier to wildlife movement. There are proposals to strengthen green links across the Park to go some way towards redressing the barrier to ecological connectivity that was created when the A38 was constructed. However, the only way to provide a solution to the barrier to ecological connectivity caused by the A38 would be if a green bridge associated with a recreational route were created to span the A38. This is important in providing connections in the short term but also when considering the potential implications of climate change.

Saltram has a crucial role to play in sustaining biodiversity in this urban fringe area. The impact of the broad severance of the estate caused by the A38 on biodiversity should not be underestimated. It is now widely accepted that conservation of biodiversity requires habitat management at a landscape scale, with increased connectivity for wildlife. This severance prevents bats, other mammal, reptiles, insects and other biodiversity from moving easily through the whole area and mammal carcasses are frequently visible on the edge of the A38.

3.2 Key Constraints

3.2.1 Construction & Ground Levels

There is insufficient space in the central reserve for a bridge pier therefore the A38 will need to be crossed in a single span structure. This will require a very deep bridge deck that will not present the visual impact required for a structure of this type.

The county road that runs parallel to the A38 poses a constraint. Options to overspan the county road either by the same structure as the A38 bridge or on a separate structure must be considered.

Significant earth works on the approach ramps will be required, this may impact on the views from Saltram House. The gradient of finished ground profile on the Saltram Estate side of the bridge will be in excess of that normally used for pedestrian access. Significant land take would be required in order to mitigate and decrease the gradient.

3.2.2 Environmental constraints

Table 2.2 below outlines the key environmental constraints at Saltram that will need to be taken into consideration and investigated further as part of a full environmental assessment.

Table 3.1: Key environmental constraints at Saltram

Proposed Location	Nearest MP	AQ/Noise Sensitive Receptors	Cultural Heritage within 300m	Designated Sites	Species Records within 2km	Habitats	Invasives within 2km
Saltram 1	53/0+50m	Saltram, residential properties within 1km, residential area of Plympton within 1km	Site within Saltram Historic Park and Garden. Four Listed Buildings	Ancient (Replanted) Woodland adjacent to county road soft estate. Two other AW sites within 1km.	Bat species inc. GHS and LHS Slow Worm Common Lizard Badger	Within soft estate: Open Grassland, Woodland	
Saltram 2/3	53/4-5	Saltram, residential area of Plympton within 1km	Site within Saltram Historic Park and Garden. One Listed Building	Ancient (Replanted) Woodland adjacent to county road soft estate. Three further AW sites within 1km.	Bat species inc. GHS and LHS Slow Worm Common Lizard Badger	Within soft estate: Open Grassland, Woodland, High Forest, Rock and Scree	

3.3 Preferred Location

The intention is to connect Saltram House and its surrounding park land on the south side of the A38 with Hardwick Woods on the north.

Access to the woods was severed when the A38 was improved in the 1970's.

The area to be considered for the location of a green bridge lies between Saltram House Access Bridge to the west and Merafield Road Bridge to the east.

This section of the A38 is predominately in a deep cutting with the county road between Merafield Road bridge and Plympton running parallel on the northern side of the A38.

The sites considered have been located in an attempt to make the best use of the existing topography and to connect the existing tracks and pathways to the north and south of the A38.

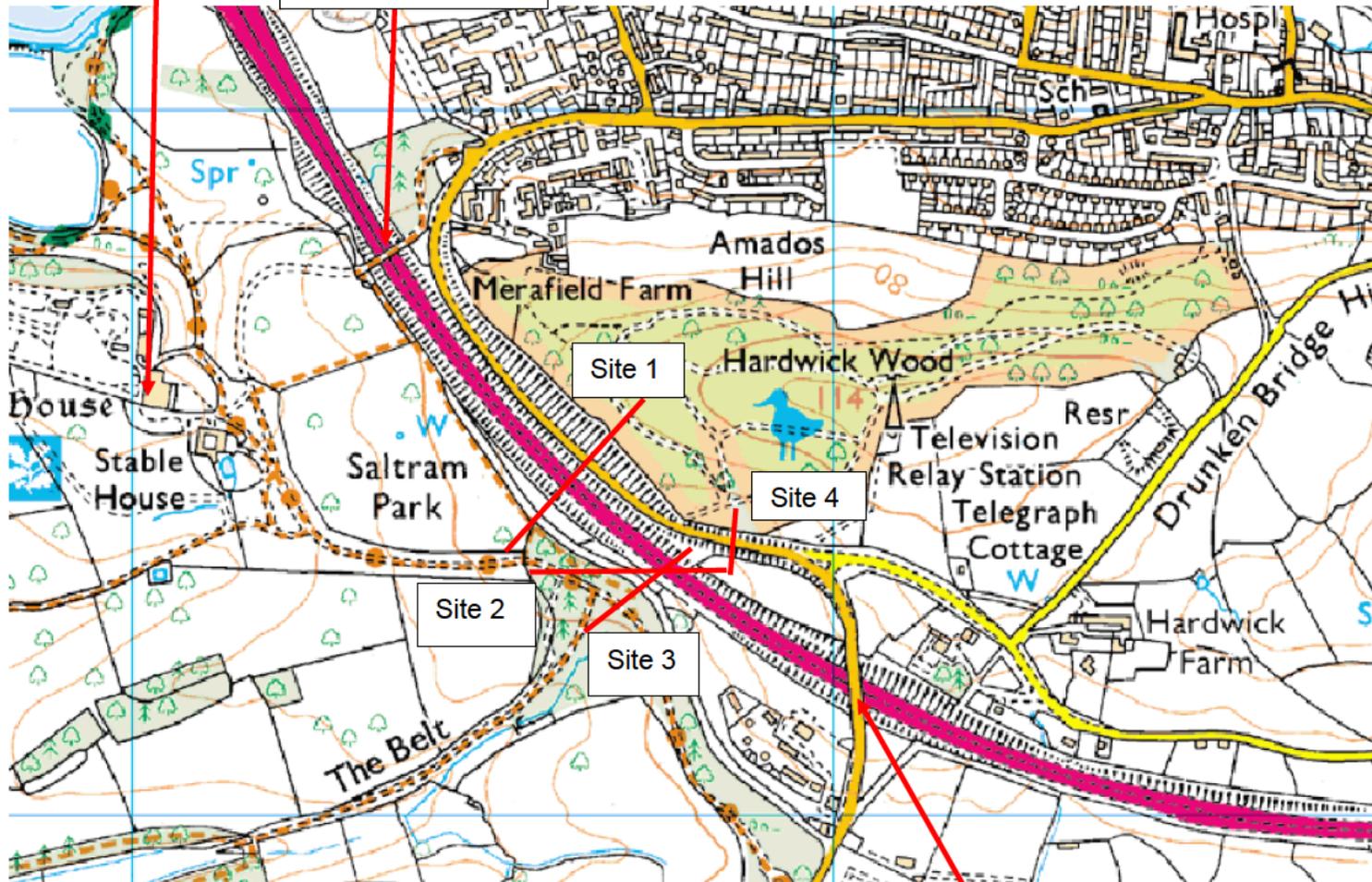
The proximity of the county road immediately to the north of the A38 will require the new bridge to either cross the A38 and the county road in a single structure or to cross the A38 and the county road on two separate structures.

Figure 3.1 below demonstrate the locations of the sites identified for further investigation as part of this interim feasibility study.

Saltram House

Saltram Park
Access Bridge

Figure 3.1: Identified sties location plan



Merafield
Road Bridge

3.3.1 General Details

This section of the A38 is a dual three lane carriageway with a standard width central reserve.

There is insufficient space in the central reserve to accommodate a bridge pier therefore the A38 must be crossed in a single span.

The northern face of the A38 cutting immediately west of Merafird Road Bridge is known to have been affected by slippages and stability problems.

A detailed geotechnical investigation will therefore be required as part of the detailed design works at the preferred green bridge site.

3.3.2 Site 1

Located approximately midway between Saltram Park Access Bridge and Merafird Road Bridge the A38 at this location is in a cutting approximately 8.5m deep. The county road between Plympton and Plymstock that passes over Merafird Road Bridge is located approximately 8m north of the top of the cutting (see figure 3.2 below).



Figure 3.2: Saltram site 1 lidar long section

Three alternatives have been considered for this site.

3.3.3 Site 2

Located approximately 150m east of Option 1 this option is located to form an extension of the existing access track from Saltram House. The proposed bridge site will connect the parkland on the south side of the A38 to the area of land on the north side sandwiched between the A38 and the county road. At this location the new bridge will cross the A38 at a high skew angle (see figure 3.3 below).

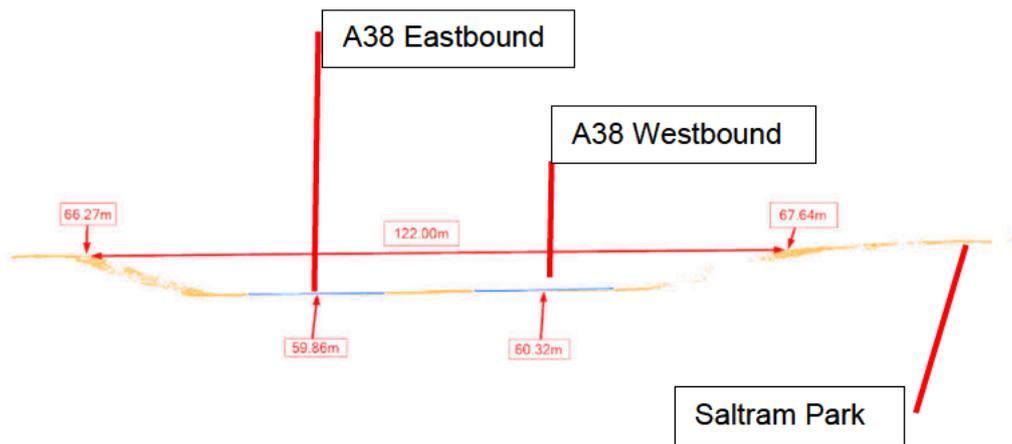


Figure 3.3: Saltram site 2 lidar long section

3.3.4 Site 3

This structure is in the same general area as Option 2 and will form a square crossing of the A38 and the county road (see figure 3.4 below).

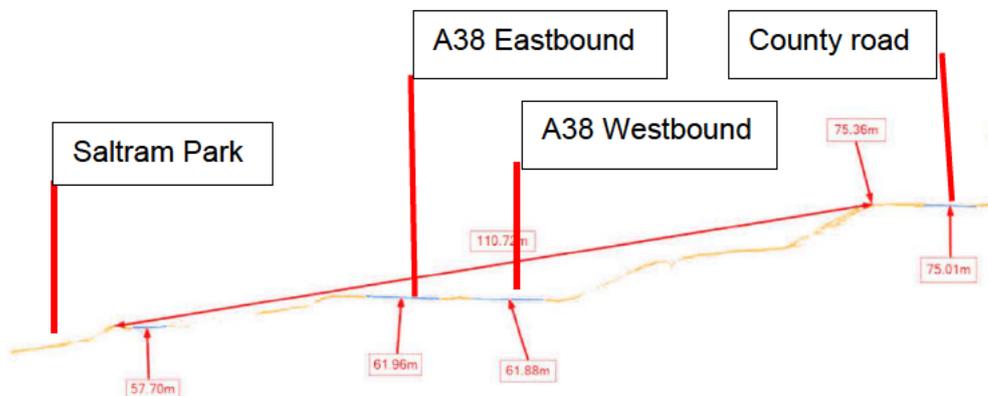


Figure 3.4: Saltram site 3 lidar long section

3.3.5 Site 4

This option is located to connect the area of land sandwiched between the A38 and the county road with Hardwick Woods to the north (see figure 3.5 below).



Figure 3.5: Saltram site 4 lidar long section

3.4 Preferred Bridge Configuration

For full details of the preferred bridge configuration see section 2.3.

For all the Saltram structures considered the most appropriate form of structure would be a precast pre-stressed concrete beam bridge.

3.4.1 Site 1

Site 1 is located to cross the A38 where it is in a cutting approximately 9m deep.

At this location the county road is located approximately 8m north of the top of the cutting slope.

Immediately north of the county road the land rises to a peak of 114m in the middle of Hardwick Woods

Three alternatives have been considered for this site.

Alternative A

A single span precast pre-stressed concrete beam deck that over sails the A38 in a single span.

Based on 3.65m lane widths, 2.5m verge widths and a 2.5m central reserve width the minimum clear span would be 33.4m.

For easy of construction and maintenance the span should be as large as possible therefore a 47m span has been assumed.

The finished ground level would be flush with the existing ground on the northern and southern sides of the A38 (see figure 3.6 below).

A significant disadvantage is that this solution does not provide a crossing of the county road.

Alternative B

A two span structure that connects the existing ground level on the southern side of the A38 with the top of the cutting slope on the northern side. This will result in a longitudinal fall of approximately 20% (1 in 5). This may be considered too steep for pedestrian / cyclist access and is certainly too steep for disabled access.

To minimise the impact on the A38 the span bridge supports should be as far from the live carriageway as possible. It has been assumed that the span configuration will be two equal spans of 45m each.

The abutment wing walls could be splayed at 45 degrees to the line of the structure to form a funnel effect to guide the wild life onto the structure (see figure 3.7 below).

Extensive deer / wild life fencing will be required within Hardwick Woods to guide animals onto the bridge.



Figure 3.6: Saltram Site 1 Alternative A





Figure 3.7: Saltram Site 1 Alternative B



Alternative C

A two span structure that would be located to provide the minimum required vertical clearance above the county road.

This would require a two span structure with a span configuration of 45m and 35m.

The finished ground level would connect the top of the cut slope on the southern side with a point part way up the cut slope on the northern side at a gradient of approximately 12% (1 in 8). Some excavation will be required within Hardwick Wood to connect the bridge to the natural ground level, this would either be locally very steep (1 in 3) or very long (see figure 3.8 below).

3.4.2 Site 2

At this location the A38 is located in a cutting approximately 7m deep. The new bridge would cross the A38 at a skew angle of approximately 45 degrees. The A38 is a dual three lane dual carriageway with 1.0m hard strips on each edge. There is insufficient space within the central reserve to accommodate a pier therefore the A38 will need to be crossed in a single span (see figure 3.9 below).

With abutments located at the back of the verges the clear span would be approximately 80m. This is in excess of what a precast pre-stressed concrete beam will span.

This solution will not be considered further at this stage.



Figure 3.8: Saltram Site 1 Alternative C





Figure 3.9: Saltram Site 2



3.4.3 Site 3

Site 3 is located to form an extension of the existing track in Saltram Park known as The Belt. This will form a square crossing of the A38 at a location where the trunk road is situated on side long ground.

The southern edge of the A38 is approximately at the same level as the natural ground however the northern edge is approximately 6m below natural ground level. At this location the county road is approximately 14m above the trunk road and 50m to the north.

Two alternatives have been considered,

Alternative A

Crossing the A38 in a single span structure to land in the section of land sandwiched between then A38 and the county road. The county road would need to be crossed on its own structure located at site 4 (see figure 3.10 below).

Alternative B

To cross the A38 on a single span structure and to cross the county road on a separate single span structure. The two structures would be connected by an embankment (see figure 3.11 below).



Figure 3.10: Saltram Site 3 Alternative A





Figure 3.11: Saltram Site 3 Alternative B





Figure 3.12: Saltram Site 4



3.4.4 Site 4

Site 4 has been located at the western end of the plot of land sandwiched between the A38 and the county road, approximately 150m west of the existing side road junction.

At this location the county road is set on side long ground with the A38 approximately 12m below and approximately 50m to the south. Hardwick Woods rises up to a maximum height of 114m approximately 300m to the north.

The county road would be crossed by a single span structure. The abutments would be set at the back of the verges to provide a clear span of approximately 13m. An approach ramp running parallel to the county road would be required to connect this structure to the site 3 alternative B structure (see figure 3.12 above).

3.4.5 Recommendations

Based on the Lidar long sections and the preliminary bridge configuration it is recommended that Site 3, Alternative A and Site 3 Alternative B in combination with Site 4 should be considered for a more detailed topographic survey and the preliminary design developed to provide sufficient detailed drawings etc for consultation with third parties.

3.5 Potential Planting Regime

Figures 3.13 and 3.14 below outline the potential planting regimes at Saltram.

3.5.1 Saltram Planting Option 1

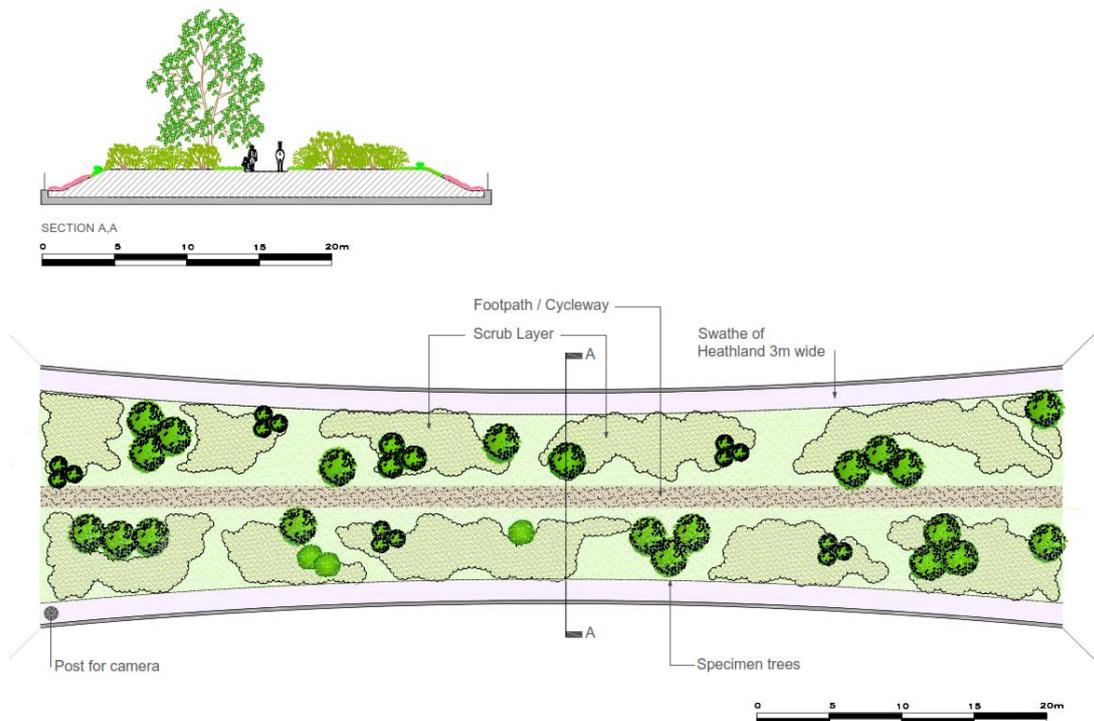


Figure 3.13: Potential Planting Regime Option 1

Landscape Strategy:

Planting to provide visual and habitat connectivity to create links to existing forage areas to the north and south of the A38. As well as providing wildlife habitat within the green bridges this will reduce the potential for fatalities of species such as deer and will encourage the broadening of habitat. This design is intended to extend Hardwick woods across the A38 providing a green pedestrian and cycle link to the Saltram Estate.

Tree species to strengthen and compliment retained woodland and encourage species diversity.

Species.

- *Acer campestre* (Field Maple)
- *Crataegus monogyna* (Hawthorn)
- *Castania sativa* (Sweet Chestnut)
- *Fagus Sylvatica* (Beech)
- *Ilex aquifolium* (Holly)
- *Quercus robur* (Oak)
- *Taxus baccatta* (Yew)

Scrub Layer

Planting to strengthen tree planting and encourage species diversity and to improve general habitat connectivity and quality of green links between settlements.

Species

- *Corylus avellana* (Hazel)
- *Crataegus monogyna* (Hawthorn)
- *Euonymus europaeus* (Spindle)
- *Ilex aquifolium* (Holly)
- *Lonicera periclymenium* (Lonicera)
- *Rosa canina* (Dog Rose)
- *Sambucus nigra* (Elder)

Heathland Species

Planting to strengthen scrub planting and encourage species diversity

Species

- *Erica cinerrea* (Heather)
- *Vaccinium myrtillis* Murtleberry)
- *Erica tetralix*(Heather)

3.5.2 Saltram Planting Option 2

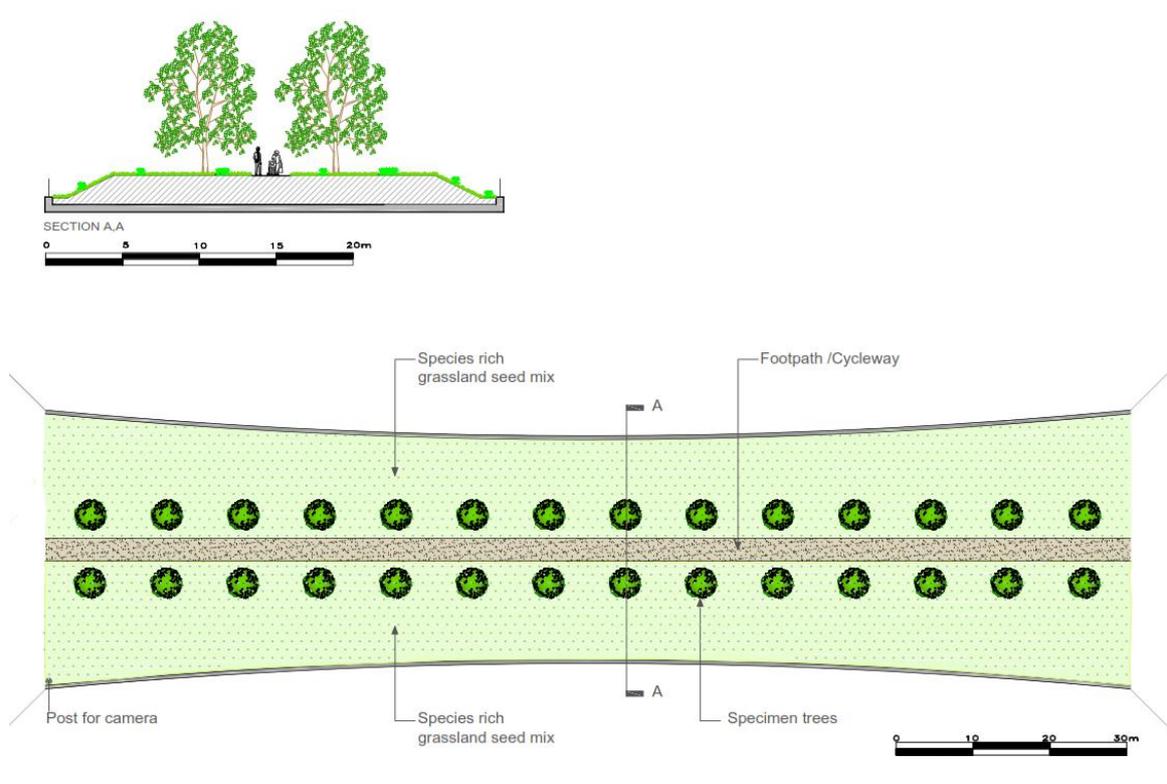


Figure 3.14: Potential Planting Regime Option 2

Landscape Strategy:

Planting to provide strong visual features linking the adjoining and designed landscapes using appropriate species, such as Oak. This design is intended to extend the parkland of Saltram Estate, mirroring the existing tree lined drive way.

Planting to provide glimpsed views to Saltram House and the estuary. In addition to enhancing habitat connectivity and creating links to existing woodland areas to the north and south of the A38. As well as providing wildlife habitat this will reduce the potential for fatalities of species such as deer. In addition the bridge will provide a green pedestrian and cycle link across the A38.

Tree species to strengthen and compliment retained woodland and provide connectivity

Possible species to include:

- Quercus robur (Oak).

Species Rich Grassland - grassland seed mix to encourage species and wildlife diversity and may include:

- Black medic
- Birds foot trefoil
- Campion
- Cats ear
- Common spotted Orchid

4 Other Potential Locations

As part of this study a sweep of the network has been undertaken to highlight any other locations that could potentially benefit from a green bridge. The results are as follows.

4.1 A30 Okehampton

The town of Okehampton is situated on the northern edge of Dartmoor, with which the town's identity is synonymously linked. The physical link to Dartmoor was cut by the construction of the A30. By way of mitigation the Highways Agency retained Oakhampton Station Wood, through which public footpaths wend and lead to a narrow amenity footbridge which crosses from the wood, over the A30 to Dartmoor on the opposite side of the trunk road (see figure 4.1).

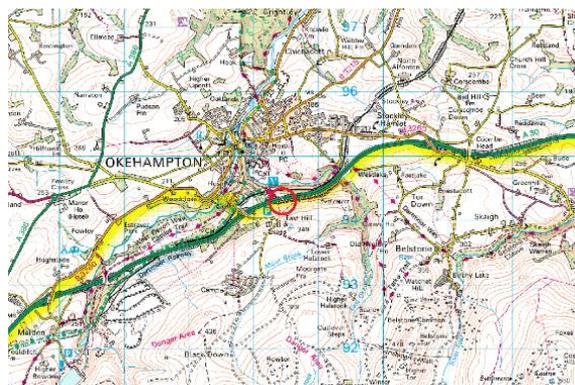


Figure 4.1: Okehampton Location map



Figure 4.2: Amenity bridge currently at Okehampton

If this narrow amenity bridge, which can be seen in figure 4.2, was replaced by a green bridge it is believed that many benefits could be realised.

Economic – Okehampton attracts large numbers of tourists each and every year, who use the town as a gateway to the moor. There are many businesses, such as the Youth Hotel and bike hire at Okehampton Station, that rely on the tourism industry. Currently the narrow footbridge provides a dull, inadequate entrance to the most famous national park in the country. A green bridge would not only boost visitor numbers, but also provide a more adequate route on to Dartmoor.

Social - Many residents feel that the town lost a large part of its identity when it was physically cut from the moor. A green bridge would reconnect the landscape, replacing the residents and towns sense of place. Many local residents would use a green bridge for leisure activities, to gain access to the moor, walk dogs, cycling etc.

Environmental – Reconnecting the landscape would also benefit local wildlife, allowing the free movement of local species such as deer, badger etc. Okehampton Station Wood has several resident protected species, such as dormice and bats. A green bridge would extend suitable habitat across the trunk road linking to the moor.

From a practical point of view, the ground levels and the wide central reservation at Okehampton could make this an ideal location.

It is felt that this location could potentially benefit from a green bridge and warrants further investigation.

4.2 A30 Halgavor

Halgavor is located on the A30 just south of Bodmin. The large National Trust estate at Landyrock is hemmed in by the A30 to the northwest and the A38 to the north east. In 2000 a new amenity bridge at Halgavor was built to connect the cycle route from Lostwithiel to Bodmin.

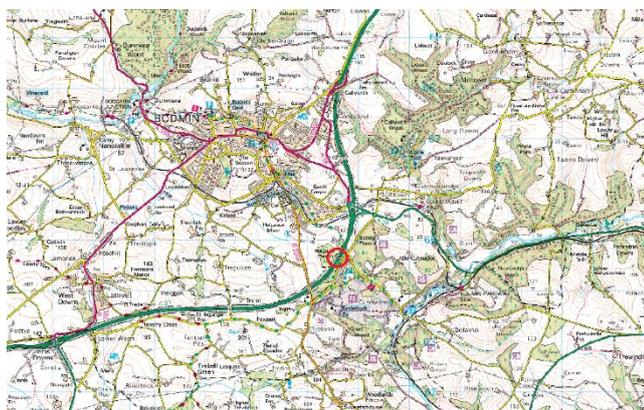


Figure 4.3: Halgavor Location map

This bridge (seen in figure 4.4), since its construction, has required more maintenance than the average structure due to the design and choice of materials used in construction (i.e. stainless steel, Glass Reinforced Plastic and wood). In fact, this is the only structure on the Area 1 network that requires jet washing and cleaning every two years. As the bridge ages the maintenance will requirement will increase.



Figure 4.4: Amenity bridge currently at Halgavor

If this amenity bridge was replaced by a green bridge it is believed that several benefits could be realised.

Economic – Halgavor attracts large numbers of visitors each year, consisting of locals from Bodmin or people from further afield visiting the National Trust property. This is a

popular destination for cyclists and a new cycling hub has been developed just to the south of the bridge location. This route is heavily used by pedestrians, cyclists and equestrians and by locals commuting from Lostwithiel to Bodmin. There are many businesses, such as those linked to the National Trust property, bike hub and those within Bodmin and Lostwithiel that rely on these visitors for survival. A green bridge would not only boost visitor numbers, but also provide a more adequate green commuter route from Lostwithiel to Bodmin.

Social - A green bridge at Halgavor would reconnect the landscape, creating a green route for locals to access areas south of the A30 and A38. Many local residents would use a green bridge for leisure activities, to gain access to the Lanhydronk House and its grounds, access large areas of woodland and the river Fowey, walk dogs, cycling etc.

Environmental – There are a relatively large number of DVC's at this location. Reconnecting the landscape would also benefit local wildlife, allowing the free movement of local species such as deer, badger etc. A green bridge would extend suitable habitat across the trunk road linking large areas for woodland, which provides a green corridor to the River Fowey and the ancient woodlands of the Glynn Valley. This connectivity is vital when considering mitigation for issues such as climate change.

From a practical point of view, the ground levels at Halgavor could make this an ideal location.

It is felt that this location could potentially benefit from a green bridge and warrants further investigation.

4.3 A30 Ebsworthy - Ellacot Farm

Ebsworthy Woods lies 2 miles from the northwestern boundary of Dartmoor National Park (see figure 4.5 opposite). DVCs at this location are not a recent problem, but have been recorded in this area for a long time. In particular along a 1 km stretch where the A30 bisects the woodland and

where wildlife warning reflectors and signs have been installed for several years in attempt to mitigate the problem. The fact that in recent years red deer (which at an average weight of >100 kg for adult females and > 150 kg to over 200 kg for adult males, are around twice as heavy as fallow and four times as heavy as roe deer) are crossing the road in this area is of particular concern, as seriousness and likelihood of injury in DVCs is known to increase with size of the species involved.

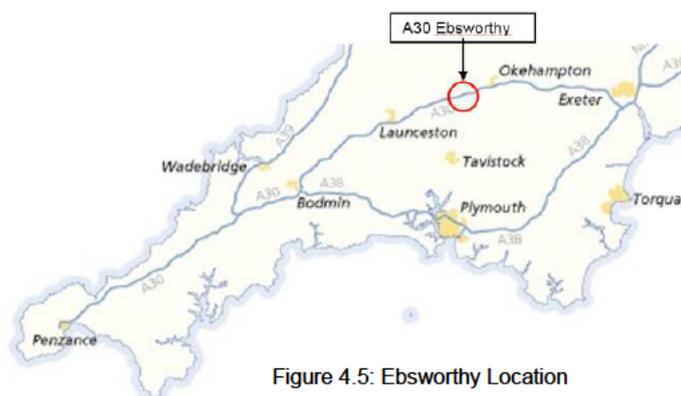


Figure 4.5: Ebsworthy Location

Two overpasses exist 2 km apart to either side of Ebsworthy Wood. Ellacott Farm Overpass and Ebsworthy Farm overpass. There are also a number of other wildlife casualties at this location including foxes, badgers and otters.

Ellacott Farm Bridge was built as an accommodation bridge to link two large sections of farmland severed when the new section of dual carriageway was built. Since then, the former farm has been divided in two (by the A30), Ellacott Barton and Churndon Ridge Farm and is owned by 2 different farmers. The accommodation bridge is no longer used for its intended purpose (livestock/farm traffic) but has become a flagship for advertisement related to nearby organic meat business.

Ellacott Farm overpass is a narrow farm accommodation bridge, free of any road traffic. For many years a lorry has been parked continuously on the structure (see figure 4.6), blocking much of the path, whilst a metal gate and piles of silage bales block much entrance onto the structure from the south. Signs of deer were found within less than 50 m on the northern side, though no signs



Figure 4.6: Lorry currently parked on bridge

noted directly on the (hard substrate) bridge itself. Although this overpass is only 4m wide, it is very favourably located to serve as a wildlife crossing in a very quiet area where Ebsworthy Wood and a new tree plantation abut closely to its northern side and pasture fields to the south.

Whilst the economic and social benefits of a green bridge in this location are not as strong as the previous sites. The potential reduction in DVCs and resultant injuries warrant further investigation.

In order to make Ellacott Farm Bridge a 'Green Bridge' or replace it completely with a new green bridge, the first action is to ensure that the Highways Agency has legal rights/ownership to make use of the structure.

4.4 Discounted Locations

Several other locations were considered for inclusion in this section but were discounted on either grounds of practicality or lack of justification. For example:

[A30 Brockabarrow over bridge at Temple](#) – (see figure 4.7 below) a green bridge at this site would have some environmental benefits. It would reconnect the landscape reuniting sections of Bodmin moor, an Area of Outstanding Natural Beauty, which was dissected

by the construction of the A30. Whilst this would act as a wildlife crossing for several species, there isn't the local deer population to cause high DVC numbers.

The justification from an economic and social perspective is weak. Whilst it would connect the moor and improve walking access to Colliford Lake, there isn't a centre of population or businesses close by to make any significant economic or social impact. Therefore this location was discounted as warranting any further investigation.



Figure 4.7: Current over bridge at Blackbarrow

5 Estimated Costs

The EM commercial team have refined a budget estimate for each of the preferred options at both Haldon and Saltram based upon existing knowledge of historic structures schemes and standard practices within the industry. A bill of quantities was produced based on a number of design assumptions. Prices used within the bill are based upon a mixture of rates from sample schemes, fleet rates, recent subcontractor quotes, SPONs published estimating pricing guide, Asset Support Framework South and researched rates created from first principles using current material and tool hire prices.

Quantities and costs for all works are assumed and based solely on a preliminary sketch at this time. This is currently a best estimate until a design can be produced which will be informed by detailed geotechnical investigation, site specific surveys and structural engineering.

5.1 Haldon Budget Estimate

Table 5.1 below outlines the breakdown of the budget estimate for the Haldon preferred option at site 2.

Table 5.1: Haldon Hill Green Bridge - Preferred Option		
Pre-Design Budget Estimate Summary		
Series	Series Description	Estimate £
100	Prelims	1,705,544.11
100	Traffic Management	1,006,948.00
200	Site Clearance	8,870.00
300	Fencing	88,950.21
400	Road Restraint Systems	263,487.00
500	Service Ducts	61,230.88
600	Earthworks	1,456,138.02
1600	Piling	107,200.00
1700	Structural Concrete	4,203,017.88
2000	Waterproofing	156,627.50
3000	Landscape and Ecology	101,024.00
	Subtotal	9,159,037.60
	Fee	412,156.69
	20% Risk	1,831,807.52
	TOTAL	11,403,001.81

The following assumptions were made during the formation of this price:

- Design - Not allowed for within price. No allowance for STATS, Landowner agreements, CPO's, etc related to N2 costs.
- Duration - Assumed 70 weeks.

- Preliminaries - Assumed 6 office units, 2 x toilet blocks, canteen and storage container in main compound. Container, canteen and toilet on opposite side of bridge.
- Wheel wash - Assumed gatesman, gate house and washer bowser required.
- Site vehicles - Assumed 3 site vehicles required.
- Road Sweeping - Assumed required twice a week.
- Barrier Guard - Assumed barrierguard required on hard strip to protect work force from traffic and to stop soil slipping on to carriage way.
- Haul Roads - Assumed 1000m x 6m required for Haul Roads. Assumed 300mm thick Type 1 on Terram.
- VRS - Assumed 50m required each side on A38 in front of bank seats
- Ducts - Assumed 3nr ducts installed for future use on each parapet (total 6 nr)
- Earthworks - Assumed 10m working space at either end of bank seats required
- Piling - Assumed bored piles required for bank seats.
- Bank Seats for Bebo - Assumed 30m x 3mx 1m deep with 0.75m x 1m high upstand with rebate
- Wing walls - Assumed 4nr wing walls. 10m long sloping from 6m to 2m. Assume base 10m x 5m x 0.5m deep
- Reinforcement - Assumed 300kg/m³ of rebar required
- Concrete protection to waterproofing - Assumed 250mm thick
- Craneage - Assumed 2 x 300T cranes required to install Bebo arches. 40T crane to move reinforcement, formwork and parapets.
- Unhooking BEBO planks - Assumed MEWPS required
- Access to deck - Assumed scaffold steps and walkways required once BEBO has been installed.

5.2 Saltram Budget Estimate

Table 5.2 below outlines the breakdown of the budget estimate for the Saltram preferred options at Site 3, Alternative A and Site 3 Alternative B in combination with Site 4.

The two preferred options at site 3 are similar and as such budget estimates for both options are the same.

Table 5.2: Saltram Park Green Bridge - Preferred Option (Site 3)		
Pre-Design Budget Estimate Summary		
Series	Series Description	Estimate £
100	Preliminaries (excluding Traffic Management etc.)	1,155,022.73
100A	Traffic Management	1,413,578.44
200	Site Clearance	50,000.00
300	Fencing	65,244.21
400	Road Restraint Systems	67,541.00
600	Earthworks	342,907.00
1600	Piling	108,000.00
1700	Structural Concrete	1,618,290.73
1800	Structural Steelwork	3,006,310.68
2000	Waterproofing	63,030.60
2300	Bridge Expansion Joints and sealing of gaps	323,220.47
3000	Landscape and Ecology	51,968.00

	Subtotal	8,265,113.86
	Fee	495,080.32
	20% Risk	1,752,038.84
	TOTAL	10,512,233.02

The following assumptions were made during the formation of this price:

- Design - Not allowed for within price. No allowance for STATS, Landowner agreements, CPO's, etc related to N2 costs.
- Duration - Assumed 60 weeks.
- Preliminaries - Assumed 6 office units, 2 x toilet blocks, canteen and storage container in main compound. Container, canteen and toilet on opposite side of bridge.
- Wheel wash - Assumed gatesman, gate house and washer bowser required.
- Site vehicles - Assumed 3 site vehicles required.
- Road Sweeping - Assumed required twice a week.
- Barrier Guard - Assumed barrierguard required on hard strip to protect work force from traffic and to stop soil slipping on to carraigeway.
- Haul Roads - Assumed 1000m x 6m required for Haul Roads. Assumed 300mm thick Type 1 on Terram.
- VRS - Assumed 50m required each side on A38 in front of bank seats
- Ducts - Assumed 3nr ducts installed for future use on each parapet (total 6 nr)
- Earthworks - Assumed 10m working space at either end of bank seats required
- Piling - Assumed bored piles required for bank seats.
- Reinforcement - Assumed 300kg/m³ of rebar required
- Concrete protection to waterproofing - Assumed 250mm thick

6 Conclusion

The provision of green bridges to create safe routes for wildlife, whilst improving the economic and social situation has been tried and test on the Continent and in North America. However, this concept has been slow to catch on in the UK. It is likely that if the A38 were to be constructed in the present day there would be a requirement to provide a green bridge at both Slatram and Haldon Hill.

Traditionally green bridges across the world have had the sole function of providing safe passage for wildlife (generally large mammals), from one side of a highway to the other. Whilst the green bridges that are the subject of this report will provide this function, particularly the bridge at Haldon which will solve the DVC issue, they will both have added economic and social benefits.

6.1 Haldon

The initial motivation behind promoting a green bridge at this location was to solve the ever growing issue of DVC's. Research has shown that Haldon is a hot spot for these collisions and a serious incident is just a matter of time. It is now clear that the benefits extend much further and a structure in this location will also provide several environmental, economic and social benefits. As well as reconnecting the SSSI, it will enable the expansion of the leisure and recreational facilities provided by the FC, allowing access to huge areas of woodland currently not being utilised. This will mean increased visitor numbers, boosting spend and investment to benefit the numerous businesses in the near-by vicinity, creating new jobs and opportunities.

The creation of new cycling routes along Haldon Ridge will mean better green links for local communities for example; between Kennford and Chudleigh. It will solve anti-social behaviour issues that currently exist due to the isolated location of certain car parks. This will result in increased numbers of people partaking in the outdoor activities that are provided at Haldon leading to associated wellbeing benefits.

Three sites were identified as possible locations for a green bridge at Haldon and were subject to further investigation. Only one bridge configuration option was considered at site 1 and 2 in contrast to 3 options at site three.

Based on the Lidar long sections and the preliminary bridge configuration it is recommended that Site 2 should be considered for a more detailed topographic survey and the preliminary design be developed to provide sufficient detailed drawings etc. for consultation with third parties.

There are two key constraints known about at present that will require further investigation; the dormouse population in the central reservation at Haldon and the land occupied by FC on a leasehold basis which will require the cooperation of the freeholder.

The current budget estimate for the preferred option at Haldon is **11,403,001.81**.

6.2 Saltram

The provision of a green bridge at Saltram was first identified by the National Trust and PCC within the Saltram House Master Plan and the PCC's Green Infrastructure Plan. However, the size, complexity and cost of the project means that it is not something they would be able to undertake. As with Haldon, it became clear that a structure in this location will also provide numerous environmental, economic and social benefits. The green bridge would facilitate the free movement for people and wildlife (bats are of particular importance). Local residents and recreational users can walk and cycle through the landscape and improve their wellbeing. The bridge will reconnect the historic landscape allowing access to Hardwick Woods, an area of ancient woodland which is currently underutilised.

Visitor numbers to the Saltram Estate would increase, boosting spend and investment to benefit the numerous businesses that rely on the Estate, creating new jobs and opportunities. New cycling routes will mean better green links for local communities, reconnecting current and future (i.e. Plymstock Quarry and Sherford) residential areas south of the A38 to Plymouth enabling more sustainable methods of commuting.

Four sites were identified as possible locations for a green bridge at Saltram and were subject to further investigation. Several bridge configuration options were considered at each site.

Based on the Lidar long sections and the preliminary bridge configuration it is recommended that Site 3, Alternative A and Site 3 Alternative B in combination with Site 4 should be considered for a more detailed topographic survey and the preliminary design developed to provide sufficient detailed drawings etc. for consultation with third parties.

The key constraints known about at present that will require further investigation involve construction and ground levels; i.e. insufficient space in the central reserve for a bridge pier, over spanning the county road that runs parallel to the A38, earth works on the approach ramps will be required due to the ground levels.

The current budget estimate for the preferred options at Saltram site 3, alternative A and alternative B in combination with site 4 is **£10,512,233.02**.