

A417 Missing Link
TR010056

6.4 Environmental Statement
Appendix 2.1 EMP Annex D
Landscape and Ecological
Management

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A417 Missing Link

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**6.4 Environmental Statement
Appendix 2.1 EMP Annex D Landscape and Ecological Management**

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Annex D Landscape and Ecological Management Plan

1 Introduction

1.1 Purpose of the report

- 1.1.1 This document forms Annex D of Appendix 2.1 Environmental Management Plan (EMP) (Document Reference 6.4). Annex D is a Landscape and Ecological Management Plan (LEMP) for the A417 Missing Link scheme (the scheme). The LEMP sets out how the landscape design and ecology mitigation measures would be delivered and managed for the scheme to promote the conservation and enhancement of the AONB.
- 1.1.2 Annex D Landscape and Ecological Management Plan is secured by environmental commitment L1 in the Register of Environmental Actions and Commitments (REAC). The REAC described in Table 3-2 of Appendix 2.1 EMP (Document Reference 6.4) presents an initial register which has been developed using information presented in the ES. The EMP and its associated Annexes will be updated by the contractor when preparing the EMP (construction stage) and then 'as required' as the scheme progresses.
- 1.1.3 This LEMP follows Table 1-1 Delivery schedule and updates of the EMP outlined in Appendix 2.1 Environmental Management Plan (EMP) (Document Reference 6.4).
- 1.1.4 The LEMP would be refined and updated at detailed design as part of the EMP (construction stage).
- 1.1.5 Upon completion of construction of the scheme the EMP (construction stage) must be converted into the EMP (end of construction stage). The scheme must be operated and maintained in accordance with the approved EMP (end of construction stage) which is secured by requirement 3 of the draft DCO.
- 1.1.6 The EMP (end of construction) will be implemented by the maintenance authority responsible for the maintenance of the scheme during the operational phase.
- 1.1.7 The approach and strategy for handover into operation and maintenance shall be defined and agreed prior to the commencement of construction, and reviewed as the scheme progresses, in accordance with DMRB GG 182 Major schemes: Enabling handover into operation and maintenance.
- 1.1.8 This document is structured as follows:
- Section 1 – Sets out roles and responsibilities for disciplines and people involved in the project. Section 1.4 provides a introduction and description of The Project, followed by section 1.5 which sets out the project objectives;
 - Section 2 – Sets out the landscape actions and commitments; and
 - Section 3 – Sets out the ecological actions and commitments;
 - Section 4 – Provides recommended pre/during construction and post construction monitoring;
 - Section 5 – Sets out other ecological structures and habitats; and
 - Section 6 – Provides detail of handover maintenance obligations.

1.2 Roles and responsibilities

- 1.2.1 The key team members with responsibilities for implementation of this LEMP are provided in Table 1-1.

Table 1-1 LEMP roles and responsibilities

Position	/responsibilities
Contractor Environmental Manager	Full-time environmental manager to be appointed by the contractor who would be responsible for developing the second and third iterations of the LEMP and implementing the LEMP during construction to end of construction. The environmental manager would oversee two key clerk of works roles.
Contractor Biodiversity Consultant	Consultant appointed by the contractor to carry out the landscape and ecological design, environmental consultancy, and inspection work.
Landscape Clerk of Works (LCoW)	The LCoW would be appointed by the contractor and be responsible for ensuring the landscape design proposals are correctly implemented, monitored and maintained in accordance with the requirements of the scheme design and LEMP. This will include involvement with landscape earthworks, vegetation protection, clearance, soil stripping/storage, landscape earthworks, planting proposals (woodland, trees, hedgerows, seeding) including liaison with the landscape planting contractor, nursery visits, approval of stock at nursery and on delivery, hard materials approvals, construction detailing and monitoring of hard materials including footpaths, surfacing, footpaths, bridleways associated drystone walling, fencing, signage. The LCoW will work in close liaison with the Ecological Clerk of Works (ECoW) throughout the construction period to end of construction.
Ecological Clerk of Works (ECoW)	The ECoW would be responsible for ensuring ecological mitigation measures are correctly implemented, monitored and maintained in accordance with the requirements of the scheme design and LEMP. This will include nesting bird checks, movement of protected species to appropriate mitigation areas, overseeing of vegetation clearance and topsoil stripping, approval of mitigation structures. The ECoW will ensure that suitably experienced ecologists are contracted to undertake monitoring for protected species. The ECoW will ensure method statements within protected species licencing are followed.

Working groups

- 1.2.2 The contractor shall establish a Working Group to continue engagement on landscape and ecology with relevant stakeholders during the construction of the scheme.
- 1.2.3 The group would meet at regular intervals during the construction stage through to end of construction to provide independent advice on the development of the landscape and ecological detailed design, construction and management of the scheme.
- 1.2.4 Consultation should be undertaken with key stakeholders including county and local authorities, district authorities, Cotswold Conservation Board, Natural England, National Trust, Gloucestershire Wildlife Trust, plus a range of other landscape, heritage wildlife and ecological stakeholders and representatives of affected landowners.

Programme

- 1.2.5 Construction is expected to start in early 2023, however, Highways England may be in a position to commence preparatory works in late 2022, subject to the consents and approvals set out in the Consents and Agreements Position Statement (Document Reference 7.2) having been obtained. The programme for ecological mitigation would be integrated into the preparatory works programme.

- 1.2.6 Following construction of newly seeded, planted or constructed elements, the initial aftercare landscape and ecological maintenance and monitoring operations are to be carried out by the contractor as part of their works up to end of construction.
- 1.2.7 The contractor's aftercare maintenance period starts immediately following end of construction. The contractor shall carry out maintenance and monitoring of the landscape and ecological works for a period of 5 years.
- 1.2.8 All landscape and ecological works shall be carried out by suitably qualified and experienced professionals in landscape and ecological construction activities. Experts would be appointed for specialist activities in horticulture, arboriculture and/or ecology as required during construction and for maintenance and management activities as appropriate. All management operations shall be carried out according to the project contract requirements.

1.3 The project

Landscape and ecological context

- 1.3.1 The scheme is set within a nationally important landscape of the Cotswolds Area of Outstanding Natural Beauty (AONB). The area also features nationally important Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Ancient Woodland and areas with local ecological designations. Habitats of principal importance at the site include broadleaved woodland, calcareous grassland and hedgerows which support a number of protected species. Heritage assets are also a key component of the AONB landscape character reflecting a rich history of human interaction since the early Neolithic period. In addition, the public rights of way network in the area is extensive and the main way for residents and visitors to explore and enjoy the Cotswolds landscape. Key rights of way include the Cotswold Way National Trail positioned on the Cotswold escarpment and the Gloucestershire Way long distance footpath near the existing Air Balloon roundabout.
- 1.3.2 Given this context the A417 'Scheme Vision'³ reflects the importance of the landscape design and ecological measures in relation for the scheme, describing it as:

*"A landscape-led highways improvement scheme that will deliver a safe and resilient free-flowing road whilst conserving and enhancing the special character of the Cotswolds AONB; reconnecting landscape and ecology; bringing about landscape, wildlife and heritage benefits, including enhanced visitors' enjoyment of the area; improving local communities' quality of life and contributing to the health of the economy and local businesses."*³

2 Landscape actions and commitments

2.1 Introduction

2.1.1 DMRB LD117 ‘Landscape design’² has been followed in the development of the landscape design proposals for the scheme.

2.2 Reference documents

2.2.1 Reference should be made to the following:

- Normative references (Ref 1N to Ref 5N) and Informative references (Ref 1.I to Ref 3.I) contained in HE DMRB LD117 - Landscape design.
- Normative references (Ref 1N to Ref 13N) contained in HE DMRB LD119 - Roadside environmental mitigation and enhancement.
- Normative references (Ref 1N to Ref 7N) and Informative references (Ref 1.I to Ref 9.I) contained in HE DMRB LD118 - Biodiversity design.

2.3 Landscape management approaches

2.3.1 The landscape design proposals are shown on ES Figure 7.11 Environmental Masterplan (Document Reference 6.3).

Environmental function codes

2.3.2 ES Figure 7.11 Environmental Masterplan (Document Reference 6.3) uses environmental function codes to illustrate the function of each landscape element that forms the scheme. The function codes define the principal function of the landscape element as defined in Table 4.2a in LD117 and are provided in Table 2-1.

Table 2-1 Environmental function codes

Code	Principal function
EFA	Visual screening
EFB	Landscape Integration
EFC	Enhancing the built environment
EFD	Nature conservation and biodiversity
EFE	Visual amenity
EFF	Heritage
EFG	Auditory amenity
EFH	Water quality

2.3.3 This information is critical to understand the management activities that are required over time for each ‘landscape element’ so that its required function or functions can be achieved and/or maintained.

2.3.4 Note that the function codes relate to the landscape element’s required principal function e.g. a landscape element of woodland planting for ‘visual screening’ (EFA) will also deliver nature conservation and biodiversity benefits, but the element with this code must be principally managed to achieve its screening function. In most cases a single code has been allocated, but in some cases more than one code has been used. In these cases, the management would seek to equally achieve each function.

Landscape element codes

- 2.3.5 The landscape element code defines the elements that make up the landscape design for the scheme and will be managed to achieve the function as defined above. Note that landscape elements include a range of measures including planting and seeding and hard elements such as landscape earthworks, boundary walls and works to cultural heritage features.
- 2.3.6 The landscape element codes employed for the scheme are provided in Table 2-2.

Table 2-2 Landscape element codes

Code	Principal function
LE 1.3	Species rich grassland
LE1.3a	Calcareous grassland (conservation grassland)
LE1.4	Rock and scree
LE2.1	Woodland
LE2.2	Woodland edge
LE2.4	Linear belts of shrubs and trees
LE2.8	Scrub
LE4.2	Native species hedgerows (trimmed)
LE4.3	Native species hedgerows
LE4.4	Native hedgerows with trees
LE5.1	Individual trees
LE6.1	Water bodies and associated plants
LE7	Hard landscape features – stone walls
P3.1	Cultural heritage feature
E1.2	Noise barrier-built elements
E1.3	Noise-reducing earthworks
E3.1	Protected species
E3.2	Ecological protection measures

- 2.3.7 All maintenance and management activities would be undertaken in such a way as to allow healthy plants to develop and thrive, unhindered by unwanted weed growth or other inhibiting factors and ensure interventions are safe and functional for use as described.
- 2.3.8 All maintenance and management operations relating to the LEMP are to be carried out in accordance with good horticultural, arboricultural and ecological practices and industry standards. All staff employed to carry out maintenance operations shall be suitably experienced. A list of best practice and industry standards would be developed and added to the LEMP (construction stage).
- 2.3.9 Maintenance and monitoring of newly planted and seeded areas shall be undertaken for the first five years to ensure the successful establishment of the planting proposals, in line with the requirements of the Environmental Masterplan and Environmental Statement to achieve the defined mitigation functions.
- 2.3.10 Following the establishment period, after the first five years, monitoring would consist of annual checks with recommendations made to ensure the maintenance is adjusted to suit the establishing planting and habitats.

2.3.11 Brief descriptions of the maintenance activities for each element are provided with the descriptions of the landscape elements in section 2.4 to section 2.19.

2.4 LE1.3 Species rich grassland

Objective

2.4.1 To create and establish species rich neutral grassland in damp areas to create healthy diverse wildflower meadow.

2.4.2 Typical maintenance requirements are described in Table 2-3 but are subject to development for future iterations of this LEMP.

Table 2-3 Species-rich grassland maintenance requirements overview

Asset	Cyclical activities	Frequency
Species rich wet meadow sward (once established by year 2 see alternative management methods)	Cut or graze to suppress growth of weed species and encourage wildflower species	Once annually for the first 2 years
	<p>Mowing: Cut or graze to suppress growth of weed species and encourage wildflower species.</p> <p>Grass to remain uncut until late September or until all desirable flowers have gone over and shed their seed. Cut to a height of 75-150mm.</p> <p>All arisings to be removed and disposed of off-site.</p> <p>-or-</p> <p>Grazing: Alternatively, the sward can be grazed during this period to achieve a similar effect. Manage area to be grazed using temporary fencing to optimise the diversity of ground flora species resilience of the sward for the benefit of wildlife and future grazing. Manage timings and stocking rates to minimise poaching and erosion damage to the soil. Graze the area in drier periods, avoiding spring and winter or when the ground is waterlogged.</p>	Once annually ongoing

2.5 LE1.3a Conservation grassland - Calcareous grassland

Objective

2.5.1 To establish and create diverse mosaics of calcareous grassland. Depending on function, these would range from closed species-rich swards through to sparsely vegetated bare ground and rock.

2.5.2 Calcareous grassland seed mix to be specified to match existing community type and species mix. To achieve this the contractor shall work with the project ecologist and local stakeholders including (Gloucestershire Wildlife Trust, Cotswolds Conservation Board and National Trust) to harvest and collect local provenance seed via green hay cutting and local seed harvesting.

2.5.3 The broad target is for a species-rich short-turf open calcareous grassland community, with little scrub encroachment and areas of sparsely vegetated ground, typically vegetated with butterfly attracting species such as kidney vetch.

2.5.4 New areas of calcareous grassland will be managed to create new species-rich communities that would enhance with the character of the existing AONB Landscape.

2.5.5 For calcareous grassland monitoring, a target National Vegetation Classification (NVC) community will inform ongoing management of the habitat.

- 2.5.6 Calcareous grassland structure and community composition is strongly affected by management such that maintaining an early successional community is dependent as much on the short-term and long-term management of the grassland as the species mix which is initially sown.
- 2.5.7 Typical maintenance requirements are described in Table 2-4 but are subject to development for the second iteration of this LEMP.

Table 2-4 Calcareous grassland maintenance requirements overview

Asset	Cyclical activities	Frequency
Species rich grass calcareous sward	<ul style="list-style-type: none"> For the establishment period, visually inspect vegetation growth every month during the growing season. Set up mowing regimes or actions to ensure the sward is developing a rich and diverse sward and certain weed or dominate grass species are not at risk of out-competing established seedlings. Grazing would be prevented for the first three years during establishment to allow seedlings to develop sufficient root systems and coverage. 	Twice annually for the three years or as long as necessary to establish a sward
	<ul style="list-style-type: none"> Cut or graze to suppress growth of weed species and encourage wildflower species. Once an even sward is established (i.e. one not dominated by a small number of competitive species) mow once or twice a growing season. Mowing: Cut the grass during February and March. This is before most flowering of verge plants and to avoid breeding bird season for ground-nesting birds, check with suitably qualified ecologist. Raising the cutter bar on the back cut will lower the risk to amphibians, reptiles and small mammals. Second cut to take place between September and October. This slightly later cutting date allows plants that were cut earlier in the year time to grow and set seed. This cutting regime is particularly suited to areas with late-flowering species, such as devil's-bit scabious (<i>Succisa pratensis</i>), which may not flower and set seed until September. It is also suited to areas with early flowering plants, such as cowslips (<i>Primula veris</i>), as it removes any shading vegetation prior to flowering. All arisings to be removed and disposed of off-site to a suitable location for composting Where specified on the Environmental Masterplan some areas of grassland would be left for a year or more between cuts to provide dense ground level cover for reptiles, small mammals and invertebrates. <p>-or-</p> <ul style="list-style-type: none"> Grazing: Alternatively, the sward can be grazed during this period to achieve a similar effect. Manage Grazing using temporary fencing to optimise the diversity of ground flora species resilience of the sward for the benefit of wildlife and future grazing. Manage timings and stocking rates to minimise poaching and erosion damage to the soil. Graze the area in drier periods, avoiding spring and winter or when the ground is waterlogged 	Twice annually ongoing

Monitoring

- 2.5.8 Monitoring would be required to confirm that creation of calcareous grassland has been successful. Monitoring criteria would be adapted from the condition assessment checklist for calcareous grassland communities such as CG2, CG3 and CG5 as set out in the Common Standards Monitoring Guidance for Lowland Grassland Habitats produced by the JNCC (2004)⁴.
- 2.5.9 Target states for species richness, percentage bare ground and sward height (for example) for different areas of grassland will be developed in consultation with the Working Groups. These targets will be monitored annually, and maintenance adjusted to ensure success of the calcareous grassland.

2.6 LE2.1 Woodland

Objectives

- 2.6.1 To create and establish healthy mixed broadleaved woodland with climax trees with appropriate understorey vegetation, depending on the required function.
- 2.6.2 Woodland would be managed for the diversity of woodland plants to benefit biodiversity and to enhance the character of the local landscape. Once established, woodland should be managed so that its required function is maintained.
- 2.6.3 New areas of woodland planting would be managed to match the form and appearance of existing woodlands in the AONB landscape as far as possible. They should also be managed to link seamlessly with areas of existing woodland and vegetation. Local provenance species would be used in more sensitive areas such as the SSSI.
- 2.6.4 Species selection would consider the potential effects of future climate change to ensure long term resilience. Therefore, species mixes are likely to require a percentage of non-native species that would be better adapted to drier/drought conditions, an increase in intensity of rainfall events/flooding, longer growing seasons and greater resistance to disease. Non-native species would be placed within the woodland areas to ensure native species appear along woodland edges to maintain AONB landscape character. The details around the planting of non-native species would be considered and agreed following consultation with the relevant consultees within a Working Group. Further site-specific details on species selection are presented within section 2.19.
- 2.6.5 Woodland mixes required for visual screening will contain a percentage of larger, faster-growing stock such as feathered, standard, and more mature trees. These 'nurse species' will be planted at close spacings (say 1m) then be thinned out over time as the climax woodland develops as part of ongoing maintenance activities.
- 2.6.6 Typical maintenance requirements are described in Table 2-5 but are subject to development for the second iteration of this LEMP.

Table 2-5 Woodland planting maintenance requirements overview

Asset	Cyclical activities	Frequency
New woodland planting	<ul style="list-style-type: none"> Keep woodland areas weed and litter free always Carry out regular walk over inspections in late summer Investigate any failed growth of trees, take remedial action and replant with replacement plant stock to levels that will ensure 	Annually for the first five years

Asset	Cyclical activities	Frequency
	<p>the required function of the planting area will be achieved (approximate 80% coverage)</p> <ul style="list-style-type: none"> • Inspect for pests, diseases and undertake remedial action • Annual formative pruning and shaping of canopy as required to encourage balanced growth • Control any invasive growth • Water as necessary to maintain healthy growth, particularly in times of low rainfall in summer (at least the first five years). • Keep areas 1m in dia. around each new plant weed free, by herbicide treatment, strimming or hand pulling, until 100% canopy cover has been achieved • Cut plants back where they overhang hard surface, structures and grass areas excessively, pay particular attention to vegetation on overbridges to prevent branches overhanging the carriageway • Check tree stability and adjust tree stakes and ties as necessary • Maintain rabbit-proof fencing, tree guards and ties in line with good horticultural practice, then remove after 3-5 years once trees and shrubs are established • Fertilizer application in April as required depending on growth • Water via a bowser during establishment phase and during prolonged periods of drought (plus 3 weeks with no rain) 	
	<ul style="list-style-type: none"> • Thin woodland, by selective tree removal, as necessary to reduce competition for space • Establish an even mix of species or remove species to restore a healthy balanced mix • Pile dead wood and felled wood in habitat piles scattered throughout the woodland locations agreed with the ECoW 	Once at year 5 and as necessary thereafter
	<ul style="list-style-type: none"> • Selective thinning and felling of trees within groups to allow more valuable trees space to develop • Thin out fast-growing nurse species at regular intervals as climax vegetation develops its required function • Remove spiral guards and tube shelters after 5 years or as necessary to ensure plants are not constricted • Arboricultural review of understorey annually during the establishment phase then every two to three years, and plan any maintenance activities such as coppicing, replanting or thinning works to maintain the woodland in healthy condition ensuring it maintains its original function • Arboricultural review of tree health annually and carry out any recommended arboricultural works to maintain woodland in healthy condition • Maintain appearance and species diversity of woodland in line with good horticultural practice ensuring that function is maintained (see Environmental function codes) 	Year 5 and ongoing

2.7 LE2.2 Woodland edge

Objective

- 2.7.1 To create and establish healthy mixed broadleaved woodland edges to new and existing woodland areas. These buffer areas would be managed to ensure a smooth ecological transition from climax woodland to field edges and land

boundaries. Final vegetation mixes for woodland edges would be managed to ensure they fulfil the required function as per ES Figure 7.11 Environmental Masterplan (Document Reference 6.3).

2.7.2 Woodland edges would be managed to enhance the character of the local landscape. Once established, woodland edges would be managed so that its required function is maintained.

2.7.3 Woodland edge management would be carried out to ensure new woodland edges match the character of existing woodland edges in the Cotswolds AONB landscape.

2.7.4 Typical maintenance requirements are described in Table 2-6 but are subject to development for the second iteration of this LEMP.

Table 2-6 Woodland edge planting maintenance requirements overview

Asset	Cyclical activities	Frequency
New woodland edge planting	<ul style="list-style-type: none"> • Keep woodland edge areas weed and litter free always • Carry out regular walk over inspections in late summer when trees are in leaf • Investigate any failed growth of trees, shrubs and groundcover, take remedial action and replant with replacement plant stock to levels that will ensure the required function of the planting area will be achieved (approximate 80% coverage) • Inspect for pests, diseases and undertake remedial action • Pruning and shaping as required to encourage balanced growth. • Control any invasive weed growth • Water as necessary to maintain healthy growth, particularly in times of low rainfall in summer (at least the first five years). • Keep areas 1m in dia. around each new plant weed free, by herbicide treatment, strimming or hand pulling, until required density of woodland edge has been achieved. • Cut plants back if they overhang hard surface and grass areas excessively. • Check plant stability and adjust any staking or guying as necessary • Maintain any rabbit-proof fencing, plant guards, ties and accessories in line with good horticultural practice • Fertilizer application in April as required depending on growth 	Annually for the first five years
	<ul style="list-style-type: none"> • Selective vegetation removal, as necessary to reduce competition for space • Remove an even mix of species or remove species to restore a healthy balanced mix • Pile any dead wood and felled wood in habitat piles in locations agreed with the ECoW 	Once at year 5 and as necessary thereafter
	<ul style="list-style-type: none"> • Selective vegetation removal, as required to allow more valuable species space to develop • Remove any planting accessories including fencing, spiral guards and tube shelters after 5 years or as necessary to ensure plants are not constricted • Arboricultural review of understorey annually and plan any maintenance activities such as coppicing, replanting or thinning 	Year 5 and ongoing

Asset	Cyclical activities	Frequency
	works to maintain the woodland in healthy condition ensuring it maintains its original function <ul style="list-style-type: none"> • Arboricultural review of tree health annually and carry out any recommended arboricultural works to maintain woodland in healthy condition • Maintain appearance and species diversity of woodland edge in line with good horticultural practice 	

2.8 LE2.4 Linear belts of shrubs and trees

Objective

- 2.8.1 To create and establish healthy shrub and tree belts that would provide a screening function whilst fitting with the local AONB landscape character.
- 2.8.2 Linear belts of shrubs and trees would be managed to enhance the character of the local landscape. Once established, belts should be managed so that their required function is maintained.
- 2.8.3 Typical maintenance requirements are described in Table 2-7 but are subject to development for the second iteration of this LEMP.

Table 2-7 Woodland planting maintenance requirements overview

Asset	Cyclical activities	Frequency
Linear belts of shrubs and trees	<ul style="list-style-type: none"> • Keep Linear belt areas weed and litter free always • Carry out regular walk over inspections in late summer when trees are in leaf • Investigate any failed growth of trees and/or shrubs, take remedial action and replant with replacement plant stock to levels that will ensure the required function of the planting area will be achieved (approximately 90-95%) • Inspect for pests, diseases and undertake remedial action • Annual formative pruning and shaping of the belt as required to encourage balanced growth. • Control any invasive growth • Water as necessary to maintain healthy growth, particularly in times of low rainfall in summer (at least the first five years) • Keep areas 1m in dia. around each new plant weed free, by herbicide treatment, strimming or hand pulling, until 100% canopy cover has been achieved • Cut plants back where they overhang hard surfaces, structures and grass areas excessively, pay particular attention to vegetation on overbridges to prevent branches overhanging the carriageway • Check tree and shrub stability and adjust planting accessories such as fencing, tree stakes and ties as necessary in line with good horticultural practice • Fertilizer application in April as required depending on growth 	Annually for the first five years
	<ul style="list-style-type: none"> • Thin woodland belt if required, by selective tree/shrub removal, as necessary to reduce competition for space • Pile dead and felled wood in habitat piles in a location to be agreed with the ECoW 	Once at year 5 and as necessary thereafter

Asset	Cyclical activities	Frequency
	<ul style="list-style-type: none"> • Selective thinning and felling of trees to allow more valuable trees space to develop • Remove planting accessories such as spiral guards and tube shelters after 5 years or as necessary to ensure plants are not constricted • Maintain appearance and species diversity of tree and shrub belts in line with good horticultural practice ensuring that function is maintained as per ES Figure 7.11 Environmental Masterplan (Document Reference 6.3). • Arboricultural review of tree health annually and carry out any recommended arboricultural works to maintain trees and shrubs in healthy condition 	Year 5 and ongoing

2.9 LE2.8 Scrub planting

Objective

- 2.9.1 To create and establish areas of scrub planting with a naturalised appearance to provide species diversity and wildlife cover and resource.
- 2.9.2 Scrub planting would be managed to enhance the character of the local AONB landscape. Once established, belts should be managed so that their required function is maintained.
- 2.9.3 Typical maintenance requirements are described in Table 2-8 but are subject to development for the second iteration of this LEMP.

Table 2-8 Scrub planting maintenance requirements overview

Asset	Cyclical activities	Frequency
Linear belts of shrubs and trees	<ul style="list-style-type: none"> • Keep areas of scrub planting weed and litter free always • Carry out regular walk over inspections in late summer when deciduous species are in leaf • Investigate any failed growth of trees and/or shrubs, take remedial action and replant with replacement plant stock to levels that will ensure the required function of the planting area will be achieved (approximately 80%) • Inspect for pests, diseases and undertake remedial action following best practices • A naturalised appearance is sought but some formative pruning and shaping may be required to encourage balanced growth • Control any invasive growth • Water as necessary to maintain healthy growth, particularly in times of low rainfall in summer (at least the first five years), or during periods of prolonged drought (plus three weeks) • Keep areas 1m in dia. around each new plant weed free, by herbicide treatment, strimming or hand pulling, until 100% canopy cover has been achieved • Cut plants back where they overhang hard surfaces, structures and grass areas excessively, pay particular attention to vegetation on overbridges to prevent branches overhanging the carriageway. • Check tree and shrub stability and adjust planting accessories such as fencing, tree stakes and ties as necessary in line with good horticultural practice 	Annually for the first five years

Asset	Cyclical activities	Frequency
	<ul style="list-style-type: none"> Fertilizer application in April as required depending on growth 	
	<ul style="list-style-type: none"> Thin scrub if required, by selective tree/shrub removal, as necessary to reduce competition for space Pile dead wood and felled wood in habitat piles in a location to be agreed with the ECoW 	Once at year 5 and as necessary thereafter
	<ul style="list-style-type: none"> Selective thinning of scrub areas to allow more valuable scrub space to develop Remove planting accessories such as spiral guards and tube shelters after 5 years or as necessary to ensure plants are not constricted Maintain appearance and species diversity of tree and shrub belts in line with good horticultural practice ensuring that function is maintained as per ES Figure 7.11 Environmental Masterplan (Document Reference 6.3). Arboricultural review of scrub health annually and carry out any recommended arboricultural works to maintain scrub in healthy condition 	Year 5 and ongoing

2.10 LE4.2-4 Hedgerows

2.10.1 This section covers the following hedgerow types:

- LE4.2 Native species hedges (trimmed)
- LE4.3 Native species hedgerows
- LE4.4 Native hedgerows with trees

Objective

2.10.2 To create and establish hedgerows that fulfil a range of functions in line with the Environmental function codes. Hedgerows are proposed to visually integrate the highway, define field boundaries, and provide shelter and function as habitat and wildlife corridors. Hedgerows would comprise native woody species from Schedule 3 of the Hedgerow Regulations 1997⁵ and include a mix of at least seven woody species per 30m of hedgerow.

2.10.3 The principle objectives for management of hedgerows are as follows:

- to maintain at a height suitable to its function, biodiversity value and to be in keeping with the character of nearby hedges within the AONB
- to replace any existing hedgerows removed during construction and to mitigate impacts on hedgerow biodiversity, form boundaries, visual screens and to improve local wildlife corridors
- establish a fully functioning hedgerow community, including the development of ground cover species and perennial sward that would suppress annual weeds
- provide conditions and manage these features to ensure longevity of hedgerow species

2.10.4 Hedgerows should be managed to enhance the character of the local AONB landscape and once established should be managed so that their required function is maintained.

2.10.5 Typical maintenance requirements are described in Table 2-9 but are subject to development for the second iteration of this management plan:

Table 2-9 Hedgerow maintenance requirements overview

Asset	Cyclical activities	Frequency
Native Hedgerows (trimmed)/ Native species hedgerows/ Native hedgerow with trees	<ul style="list-style-type: none"> • Keep hedgerows weed and litter free always • Carry out regular walk over inspections in late summer when deciduous species are in leaf • Investigate any failed growth of hedgerow, take remedial action and replant with replacement plant stock to levels that ensure the required function of the hedgerow will be achieved • Inspect for pests, diseases and undertake remedial action • Maintain 1m bare ground strip alongside hedgerows during establishment, to reduce weed and grass growing and to encourage establishment of woody hedgerow species. • Trimmed hedges as required once in year two, leaving some short sections uncut to ensure the provision of berries as a food source for birds • Growth shall be reduced to the point of the previous cut. • For trimmed hedges on completion the sides of the hedge shall be perpendicular, and the top shall be level and at right angles to the sides. • Trees within hedgerows to be managed in accordance with maintenance specification for individual trees (LE5.1) • During cutting operations, all litter, and debris within the structure of the hedge shall be collected and removed off site. • Annual formative pruning and shaping of hedges as required, ensure clear stem is maintained. Remove dead wood and encourage balanced growth. • Watering as required during the dry months • Cut hedgerows back at the appropriate time of year where they overhang hard surface, structures and grass areas excessively, pay particular attention to vegetation on overbridges to prevent branches overhanging the carriageway. • Check tree and hedge stability and adjust planting accessories such as fencing, stakes and ties as necessary in line with good horticultural practice • Fertilizer application in April as required depending on growth 	Annually for the first five years
	<ul style="list-style-type: none"> • Hedges LE4.2 shall be trimmed once in year two • Hedges LE4.3/4 to be trimmed only if/as necessary to ensure a more natural form is achieved 	Once at year 5 and as necessary thereafter
	<ul style="list-style-type: none"> • Hedges LE4.2 to be cut once a year between September and February, cutting only one side of the hedge each year, alternating sides every year. • Remove any planting accessories including stakes or guards remaining on all hedgerow planting. • Maintain appearance and species diversity of hedgerows in line with good horticultural practice ensuring that function is maintained as per ES Figure 7.11 Environmental Masterplan (Document Reference 6.3). 	Year 5 and ongoing

Asset	Cyclical activities	Frequency
	<ul style="list-style-type: none"> Arboricultural review of hedgerow health annually and carry out any recommended arboricultural works to maintain these landscape elements in healthy condition 	

2.11 LE5.1 Individual trees

Objective

- 2.11.1 To create and establish individual trees within calcareous grassland areas to create wood pasture habitat for the benefit of biodiversity and in other areas to guide bats and barn owl away from the road towards other wildlife corridors and glade areas. To enhance landscape character throughout and create new avenue planting in the lead up and crossings of the Stockwell and Cowley overbridges.
- 2.11.2 Trees are to be maintained in a safe and healthy condition to promote growth, achieve good form and longevity. Management should be arranged and varied as required for each individual tree so that it fulfil and maintains its required function (see Environmental function codes from DMRB LD 117, Table 4.2a). Refer to Table 2-10 for further details.
- 2.11.3 Maintain trees with adequate clearance to crown and without obstruction to vehicles, walkers, horse riders and cyclists.
- 2.11.4 Maintain trees using good horticultural practice to establish a healthy tree canopy and good root system.

Table 2-10 Individual tree planting maintenance requirements overview

Asset	Maintenance requirements 0-5 years	Frequency
Scattered tree planting	<ul style="list-style-type: none"> Maintain 1m minimum diameter weed-free area by herbicide to trees always Investigate any failed growth of trees, take remedial actions, and replace annually to ensure 100% replacement Inspect trees for pests, diseases and undertake remedial action Check tree stability and adjust tree accessories including tree ties and stakes annually or as necessary Carry out annual formative pruning and shaping of canopy as required, and to ensure clear stem is maintained. Remove dead wood and encourage balanced growth Water as necessary to maintain healthy growth, particularly in times of low rainfall in summer (at least the first five years) 	Annually for the first five years
	<ul style="list-style-type: none"> Fertilizer application in April of the second and fourth years, as required depending on growth 	Year 2 and 4
	<ul style="list-style-type: none"> Remove tree accessories including stakes and ties after 5 years subject to inspection 	Year 5
	<ul style="list-style-type: none"> Maintain appearance of trees as individual specimens in line with good horticultural practice ensuring that function is maintained as per ES Figure 7.11 Environmental Masterplan (Document Reference 6.3). Individual trees for avenues should be maintained to create a uniform line of trees consistent in height and appearance An arboricultural review of tree health is to be carried out annually and any recommended arboricultural works undertaken to maintain individual trees in healthy condition 	Year 5 and ongoing

2.12 LE 6.1 Waterbodies and associated plants

Objective

- 2.12.1 The primary purpose of the waterbodies is control of surface water run-off from the scheme, to avoid increasing flood risk and to maintain or improve the quality of water infiltrating groundwater. An additional purpose is to provide benefits for biodiversity, creating ephemeral wet areas and grassland habitats.
- 2.12.2 Since drainage basins will be dry most of the time, they shall be managed as described in section 2.4 LE1.3 Species rich grassland.
- 2.12.3 The vegetation along the margin of watercourses shall be managed to provide diversity of structure. Natural regeneration of willow (*Salix*) or other woody species shall be controlled as necessary to allow natural light into the watercourse corridor.

2.13 LE7 Hard landscape features

Objective

- 2.13.1 Hard landscape features include a variety of Public Rights of Way, Private Means of Access (PMA), with associated surfacing, new and upgraded parking areas, stone walls, works to cultural heritage features, noise barriers and landscape earthworks.
- 2.13.1 The principle objectives for management of the hard landscape is as follows:
- carry out regular inspections of hard landscape features
 - ensure a safe environment for footpath, cycleway, bridleway surfacing, including new areas of surfacing and hard landscape at all times. Area should be free from projections, sudden changes of level and degraded or missing sections of pavement
 - maintain all hard landscape features in good condition and ensure they maintain their intended function
 - carry out replacement and reinstatement work where necessary
 - undertake a regular programme of cleaning and weed removal as appropriate
 - maintenance and repairs should ensure smooth and safe surfaces
- 2.13.2 Typical maintenance requirements described in Table 2-11 but are subject to development for future iterations of this LEMP.

Table 2-11 Hard landscape elements

Asset	Cyclical activities	Frequency
Hard surfacing, footpath/ cycleway/ bridleway/ parking areas	<ul style="list-style-type: none"> • Regularly inspect (e.g. annually or following storm conditions) surfaces for wear, malfunction etc. carry out reinstatement works including topping up or replacement of surface finish as required to maintain intended appearance and function. Keep areas litter free always, sweep and pick over to keep surfaces clear of debris 	Annually ongoing and following storms
Landscape gates/ fencing/ bollards	<ul style="list-style-type: none"> • Firming up or re-setting of features such as gate posts/ bollards as necessary • ensure correct and smooth operation of the clasp/closing mechanism • Inspect and maintain/oil hinges twice annually or as necessary to ensure correct working order. 	Every 3 months

Asset	Cyclical activities	Frequency
	<ul style="list-style-type: none"> Regularly inspect items for damage, dirt, graffiti, wear malfunction etc. Instigate repair, cleaning, repainting as necessary. 	
Cultural heritage items	<ul style="list-style-type: none"> See 2.14 maintenance notes below 	-
Noise-barrier built elements	<ul style="list-style-type: none"> See 2.15 maintenance notes below 	-
Noise reducing earthworks	<ul style="list-style-type: none"> See 2.16 maintenance notes below 	-

2.14 P3.1 Cultural heritage feature(s)

Objective

- 2.14.1 This element code has been used for selective vegetation clearance of the tumuli within Emma's Grove.
- 2.14.2 The scheduled area would be fenced off clearly during construction to prevent accidental damage and only specified approved works would be undertaken in this area.
- 2.14.3 Selective vegetation clearance would be carried out following arboricultural inspection in collaboration with the cultural heritage team. An arboricultural report would be produced with recommended arboricultural works for vegetation clearance including methodologies required for working within this sensitive designated heritage site. The methodology for vegetation clearance in this scheduled area will be agreed with Historic England.
- 2.14.4 Follow up maintenance inspections by the Contractor will be required during the 5 year after care period, following the arboricultural work to maintain the appearance of the site in terms of controlling potential further natural regeneration of vegetation to ensure the cleared area remains clear of vegetation.
- 2.14.5 This environmental code also covers Cotswold stone walls that act as the highway boundary. Maintenance works to the stone walls would include regular inspection to ensure stability and completeness with recommendations for any repair or maintenance work that is required.
- 2.14.6 Locations identified within Annex C Detailed Archaeological Mitigation Strategy and Overarching Written Schemes of Investigation (Document Ref 6.4), shall be protected from landscape planting and other works which might cause damage to identified buried archaeology.

2.15 E1.2 Noise barrier-built elements

Objective

- 2.15.1 This element code has been used for noise barrier built elements. The proposal is for planted or vegetation noise barriers, and their design has not been confirmed at this stage. Maintenance operations would therefore be developed and confirmed at a later stage. Barriers shall comply with LD 119 and BS EN 14388 and be acceptable to the operational area team.

- 2.15.2 Ensure that noise barriers remain in a functional state of repair at all times. Replace any section of barrier that is damaged or missing with similar to match remain section.
- 2.15.3 Maintenance operations would include operations to establish vegetation and thereafter inspections to maintain the design function and intended appearance of these structures.

2.16 E1.3 Noise-reducing earthworks

Objective

- 2.16.1 Earthworks primarily to act as noise bunds include the landscape earthworks as integral design elements in the scheme design that will serve multiple functions:
- visual screening
 - integration of the route into the AONB landscape
 - noise attenuation
 - return of land for agricultural use
- 2.16.2 The intention is that the 'back slopes' of the earthworks would be returned through legal agreement with the local landowners for agricultural purposes. The earthworks would then integrate into the adjacent field and be managed as part of the landowner's land holding. Covenants would be in place to ensure that the earthwork features are maintained appropriately to retain their required function.

2.17 E3.1 Protected species

Objective

- 2.17.1 For management of protected species see Section 3 Ecological actions and commitments, of this LEMP.

2.18 Existing vegetation and habitats

- 2.18.1 When developing the LEMP (construction stage) the contractor will refer to ES Appendix 7.8 Arboriculture Impact Assessment Report (Document Reference 6.4) which provides information on the condition of existing trees, indicative tree groups, veteran trees, species and root protection areas (RPA).
- 2.18.2 Areas of existing vegetation would require protection during construction and the contractor shall follow standard industry guidelines and standards for tree works and tree protection works including British Standard BS5837:2012 Trees in Relation to Design, Demolition and Construction. Veteran trees that can be retained, including the orchard apple at the Air Balloon Pub, would be protected using these methods but also applying protective buffer zones in accordance with Natural England Guidance⁶ where feasible. Retained veteran trees are shown on ES Figure 7.9 Retained vegetation (Document Reference 6.3).
- 2.18.3 All areas of existing vegetation to be retained as identified on the ES Figure 7.11 Environmental masterplan (Document Reference 6.3) would require an arboricultural survey carried out by Arboricultural Association approved consultant and works identified to include:
- Recommended protection measures required during the construction process (including fencing, individual tree protection and confirmation of RPAs).

- Any tree works including pruning, crown thinning, disease control etc to ensure health and longevity of the trees/ vegetation.
- Recommendations when the arboricultural works should be carried out in the programme.
- A protection buffer zone of at least 15m around retained ancient woodland at Ullen Wood would be implemented in accordance with Natural England Guidelines⁷ to reduce the risks of habitat degradation caused by vehicular movements or pollution from dust as a result of construction or activities such as material crushing.
- A buffer of at least 2m between construction areas and hedgerows would also be implemented to protect root zones of the hedgerow but also to maintain a vegetated strip adjacent to the hedgerow for wildlife. Such protection measures required are detailed in the EMP.
- No construction activities or storage of materials etc will be permitted within any RPA or buffer zone during construction.

2.18.4 All vegetation management and clearance work will be consulted on and overseen by the LCoW and/or ECoW.

2.18.5 Where agreed, any tree work will be carried out by an approved member of the Arboricultural Association and will be undertaken in accordance with BS 3998 British Standard for Tree Work and HSE 'Forestry and arboriculture safety leaflets'.

2.18.6 Site specific measures to protect sensitive habitats such as Ullen Wood ancient woodland, from dust deposition caused by activities such as material crushing. Measures will include:

- the location of the material crushing compound would be over 200m from Ullen Wood ancient woodland and the crusher would be sensitively located within the compound area so that dust generating activities would be furthest from the woodland, taking into account prevailing wind directions
- water sprinkler systems to be used whenever there is a risk of dust emissions
- screening bunds or barriers
- no material crushing in high prevailing winds in the direction of the ancient woodland
- removal of crushed materials from site as soon as possible

2.18.7 Site-specific methods, for example silt busters or bales would be used to prevent silt or contaminants from being released into watercourses such as Norman's Brook. Such precautions will be undertaken in accordance with relevant legislation and undertaken in compliance with the relevant Guidance for Pollution Prevention (GPPs) and industry best practice (GPP5⁸, CIRIA).

2.19 Site specific habitat specifications

Woodland and scattered trees

2.19.1 New broadleaved woodland species of native variety characteristic of existing woodland will be planted along the southern verge of the scheme from Brockworth to Crickley Hill to replace what was lost. Woodland planting is also proposed in a field bordering Ullen Wood which would provide a buffer for the ancient woodland and provide connectivity of habitat to the Gloucestershire Way crossing. Similarly, additional trees and scrub would be planted around the eastern edge of Emma's Grove to create a tiered buffer of woodland edge

vegetation including hazel scrub and small trees. Established hazel stands within Emma's Grove which would be lost would be coppiced at the appropriate time of the year and translocated to other areas of the woodland to be retained, or within the new woodland buffer surrounding the retained woodland on the eastern side.

- 2.19.2 Planting new woodland and scrub either adjacent to existing high value habitat such as Ullen Wood or where woodland is lost or fragmented would provide valuable edge habitat to protect the core areas of woodland from variable environmental factors and stresses such as varied light conditions increased wind exposure and pollution. The diverse species mix and structure of edge habitat provides a transition between two habitat types, usually woodland and grassland, and therefore supports a wider array of species. Planting of edge habitat would maximise biodiversity delivery and increase the resilience of existing woodland to climate change.
- 2.19.3 Species selection for new planting would include a diverse mix of native trees of local provenance and characteristic of the local area. The use of non-native species would be considered to provide resilience against the effects of climate change. No ash will be replanted due to the spread of ash die-back disease, however species would be selected that offer similar habitat for lichens and invertebrates and or have similar pollen and nectar production, such as elm, oak and beech. Woodland planting is shown on ES Figure 7.11 Environmental Masterplan (Document Reference 6.3).
- 2.19.4 Scattered trees and lines of trees are found throughout the study area generally within grassland fields and along minor roads. Historic maps show areas of likely wood pasture which some of these trees could be relics of, such as at the south eastern corner of Crickley Hill. Lines of trees would be recreated in the location of Cowley and Stockwell Farm over bridges and scattered trees would be included along the road verges of the repurposed A417. The root zones and canopies of scattered trees to be retained would be protected during construction.

Grassland

- 2.19.5 The most notable grassland habitat within the area is lowland calcareous grassland and some areas of lowland neutral species-rich meadows. All grassland habitat creation will seek to replace and replicate these habitats. Grassland verges of the existing A417 to be repurposed to a WCH route would be widened to create species-rich calcareous grassland. Seeds of native and local provenance would be used, and species chosen which are beneficial for pollinators and other notable invertebrates present in the area. Where possible seed would be sourced by harvesting local meadows or using green hay.
- 2.19.6 Where there is loss of calcareous grassland habitat such as within the Barrow Wake unit of Crickley Hill and Barrow Wake SSSI, it , it will be reinstated using a local seed source. Any turf or topsoil would be used in other areas designated for advanced calcareous grassland habitat creation. A method statement will be developed further during detailed design,
- 2.19.7 A botanically rich grassland meadow is to be unavoidably lost to the north of Shab Hill. This lowland meadow is known to contain an abundance of orchids and assessed as NVC community MG5a, a scarce community of grazed hay meadow. Due to the high botanical value, it is proposed that turf or topsoil is stored from this meadow to retain the seed bank for use in other areas of the scheme designated for habitat creation. Receptor site locations for translocated turf are shown on the ES figure 7.11 Environmental Masterplan (Document Reference

6.3) and methods for grassland translocation would be included in future iterations of Annex D of the EMP (ES appendix 2.1).

Hedgerows

- 2.19.8 Hedgerow surveys identified 13 species-rich hedges within 50m of the scheme. Ten of these are classified as important hedgerows under the criteria of The Hedgerows Regulations 1997 and an additional three hedgerows qualify as important due to features other than biodiversity.
- 2.19.9 The scheme impacts 21 of the 34 hedgerows surveyed with many of these being lost entirely. In total approximately 3,473m of hedgerows would be lost including 1,250m of important hedgerow.
- 2.19.10 Sections of hedgerows of particular importance and species richness that would be lost (Hedges 1, 2, 9,17, 17a, 20, 21, 22, 23,24, 27, 28 and 29 as shown in ES Appendix 8.2 Hedgerow technical report (Document Reference 6.4)) would be assessed and coppiced where suitable prior to the commencement of construction and translocated to other areas of the scheme where hedgerow planting is planned or to in-fill gaps in defunct hedgerows to improve habitat connectivity and mitigate for habitat loss. As part of this process the soil containing hedgerow ground flora would also be translocated. Details of translocation methods would be developed at later design stages to include consultation with key stakeholders. Once translocation works are finalised and agreed, details would be added to the LEMP (construction stage).
- 2.19.11 New hedgerows with standard trees would be planted along much of the eastern section of the scheme and connect areas of woodland or existing habitat where possible to mitigate hedgerow loss and habitat fragmentation. Newly planted hedgerows would be species-rich comprising a mix of at least seven woody native species of local provenance and in keeping with species recorded in the area. A mix of seven species would be planted every 30m of hedgerow in accordance with criteria for an important hedgerow. The species mix would include hazel and honeysuckle to provide food and nesting resource for dormice which are known to be present in the wider area. Where land is not required for construction of the scheme, hedgerow planting would occur in the first suitable season prior to commencement of works to allow some establishment in advance of habitat loss. New hedgerow planting will total 9,024m.
- 2.19.12 Areas of hedgerow translocation and planting are shown in the ES Figure 7.11 Environmental Masterplan (Document Reference 6.3). Planting schedules detailing the species to be used would be further developed and described in the LEMP (construction stage).

3 Ecological actions and commitments

3.1 Introduction

3.1.1 This section covers ecological actions and commitments and follows the DMRB standard LD118 Biodiversity design⁹, that sets out the requirements for ecological survey and design of biodiversity measures on highways projects.

3.2 Reference documents

3.2.1 Reference should be made to the following:

- Normative references (Ref 1N to Ref 7N) and Informative references (Ref 1.I to Ref 9.I) contained in HE DMRB LD118 - Biodiversity design.

3.3 Ecology designations

3.3.1 The statutory ecological designations within, or bordering the scheme (up to 2 km from the scheme) are:

- Crickley Hill and Barrow Wake SSSI (comprising Crickley Hill and Barrow Wake Nature Reserve (within the scheme boundary)
- Knap House Quarry, Birdlip SSSI (167m to the west of the scheme)
- Bushley Muzzard SSSI at Brimpsfield (218m to the west of the scheme)
- Cotswold Commons and Beechwoods SAC (291m to the west of the scheme)
- Cotswold Commons and Beechwoods SSSI (291m to the west of the scheme)
- Leckhampton Hill and Charlton Kings Common SSSI (1.2km to the north east of the scheme)

3.3.2 There are also 11 non-statutory designated sites within 500m of the scheme. These sites include Local Wildlife Reserves (LWR), former Conservation Road Verges (CVR), Local Wildlife Sites (LWS), potential LWS (pLWS) and Ancient Woodland Inventory (AWI) sites.

3.3.3 The non-statutory designated sites within 500m of the scheme are:

- Barrow Wake Gloucestershire Wildlife Trust Reserve LWR (adjacent/within the scheme boundary)
- Crickley Hill Country Park Gloucestershire Wildlife Trust Reserve LWR (adjacent/within the scheme boundary)
- Haroldstone Fields (Crickley Hill) pLWS (adjacent/within the scheme boundary)
- Bentham, Dog Lane Fields pLWS (adjacent to scheme boundary)
- Ullen Woods Ancient Woodland LWS (adjacent to scheme boundary)
- River Frome Mainstream and Tributaries LWS (adjacent to scheme boundary)
- Cowley and Wards Woods LWS (148m to the east of the scheme)
- Hawcote Hill Wood LWS (252m to the south-west of the scheme)
- Coldwell Bottom LWS (281m to the east of the scheme)
- Witcombe and Buckle Wood AWI site (291m to the west of the scheme)
- Birdlip (Hawcote Hill) fCVR (468m to the south west of the scheme).

3.3.4 Locations of these site are shown on ES Figure 8.1 Statutory Designated Sites and Figure 8.2 Non-statutory Designated Sites (Document Reference 6.3).

3.4 Protected species licencing mitigation

- 3.4.1 The details of the mitigation would be agreed with Natural England and documented through the licencing process. Draft Protected Species Licence applications will be submitted to Natural England for informal review prior to the formal licence application to ensure prompt agreement.
- 3.4.2 Following receipt of necessary licences, this section of the LEMP would be developed by the contractor to include the details of mitigation required through the licencing process, and described in the LEMP (construction stage).
- 3.4.3 Formal Protected Species licence applications would be submitted following finalisation of the detailed design, construction schedule and updated ecological survey for the relevant species, if required, and once the Development Consent Order has been granted. The detailed design of relevant mitigation will be transposed into this section of the LEMP (construction stage).
- 3.4.4 Specific mitigation that would be required include, but may not be limited to, the following (note the asterisk indicates those receptors where a mitigation licence or permit is known to be required based on data gathered to date):
- Bats* – pre-construction bat surveys of trees and buildings, provision of alternative roost sites and foraging/commuting habitat, exclusion of existing roost sites and subsequent monitoring of newly created or enhanced roost sites.
 - Badgers* – pre-construction surveys to locate badger setts, provision of alternative setts and associated tasks (such as supplementary feeding), closure of active setts and subsequent monitoring of the replacement setts.
 - Barn owls – pre-construction surveys to locate breeding sites, provision of alternative breeding sites, exclusion of existing breeding sites and subsequent monitoring of the alternative breeding sites.
 - Otters – pre-construction surveys, identification of otter places of shelter, creation of alternative holt sites, exclusion of the existing holts and subsequent monitoring of the alternative holts if required.
 - Roman snail* - pre-construction surveys, identification/creation of receptor sites, translocation and monitoring.
 - Fish* – preconstruction electric fish surveys to refine mitigation requirements and mitigation strategy.
- 3.4.5 Licence method statements for the above species, where required, would be included as appendices to the second iteration of the LEMP within Annex D.

3.5 Essential construction stage mitigation

- 3.5.1 Construction stage mitigation measures are documented within the Register of Environmental Actions and Conditions (REAC) in ES Appendix 2.1 Environmental Management Plan (Document Reference 6.4).
- 3.5.2 In addition to commitments directly linked to mitigation licences obtained from Natural England, additional ecological construction stage mitigation measures will include the following:
- i. pre-construction surveys for badgers (activity and setts)
 - ii. pre-construction surveys for bat roosts (built structures and trees)

- iii. pre-construction checks for Wildlife and Countryside Act 1981 Schedule 9 and The Invasive Alien Species (Enforcement and Permitting) Order 2019 Schedule 2 listed invasive plant species
- iv. pre-construction surveys for otters (activity and holts)
- v. pre-construction surveys for Wildlife and Countryside Act 1981 Schedule 1 birds, including all identified potential nesting site (PNS), temporary roost sites (TRS) and active roost sites (ARS) considered suitable to ascertain whether barn owls are present or absent from works areas;
- vi. pre-construction surveys for Roman snails
- vii. pre-construction surveys for fish, identification/creation of receptor sites, translocation and monitoring prior to realignment of Norman's Brook
- viii. advance planting of woodland hedgerows and grassland where possible and required
- ix. offsite restoration of existing tufaceous formations in degraded condition (restoration of features such as those identified during the 2020 survey, subject to further detailed consultation with Natural England and consideration of any additional or alternative restoration opportunities identified through this consultation)
- x. sensitive timing of works such as the removal of vegetation between September and February, outside of the core breeding bird season. No netting of vegetation would be used to deter birds from suitable habitat (including buildings) prior to clearance or demolition) and dismantling of stone walls during the reptile active season (April to October) to avoid disturbance to hibernating reptiles
- xi. installation of bird boxes in identified retained habitat prior to nesting season
- xii. provision of bat boxes prior to vegetation clearance or structure (including stone walls) demolition works to be installed in retained trees within the vicinity of the roosts either lost or likely to be disturbed
- xiii. provision of 'dead hedges'¹ to allow bats to continue to use established commuting routes during construction
- xiv. sensitive timing of works near known bat roosts (including avoidance of works during the maternity period in the vicinity of the lesser horseshoe maternity roost/multi-species roost at Haroldstone House cottages), badger setts, otter holts
- xv. sensitive timing of works involving Norman's Brook realignment regarding tufa habitat, aquatic macroinvertebrates and fish
- xvi. sensitive timing of ground works and removal of stone walls in key reptile habitat and Roman snail habitat, for example avoidance of hibernation period from October to March (slow-worm and grass snake tend to hibernate from October to March, while adders tend to hibernate from late October/early November to January/February in southern England)¹⁰
- xvii. sensitive timing of works within 100m of barn owl PNS, ARS and TRS (avoiding the key early breeding season)
- xviii. site speed limits to be implemented to reduce potential for injury/direct mortality of wildlife, such as barn owl and otter

¹ When a scheme involves the temporary removal of edge habitat such as woodland edges, hedgerows or tree lines, temporary structures 'dead hedges', can be used to provide connectivity and allow bats to continue along severed flight paths during construction. Such dead hedges may comprise a line of Heras fencing panels or similar with hessian stretched across them to provide a solid structure along which bats can commute. Such structures are only suitable to maintain connectivity for bats over relatively short distances. The structures can be moved during the day to accommodate construction activities, and then put back before dusk so that the mitigation is effective between dusk and dawn every night.

- xix. sensitive timing and non-licensed methodologies written and overseen by ecological clerk of works for temporary drainage maintenance works required to a culvert adjoining a pond at Bentham Country Club that supports great crested newt and in woodland on the northern verge of the existing A417 within 250m of a breeding pond (pond 2a) (as shown in ES Appendix 8.15 Great crested newt survey report (Document Reference 6.4), to ensure that no loss of great crested newt habitat occurs and that killing or injury of individual newts is avoided
- xx. temporary reptile fencing and temporary badger fencing to be installed prior to construction works. Badger fencing would be phased as the scheme progresses. Permanent badger fencing is to be installed prior to scheme operation, as shown on ES Figure 7.11 Environmental masterplan (Document Reference 6.3);
- xxi. installation of temporary fencing to protect retained habitats (i.e. ancient and broadleaved woodland, calcareous grassland) during adjacent construction works;
- xxii. habitat manipulation and or translocation of reptiles from suitable habitat to suitable receptor sites;
- xxiii. [REDACTED]
- xxiv. translocation of valuable habitat such as important species rich hedgerows, trees including hazel coppice or priority grassland habitat to identified receptor sites;
- xxv. habitat manipulation techniques to deter barn owls from entering construction areas, including mowing long grass to reduce foraging potential. Species-rich grassland meadow areas in the Shab hill area to be managed to provide barn owl foraging habitat, providing rough grassland to encourage prey species;
- xxvi. work during hours of darkness will be avoided as far as practicable and where unavoidable, the Contractor will agree any exceptions with the ECoW in advance of construction activities. Should night working be required, these will be discussed with the ECoW and appropriate mitigation put in place as determined by the ECoW (particularly concerning lighting);
- xxvii. where bat roosts are retained within the scheme boundary, the following methods should be incorporated: a) consideration given to seasonal use of roost in defining working methods; b) exclusion zones to be established and maintained; c) any works within 20m of a confirmed roost shall be carried out under the supervision of an appropriate specialist; and d) measures shall be applied to maintain dark conditions within 20m of identified roosts, including measures to avoid light spill from construction lighting onto adjacent habitat, watercourses and key bat flight lines;
- xxviii. avoidance of works within 30m of active badger setts and/or closure of active setts within or near the construction area under licence from Natural England between July and November inclusive;
- xxix. provision of alternative setts to replace any main setts closed under licence from Natural England (to be done in advance of sett closure);
- xxx. closure of excavations overnight or provision of ramps to reduce risk of trapping or injuring wildlife;
- xxxi. consideration of Section 41 Species of Principal Importance (SPI) (S41 of the NERC Act 2006) during habitat clearance and manipulation techniques including ecological watching brief;

- xxxii. the implementation of biosecurity best practice described as ‘check, clean, dry’ to mitigate any potential mobilisation of invasive aquatic plant and macroinvertebrate species and also chytrid fungus which affects amphibians;
- xxxiii. provision of wildlife culverts, underpasses and greened overbridges in line with appropriate stages of construction;
- xxxiv. pollution prevention measures for air quality, noise and the water environment are incorporated within ES Appendix 2.1 Environmental Management Plan (Document Reference 6.4).

3.5.3 It is anticipated that effects of disturbance or risk of mortality to species during construction as detailed in ES Chapter 8 Biodiversity (Document Reference 6.2) would be mitigated through specific construction phase method statements detailing best practice that would address potential impacts on species and prevent committing offences in relation to the Wildlife and Countryside Act, 1981 (as amended) and other relevant legislation. Design stage method statements describing requirements to be met during construction are provided in the following sections and will be developed by the contractor during the detailed design stage and provided in the LEMP (construction stage) prior to construction.

3.6 Ecology method statements

- 3.6.1 The purpose of the method statements is to set out appropriate measures to protect the ecology of the site with special attention to specified ecological resources, as identified in the Environmental Statement. Ecological method statements will be written by an appropriately experienced ecologist who will also oversee compliance.
- 3.6.2 The ecology method statements will:
- Specify measures that would be implemented during construction to ensure that impacts on sensitive ecological features are reduced. This will include a general site toolbox talk written and delivered by a suitably experienced ecologist prior to the start of any construction or site preparation works to ensure contractors are aware of the ecological value of the site and of specific areas of the site where additional measures are required.
 - Outline principles for the monitoring and maintenance of the above features.
- 3.6.3 If significant new ecological information comes to light, then the method statements would be revised accordingly by the scheme ecologist. The design stage method statements will be superseded by final ecology method statements ahead of construction once the scheme has been consented, which will elaborate on the information presented herein.
- 3.6.4 Where reasonably practicable, environmental mitigation has been provided within the design and would be implemented by the contractor within the works. This requires preparatory work to be undertaken ahead of the start of construction to permit timely progress of the programme.
- 3.6.5 The contractor shall, where reasonably practicable, reduce any habitat loss within the land provided for the scheme by keeping the working area to the minimum required for construction of the scheme.

3.7 Badger

- 3.7.1 The potential impacts on badgers during the construction phase are:
- mortality, injury or trapping

- disturbance from noise and vibration
 - habitat loss (including setts) and degradation
 - severance of habitat and barrier to dispersal
- 3.7.2 To reduce the chance of mortality and injury during construction all compound areas will be temporarily fenced off using suitable badger fencing prior to any construction activities.
- 3.7.3 Wildlife fencing for badgers has been included in the scheme design throughout the entire length of the scheme due to the complexity of some of the junction layouts. The fencing is designed to funnel badgers and potentially other species through the wildlife crossings and overbridges and away from potential entry onto the road network, for example via side roads or property access roads to reduce the risk of mortality from road traffic accidents. One-way gates would be provided where this is a risk, so that badgers can exit the road network. The exact location of the one-way gates will be determined by the project ecologist during detailed design. Badger fencing is generally synonymous with the highways fencing location and is shown on ES Figure 7.11 Environmental Masterplan (Document Reference 6.3).
- 3.7.4 A pre-construction badger survey would be undertaken to inform the licence and identify any setts that could be impacted by the scheme. Any setts that would be lost or predicted to be affected as a result of the scheme construction would be closed under a Natural England development licence between the months of July and November with 21 clear days from badger activity prior to commencement of construction. Artificial setts would be provided to replace any main setts which would be lost to the scheme or which would need to be temporarily closed to accommodate the scheme. The artificial setts would be built and in use at least four weeks prior to main sett closure.
- 3.7.5 A badger licence from Natural England will be obtained which would detail mitigation for any impacts including disturbance to any badger sett. This would be drawn up in consultation with Natural England.
- 3.7.6 Best practice methods to avoid mortality to badgers during construction as a result of vehicle collisions or entrapment in excavations would also be implemented:
- Toolbox talks will be provided by the project ecologist to all construction workers to highlight the speed limits and risk of collisions with wildlife and the procedure for covering excavations
 - Construction traffic will obey site speed limits at all times
 - Any excavations to be left overnight will be covered to avoid badgers becoming trapped
 - Where it is not possible to cover an excavation, a gently sloping ramp or battering of the slope will be incorporated into the excavation to allow badgers to climb out
 - The ECoW will inspect all open excavations each morning before work commences to ensure badgers or other wildlife are not trapped
- 3.7.7 Construction activities which cause noise and vibration can result in temporary disturbance which can lead to abandonment of setts and young or in the case of vibration could lead to collapse of sett tunnels leading to mortality. Where badger setts outside the DCO boundary have not required closure, suitable working methods would be adhered to including:

- no works involving heavy machinery or piling to be undertaken within at least 30 metres of an active badger sett
- no storage of construction material within 30 meters of an active badger sett
- ECoW to be consulted prior to any works within 30 meters of an active badger sett
- no tree removal within 30 meters of an active badger sett

3.7.8 The construction activities also have the potential to cause habitat degradation and a potential loss of foraging resource for badgers because of pollution events and run off from construction areas including compounds and spoil heaps. Suitable working methods would be adhered to including:

- no application of chemicals, especially those which are toxic to mammals
- no burning of materials
- spoil heaps should be covered with tarpaulin or sheeting to avoid digging by creation of new sett entrances by badgers or fenced off using badger fencing. Covering the spoil heaps would also reduce the risk of pollution from runoff from the spoil heaps. If spoil heaps are too large to cover, they will be vegetated as soon as possible with a suitable seed mix in agreement with the project ecologist.

3.7.9 Severance during site clearance and construction could lead to isolation of badger populations. A detailed construction programme would be devised so that certain crossing areas remain open and enough foraging areas remain available to badgers prior to final crossing points in the form of wildlife culverts being completed. Temporary fencing may be required to funnel badgers to these areas throughout the construction phase.

3.8 Bats

3.8.1 The potential impacts on bats during the construction phase are:

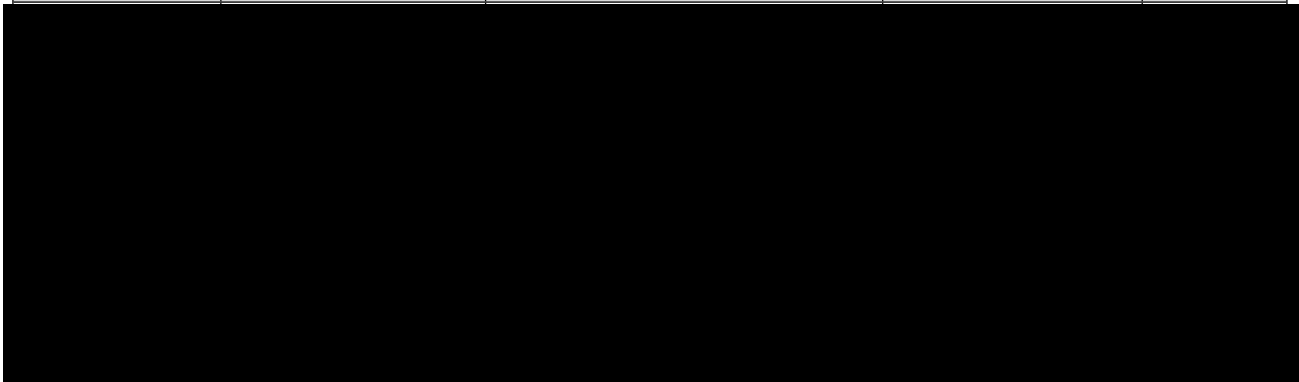
- habitat loss
- degradation of habitat
- disturbance from noise and vibration
- severance of habitat and barrier to dispersal (habitat fragmentation)

3.8.2 A European Protected Species (EPS) mitigation licence from Natural England will be obtained to cover any loss or disturbance of bat roosts as a result of the scheme. This would be a scheme-wide licence which would cover all licensable activities relating to impacts to bats as a result of the scheme, as opposed to individual licences for each distinct licensable activity. The licence application would be drawn up in consultation with Natural England. The details in the method statement of the licence must be adhered to.

3.8.3 The location of bat roosts can be found in ES Figure 8.4 Combined Bat survey results CONFIDENTIAL (Document Reference 6.3). Construction would result in the loss of three roosts in buildings and four roosts in trees, as detailed in Table 3-1.

Table 3-1 Bat roosts to be lost due to scheme construction

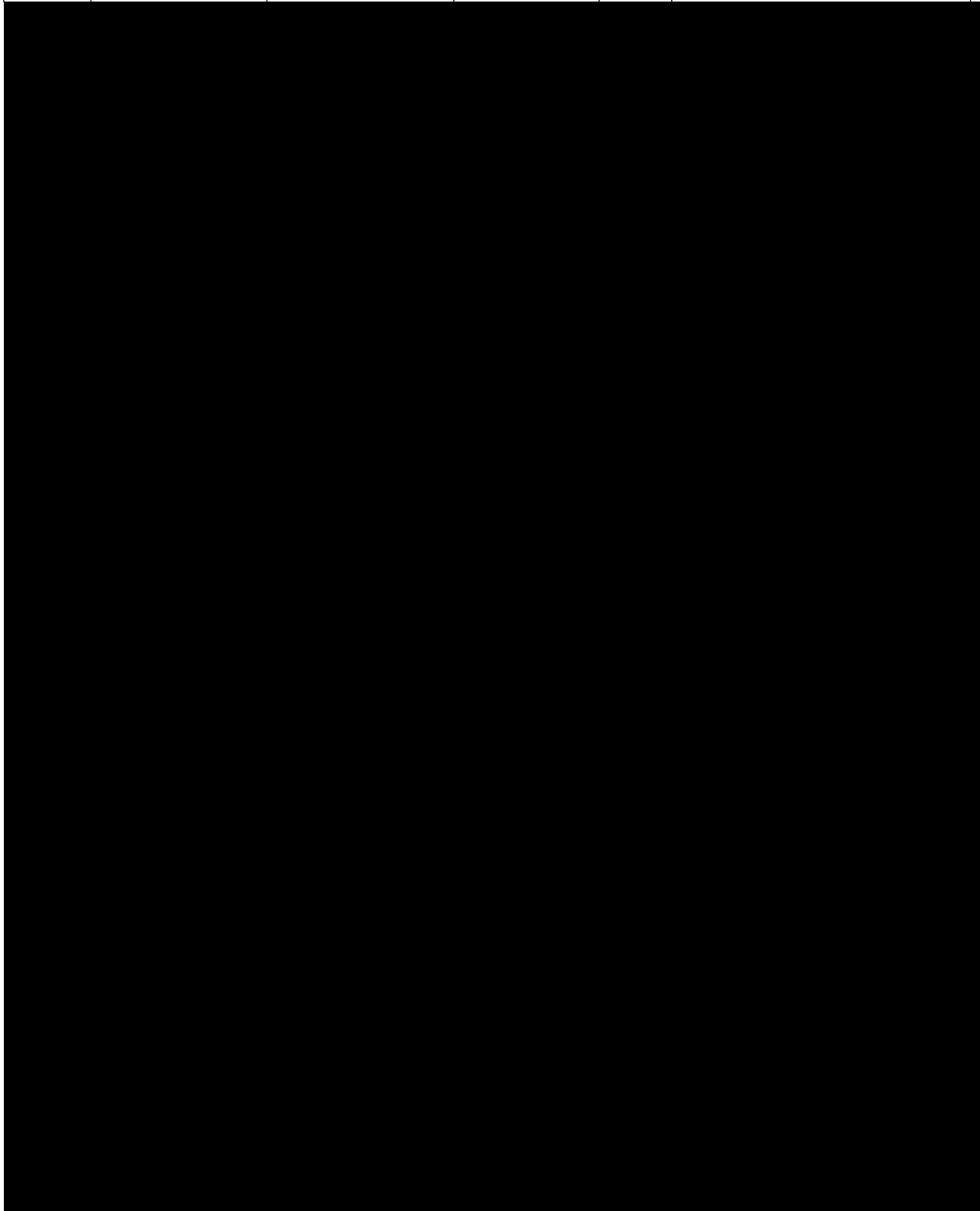
Tree number / building roost ID	Approx. nearest chainage	Tree species and roost location / approx. building location	Species present	Roost type
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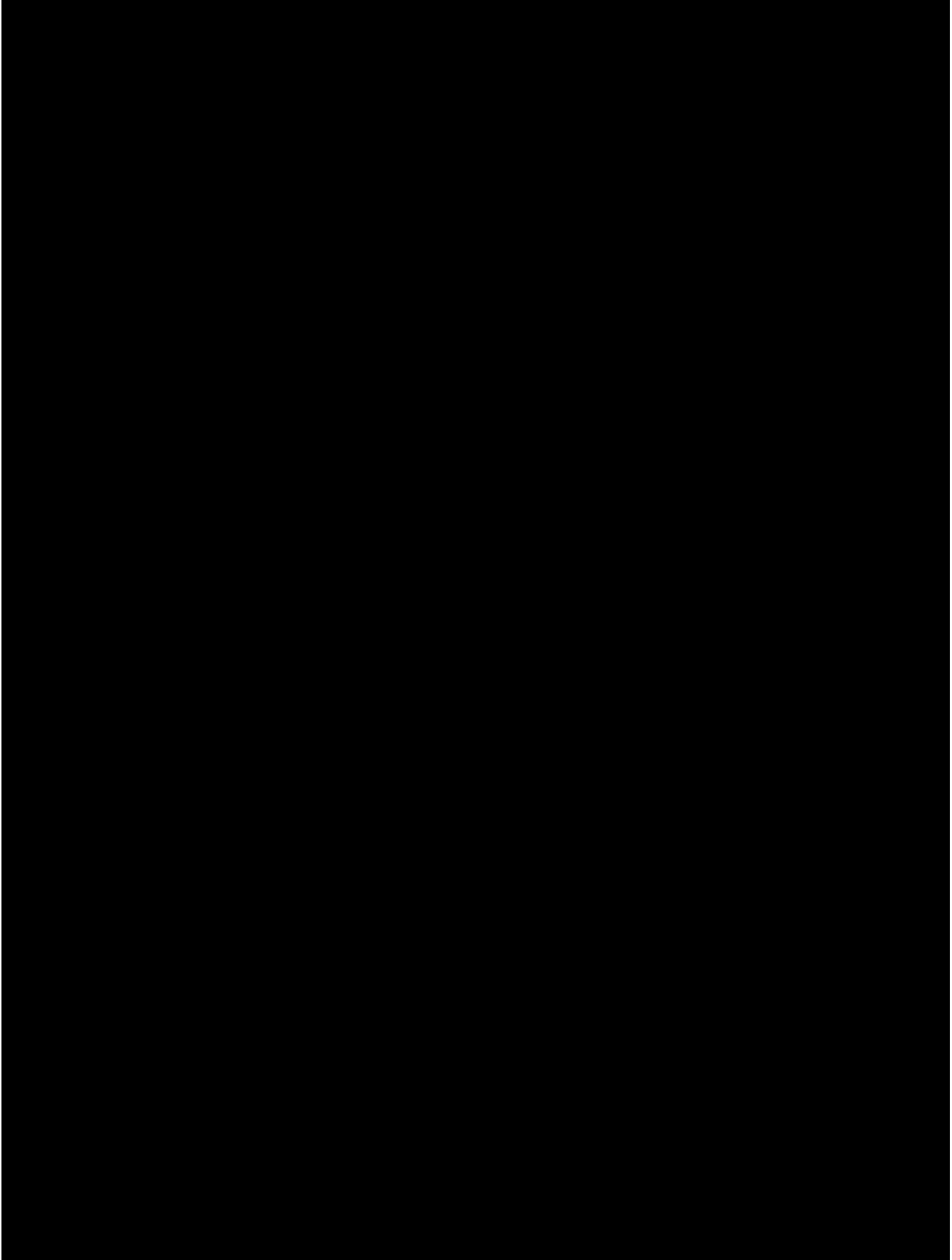
- 3.8.4 Replacement roosts would be provided under a mitigation licence from Natural England. The destruction of the roosts would take place at an appropriate time of year when the bats are least vulnerable and as set out in the licence. Existing tree roosting features would be salvaged where possible through careful section-felling and strapping onto nearby trees and at a similar height and orientation to that of the original tree roost. Where this is not possible, suitable bat boxes would be provided as an alternative.
- 3.8.5 A small bat barn would be provided for the loss of the lesser horseshoe and brown long-eared day roosts in Building 28 and would include a hibernation feature. Four crevice bat boxes would also be provided for the loss of the common pipistrelle day roost in Building 31. The locations and exact details will be provided in the LEMP (construction).
- 3.8.6 The nature and location of the replacement roosts, timing of the exclusion (where appropriate) and timing of the building demolition and tree felling would all be in accordance with the licence method statement which would be developed in consultation with Natural England. Mitigation measures will include the replacement of roosts which are to be lost to the scheme as detailed in sections 5.4 and 5.5 of this LEMP.
- 3.8.7 An artificial bat roost will be provided using the existing stone-built bus stop and enhancement of the existing World War II structure at Shab Hill. Furthermore, use of veteranisation techniques would be used in younger trees to create bat roosting features usually found on older veteran trees in habitat identified by an experienced bat ecologist.
- 3.8.8 Retained bat roosts that may be subject to disturbance due to being within close proximity to the scheme (either within the DCO boundary itself or within 50 metres of the DCO boundary) are detailed Table 3-2.

Table 3-2 Retained bat roosts, subject to disturbance, within 50m of the DCO boundary

Tree number / building roost ID	Approx. nearest chainage	Tree species and roost location / approx. building location	Species present	Roost type	Distance from scheme (m)
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Tree number / building roost ID	Approx. nearest chainage	Tree species and roost location / approx. building location	Species present	Roost type	Distance from scheme (m)
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Tree number / building roost ID	Approx. nearest chainage	Tree species and roost location / approx. building location	Species present	Roost type	Distance from scheme (m)
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- 3.8.9 As the roosts described above in Table 3-2 are in close proximity to the scheme, a method statement would be drawn up to minimise potential disturbance impacts such as noise and lighting on these roosts during construction and they may be included in a bat mitigation licence application as appropriate, as detailed within the LEMP (construction stage).
- 3.8.10 Suitable alternative roosting habitat would be provided close to the existing foraging and commuting routes (location of bat barn is shown on ES Figure 7.11 Environmental masterplan (Document Reference 6.3). The location of other alternative roosting features will be identified at detailed design.
- 3.8.11 Pre-construction surveys are to be undertaken prior to any tree clearance and demolition of buildings to ensure there are no new bat roost in trees and buildings to be cleared. If any new roosts are identified these will need to be included within the scheme bat mitigation licence and mitigation agreed with Natural England.
- 3.8.12 Following pre-construction surveys, any trees where the potential for roosting bats cannot be ruled out after survey would be soft felled with a bat licenced ECoW present to oversee the felling of the trees.
- 3.8.13 Where potential presence of roosting bats in any building or tree cannot be ruled out after the full suite of field surveys and pre-construction surveys (undertaken in accordance with best practice guidance), precautionary measures would be carried out including the soft-felling of trees and the soft-stripping of buildings or other built structures under ECoW watching briefs.
- 3.8.14 As a general precaution, tree felling would only be undertaken in autumn, between late August and October/early November. This is because bats do not have dependent young at this time and are not hibernating and should therefore be active enough to escape harm if proper precautions are taken.
- 3.8.15 Any building or tree roosts within 50 metres, depending on the type of roost, environmental factors and type of construction activity within the area, may also require inclusion on the mitigation licence from Natural England and associated method statements drawn up to minimise potential disturbance impacts, such as noise and lighting on these roosts during construction.

- 3.8.16 Night working would be avoided where possible. If it cannot be avoided, it would be restricted in the vicinity of known bat commuting routes and valuable areas of foraging habitat (i.e. commuting routes would not be illuminated nor have generators placed next to them).
- 3.8.17 If temporary construction lighting is required during the bat activity season, at compound areas for example, or for health and safety requirements, this would consist of directional lighting designed to ensure no light spill over 0.5 Lux on to any identified commuting and foraging areas, as well as roosting habitats.
- 3.8.18 Production of a construction stage lighting strategy to limit the use of construction lighting would be produced by the contractor to ensure all essential lighting is specified and designed to reduce light spill. This is to include locations of lighting and lighting levels details. The following measures would be considered within the construction stage lighting strategy:
- No bat roosts, or important foraging and commuting habitat (hedgerows, tree lines or watercourses) will be directly illuminated.
 - Lighting levels will be as low as current standards and guidelines allow.
 - Lighting will only be provided only in essential areas.
 - Lighting will be directed to where it is needed and light spill to adjacent habitat such as woodland, hedges or watercourses, avoided.
 - LED lighting produces no ultraviolet component and therefore is ideally suited as it greatly reduces the attraction of insects.
 - The height of lighting columns in general will be as low as possible. However, there are cases where taller columns will enable light to be directed downwards at a more acute angle and therefore reduce horizontal spill light.
- 3.8.19 Construction would result in the severance and fragmentation of foraging habitat and important commuting habitat notably the following areas identified as hotspots for bats activity (see ES Figure 8.4 Combined Bat Survey Results Confidential (Document Reference 6.3):
- [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]
- 3.8.20 Key commuting routes for bats would be retained in these areas for as long as possible in the works programme. Works would be sensitively timed, including the early construction of the bat underpass east of Fly-Up and the Gloucestershire Way crossing and the use of advanced planting in the first year of the programme (2023-2024), including the use of translocated hedgerows. Dead hedges would be used to allow bats to continue using commuting routes.
- 3.8.21 The creation of a linked mosaic of higher quality habitats, including drainage swales, hedgerows and wood pasture, would increase the foraging habitat to the east and west of the scheme.

3.9 Breeding and wintering birds

- 3.9.1 Construction activities would have the following potential impacts on breeding birds during construction:
- injury/direct mortality
 - loss of breeding habitat (breeding birds only)
 - loss and fragmentation of foraging habitat
 - disturbance, including sound and lighting
- 3.9.2 To mitigate for the potential for injury/direct mortality, all vegetation removal would be undertaken outside of the nesting bird season that runs from March to August inclusive. If vegetation removal is required within the nesting bird season pre-construction nest checks would be undertaken by a suitably experienced ECoW, prior to removal of the vegetation.
- 3.9.3 To mitigate for loss of breeding habitat, habitat replacement would begin before construction, e.g. woodland/scrub/hedgerow planting. The provision of planting detailed within the landscape specifications will mitigate for the loss of connectivity and habitat fragmentation. Areas of grassland creation for ground nesting birds would be kept free of trees to avoid providing predator perches. Nesting bird boxes would also be provided for a range of species impacted within retained woodland. Areas of advanced planting and indicative locations for bird boxes are shown on ES Figure 7.11 Environmental masterplan (Document Reference 6.3).
- 3.9.4 Pre-construction surveys for Schedule 1 birds are to be undertaken. If Schedule 1 birds are found breeding on site or within a distance from the construction works that would make them susceptible to disturbance, then advice would be sought from a suitably qualified ecologist to ensure damage or disturbance that could be deemed an offence would not occur. The distances would be species specific, for example 100m for barn owl.

3.10 Barn Owl

- 3.10.1 Construction activities would have the following potential impacts on barn owl during construction:
- injury/direct mortality from construction activities
 - loss of breeding and roosting habitat
 - loss and fragmentation of foraging habitat
 - increased lighting and disturbance
- 3.10.2 Lighting of construction areas and access routes when barn owls are active may cause owls to avoid affected foraging areas and/or have an impact on roosting. An increase in noise and physical disturbance would occur during clearance and construction activities and has the potential to cause abandonment of roosts and/or nests, particularly if disturbance occurs during the early breeding season, when birds are egg-laying or incubating. The distance (from disturbance) at which barn owls will abandon a nest will vary depending on the level of disturbance, length of disturbance and the existing disturbance levels that the birds experience. Studies suggest disturbance from human activity can be caused up to 100 metres from the nest site, although the distance at which nesting barn owls become intolerant to the approach of humans and works activities can vary depending on levels of localised day to day activity. The Forestry Commission

(2007)¹¹ sets a safe working distance from barn owls of between 100 metres to 250 metres.

- 3.10.3 There is potential for injury and/or mortality of barn owls directly caused by construction activities. This could occur through disturbance causing abandonment of a nest (resulting in the death of dependent young birds), destruction of active nests, and/or collisions with construction vehicles.
- 3.10.4 Best practice methods to avoid mortality to barn owls during construction would include:
- Sensitive timing of the works within 100m of Potential Nest Sites (PNS), Active Roost Sites (ARS) and Temporary Roost Sites (TRS) (avoiding the key early breeding season).
 - Construction traffic will obey site speed limits at all times.
- 3.10.5 Best practice methods to include sensitive lighting design, timing of activities, pre-works construction surveys, which will ensure physical disturbance to barn owls is avoided:
- Pre-construction surveys will be undertaken on all previously identified PNS, ARS and TRS within 500m of the scheme boundary, as well as any new roosting or nesting barn owl sites in suitable habitat within 100 metres of the scheme.
 - ECoW will be consulted prior to any work within 100 metres of an active breeding site.
 - Use of heavy machinery within 250m of an active breeding site will be timed to fall outside of the most sensitive breeding period (February to June).
 - Lighting during construction will be designed to be sensitive to bats, which in turn will also provide suitable mitigation for lighting disturbance impacts to benefit barn owls.
 - Habitat manipulation techniques will be employed to deter barn owls from entering construction areas, such as mowing long grass to reduce foraging potential.
 - During construction, night working would be avoided where possible. If it cannot be avoided, it would be restricted in the vicinity of known barn owl commuting routes and valuable areas of foraging habitat (i.e. commuting hedgerows would not be illuminated nor have generators placed next to them).
- 3.10.6 Graphic 4-1 (Shawyer, 2011¹²) would be consulted regarding potential disturbance from types of construction activity within protection zone distances following the pre-construction surveys.

Activity Type	Example	Disturbance Risk (displacement from the nest) Continuous activity	Protection Zone	Disturbance Risk (displacement from the nest) Occasional activity	Protection Zone
Pedestrian movement	Construction workers walking near nest	Low/Medium	20 m	Low	10 m
Artificial lighting	Arc lights illuminating works but (not directed toward the nest)	Low/Medium	30 m	Low	20 m
Vehicular movement	Vehicles or heavy plant moving past the nest	Medium	40 m	Low	30 m
General building and landscape works	Laying of concrete, bricks, roofing using mechanised plant	Medium/High	60 m	Medium	40 m
Heavy construction works	Ground levelling, pile-driving, concrete crushing etc. using heavy plant.	High	175 m	High	150 m

Graphic 4-1 Barn owl protection zones for construction activities

3.11 Otter

3.11.1 Construction activities in close proximity to watercourses could result in the following potential impacts:

- Habitat loss
- Disturbance
- Degradation of habitat

3.11.2 A pre-construction survey of all wooded areas adjacent to watercourses within the scheme would be carried out to confirm the presence or absence of any otter resting/breeding places within the construction area and to inform the requirement for any Natural England mitigation licence required.

3.11.3 Pre-construction surveys would confirm if a mitigation licence is required, and identify any potential restrictions on works within 50m that may be required to avoid disturbance to otters. This includes timing of works, lighting in the proximity of watercourses and requirements for artificial holts (if required). Where otters are known to be present, work by the contractor shall be done under a precautionary method of working as directed by the ECoW, following mitigation licence requirements.

3.11.4 No steep-sided, deep and/or water-filled excavations would be left unguarded overnight as otters could fall in and become trapped. Any major excavations that need to be left uncovered overnight would have their slopes battered, if practicable or a ramp provided. If it is necessary to leave small deep, steep-sided

or water-filled excavations open overnight they would be plated over or protected with suitable fencing.

- 3.11.5 Night working would be avoided where possible. If it cannot be avoided, it would be restricted near known commuting routes and valuable areas of foraging habitat.
- 3.11.6 The following measures would be considered within the construction stage lighting design:
- No known otter commuting routes, or important foraging would be directly illuminated.
 - Lighting levels would be as low as current standards and guidelines allow.
 - Lighting would only be provided only in essential areas.
 - Lighting would be directed to where it is needed, and light spill avoided.
 - The height of lighting columns in general would be as low as possible. However, there are cases where taller columns will enable light to be directed downwards at a more acute angle and therefore reduce horizontal spill light.
- 3.11.7 Restrictions on working hours to avoid night working (taken as the period 30 minutes before sunset to 30 minutes after sunrise) and task lighting, such that no night working is undertaken in the vicinity of watercourses, and any task lighting elsewhere is restricted to ensure no light spill into adjacent habitats. Any such temporary lighting would be directional and designed to ensure no light spill over 0.5 Lux on any watercourses with regard to otters (design to be finalised at detailed design). Lighting designed to be sensitive to otters, would also provide suitable mitigation for other nocturnal wildlife such as owls and badgers.
- 3.11.8 Pollution of watercourses could result in direct impacts of otters and their food source. Pollution prevention measures are described in ES Appendix 2.1 Environmental Management Plan (Document Reference 6.4).

3.12 Fish

- 3.12.1 The potential impacts on fish during construction are:
- direct mortality
 - habitat degradation
 - habitat loss
 - disturbance
- 3.12.2 Pre-construction electric fishing surveys will be carried out across all directly impacted locations. The results of these surveys would be used to refine mitigation requirements and translocation strategy.
- 3.12.3 In-river construction would avoid sensitive fish breeding seasons, the timing of these spawning periods would be determined following pre-construction surveys which identify the fish population present. These may be March – June for a coarse fish population and October to May for salmonid fish population.
- 3.12.4 Consultation with the Environment Agency would be undertaken in advance of construction to confirm timings of works, and to obtain a Section 27a exception permit under The Salmon and Freshwater Fisheries Act 1975 (SAFFA) (Form FR2) to allow to catch fish using electric fishing.
- 3.12.5 The ECoW, a suitably experienced aquatic ecologist, would be present during in river construction phases.

- 3.12.6 Fish translocation of the affected reach of Norman's Brook would be carried out prior to and during the flow transfer and dewatering of the existing channel. Fish would be relocated to an unaffected reach of Norman's Brook downstream of the new channel (as opposed to the new channel section itself).
- 3.12.7 Watercourses would be electric fished during the de-watering process, with fish placed in temporary bankside water-tanks. Fish species and number would be recorded prior to their release at the agreed location. Should fish be required to be translocated to a different waterbody this would be undertaken by subcontractors who are accredited under the 'Performing Section 30 Fish Health Checks Accreditation Scheme'. The Accreditation Scheme has been developed in response to discussions between the EA and the Institute of Fisheries Management (IFM). The Accreditation Scheme evaluated the experience and technical ability of individuals to perform fish examinations, to meet the requirements of the EA under Section 30 of the Salmon and Freshwater Fisheries Act 1975 (SAFFA).
- 3.12.8 The realignment of Norman's Brook would be conducted under the relevant guidance in this LEMP and EA permits.
- 3.12.9 In addition to direct damage to habitats there is potential for damage to occur through water pollution and reduction of habitat quality. This could be caused through direct pollution from fuel or chemical spills, or surface runoff carrying pollution and sediments into ditches and watercourses. To avoid such instances, the following mitigation would be applied:
- Silt traps would be installed in ditches and watercourses which are affected by works to prevent materials being transported into adjacent habitats.
 - Spill trays would be used to ensure that any spillages are unable to enter ditches or watercourses.
 - Bunds will be created where working areas are adjacent to retained ditches and watercourses to prevent sediments and pollution being washed into the ditches through surface run off.

3.13 Aquatic invertebrates

- 3.13.1 The potential impacts on aquatic invertebrates during construction are:
- Direct mortality
 - Habitat loss
 - Habitat degradation
- 3.13.2 The realignment of Norman's Brook will result in unavoidable mortality to resident aquatic invertebrates in this reach. The realignment of Norman's Brook would be conducted under the relevant guidance and EA permits. The detailed design of the new river habitat in the diverted channel would be agreed in consultation with EA specialists. The detailed design would focus on balancing the habitat requirements (substrate, depth, flow types and refuges) of aquatic communities present, with returning the river to a more natural step-pool habitat that would have existed prior to modification of the river by numerous weirs.
- 3.13.3 Substrate from the original channel would be relocated to the new channel, where practicable, to increase the likelihood of transferring aquatic invertebrate species.
- 3.13.4 Transfer would be timed to reduce drying out of substrate as this will increase the mortality of resident macroinvertebrates. Recolonisation from upstream and

downstream locations is expected to occur following completion of the new channel.

- 3.13.5 In addition to direct damage to habitats there is potential for damage to occur through reduction of habitat and water quality. This could be caused through direct pollution from fuel or chemical spills, or surface runoff carrying pollution and sediments into ditches and watercourses. To avoid such instances, the following mitigation would be applied:
- Silt traps will be installed in ditches and watercourses which are affected by works to prevent materials being transported into adjacent habitats.
 - Spill trays will be used to ensure that any spillages are unable to enter ditches or watercourses.
 - Bunds will be created where working areas are adjacent to retained ditches and watercourses to prevent sediments and pollution being washed into the ditches through surface run off.
- 3.13.6 Further details of pollution prevention methods and procedures are detailed within the ES Chapter 13 Road Drainage and the Water Environment (Document Reference 6.2) and ES Appendix 2.1 Environmental Management Plan (Document Reference 6.4).

3.14 Great crested newts

- 3.14.1 The following potential impacts on great crested newts during construction have been identified:
- direct mortality
 - habitat loss (terrestrial)
- 3.14.2 The presence of great crested newt was confirmed within 500m of the scheme, within ponds at three locations: Crickley Hill, Birdlip and Bentham. None of these ponds will be lost to the Scheme, however construction activities are taking place within 500m of these populations. At Bentham, access is required to a culverted section of the ditch for inspection, cleaning and potentially repair of the culvert and headwall where the ditch joins the pond supporting great crested newt. No major physical works are proposed to the culvert. In the Crickley Hill area, suitable terrestrial habitat loss of 0.25ha woodland is required approximately 240m from a pond supporting a small great crested newt population.
- 3.14.3 Construction activities could result in individual great crested newts being injured and/or killed, in the absence of mitigation or suitable working practices. Reasonable avoidance measures would be implemented during any vegetation clearance works to ensure that no loss of great crested newt habitat would occur and that risk to individual newts was reduced to a negligible level, i.e. licensable impacts to great crested newt would be avoided.
- 3.14.4 This would principally be achieved through planning the timing and duration of works for periods when great crested newt would be unlikely to be present within any affected habitat. In addition, any works at this location would follow a precautionary non-licensed working method, including a watching brief by a suitably qualified ecologist.
- 3.14.5 No works in identified suitable great crested newt habitat will be conducted during the hibernation period between November to March inclusive.

3.15 Reptiles

3.15.1 Reptiles were identified at 17 locations across the scheme. Construction activities would take place at locations with confirmed reptile presence and the potential impacts during construction are:

- direct mortality
- habitat loss and fragmentation

3.15.2 A translocation exercise would be carried out in key reptile habitat, and sites where adders were recorded, where there is no suitable or sufficient adjacent habitat retained and displacement of reptiles would occur in other areas where lower numbers of reptiles were recorded. These are Barrow Wake SSSI, Birdlip Quarry, Shab Hill and the field adjacent to the Air Balloon public house, which would be used as a construction compound for the Cotswold Way crossing. The translocation would be undertaken during the active season for reptiles (March to September) prior to construction.

3.15.3 The translocation would follow the best practice guidance outlined in the Herpetofauna Groups of Britain and Ireland (HGBI) advisory note¹³ including:

- Early construction stage development of the main receptor site north of Birdlip Quarry (as shown on ES Figure 7.11 Environmental masterplan (Document Reference 6.3)).
- Additional suitable receptor site(s), if required, will be identified and agreed with the project ecologist, contractor, and landowners (Crickley Hill SSSI has been agreed in principle with Gloucester Wildlife Trust).
- Reptile fencing will be installed surrounding the translocation site.
- The use of artificial refugia suitable for the reptile species present at each site.
- The refugia will be placed in locations which will be attractive to reptiles, nominally south facing sun traps.
- Following the HGBI guidance, a minimum of 50 artificial cover objects per hectare will be placed and the translocation will be undertaken over a period of 60 suitable days between March to September, when weather conditions are dry, calm, and of ambient temperature 9-18°C.

3.15.4 Where possible, mitigation habitats would be created prior to construction to minimise potential impacts from habitat loss. This includes log piles as refugia for reptiles

[REDACTED] Habitats created as shown on ES Figure 7.11 Environmental masterplan (Document Reference 6.3) would provide habitat for reptiles.

3.16 Terrestrial Invertebrates

3.16.1 Construction activities would have the following impacts on terrestrial invertebrates, in the absence of mitigation or suitable working practices:

- habitat loss and fragmentation
- direct mortality

3.16.2 Where possible, mitigation habitats would be created during the preliminary works, prior to the main works, to minimise potential impacts from habitat loss.

[REDACTED] that would also benefit invertebrates. Habitats created as as shown on ES Figure 7.11

Environmental masterplan (Document Reference 6.3) would provide habitat for terrestrial invertebrates.

3.16.3 During habitat clearance, mitigation measures would include:

- sensitive timing of grassland removal.
- translocation of valuable species-rich grasslands, leaf litter and logs, including deadwood from lost habitats.
- felled trees and deadwood will be used to create habitat in areas to be specified by the ECoW (preferably within the same woodland).
- existing deadwood can be translocated at any time of year but would be done carefully to avoid damage and would be moved to a location with similar shade conditions to its original location.
- freshly felled wood would be moved in the winter, or soon after its felling, before egg-laying adults start to inhabit it.

3.17

[Redacted content]

3.18 Section 41 Species

3.18.1 Method statements will be drawn up within the second iteration of the LEMP (construction phase) comprising a series of mitigation measures including timing of works, to prevent adverse impacts on Section 41 species (of the NERC Act 2006) which have been identified as potentially being present throughout the scheme including:

- hedgehog
- harvest mouse
- brown hare
- European polecat
- common toad

3.19 Biosecurity and invasive non-native species

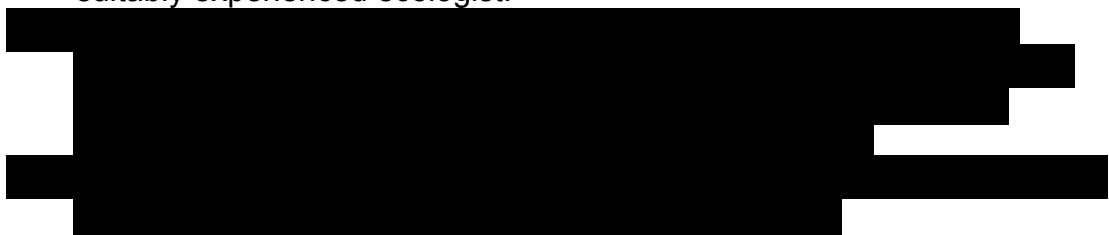
- 3.19.1 Invasive species cherry laurel (*Prunus laurocerasus*) and cotoneaster spp' are present within the woodland adjacent to the tributary of Norman's Brook. A pre-construction check for Wildlife and Countryside Act 1981 Schedule 9 and The Invasive Alien Species (Enforcement and Permitting) Order 2019 Schedule 2 listed invasive plant species (including both terrestrial and aquatic species) will be undertaken at the appropriate time of year to inform any requirement to avoid or remove invasive species. Pre-construction surveys will include aquatic macroinvertebrate Invasive Non-Native Species (INNS).
- 3.19.2 The implementation of biosecurity best practice would be described as 'check, clean, dry¹⁴ and would mitigate any potential mobilisation of invasive aquatic plant or macroinvertebrate species and chytrid fungus which effects amphibians.
- 3.19.3 During the construction of the works, the contractor shall prevent the introduction or spread of pests and diseases with measures including:
- assess risk, manage supply chains, inform all construction personnel, and manage and inspect vehicles and machinery coming onto site
 - contain and control identified animal and crop pests and diseases and prevent introduction, spread and/or proliferation
 - use Defra approved disinfectant appropriate to the potential pests and diseases
 - mitigate adverse impacts of any control and eradication actions on pests and diseases
 - report and record any infestation or disease incidents
 - mitigate any pest or disease impacts
 - monitor the effectiveness of mitigation to reduce the introduction and/or spread of significant pest or diseases
 - identify performance standards in the EMP
 - undertake a review of ES EMP (Appendix 2.1 Environmental Management Plan (Document Reference 6.4) and identify the need for any further actions.

4 Monitoring

4.1.1 Monitoring of proposed mitigation would be required to ensure its success in delivering the required outcome or function for the ecological receptor, either habitat or a specific species and proposed landscape mitigation. Monitoring may be required during and post construction stages of the scheme. The monitoring required is listed below, and further details on the objectives of monitoring, timing and frequency would be provided in the second iteration of the LEMP (construction) following refinement prior to construction.

4.2 Pre/During construction


- xxxv. Wildlife fencing installed as part of mitigation for species such as reptiles and badgers, either to exclude animals or as part of translocation exercises in the case of reptiles would require monitoring throughout construction to ensure the fencing is maintained.
- xxxvi. Monitoring will be required during and post-construction at identified crossing points for bats (and possibly along landscape scale transects) and at locations of new crossing structures (the Gloucestershire Way crossing and the bat underpass east of Fly-Up) for comparative analysis.
- xxxvii. Prior to the realignment of Norman's Brook, translocation of fish will be required and fish monitoring throughout construction and post-construction to occur where necessary.
- xxxviii. Immediately prior to the dewatering of Norman's Brook, monitoring through manual hand searches and trapping (under Common Standards Monitoring guidance¹⁵) or the use of eDNA would be conducted to confirm the likely absence of white-clawed crayfish. The manual hand-search will be undertaken by a licenced white-clawed crayfish ecologist to supervise the dewatering process.
- xxxix. Habitat creation and habitat translocation that occurs prior to construction will require monitoring during construction to ensure it is establishing and is not damaged during construction activities.
- xl. Protection measures of retained veteran trees will be monitored throughout the construction stage to ensure continued efficacy.
- xli. Works under EPS licences for bats (as well as otters and GCN, if required) would require ECoW during works, monitoring of the species, retained roosts subject to disturbance, and any mitigation such as habitat creation would be necessary.
- xlii. Works under Natural England development licence to exclude badgers from active setts and create artificial setts would require monitoring by a suitably experienced ecologist.



4.3 Post construction

- xliv. Works under EPS licences for bats (as well as otters and GCN, if required) would require monitoring post construction, including monitoring of the

- species, retained roosts subject to disturbance, and any mitigation such as replacement roosts and habitat creation. Duration and frequency of monitoring will be specified within the licence.
- xlvi. Monitoring for change in species composition would be required in Ullen wood during the operational phase of the scheme to ensure the efficacy of conservation management techniques in preventing degradation of woodland habitat from increased nitrogen deposition.
 - xlvii. A conservation led woodland management plan to alleviate environmental pressures on Ullen Wood will be implemented to improve woodland structure, creating variation of light conditions in the woodland and increasing diversity of the ground flora. This will be achieved through introduction of woodland management measures such as selective thinning of trees (taking natural ash dieback/ related felling into account), rotational coppicing of hazel, and erection of deer exclusion fencing
 - xlviii. Monitoring of the condition of the veteran beech tree to be impacted by nitrogen deposition to ensure the efficacy of sensitive arboricultural management and functionality of protective measures to prolong the longevity of the tree would be required during the operational phase of the scheme.
 - xliv. Annual monitoring during the bat activity period (May to September) of the [REDACTED] in years one to five post-construction would be required, along with the other important crossing features monitored before and during construction, for comparative analysis of bat activity in years one to five post-construction to build data on the effectiveness of mitigation.
 - i. Annual monitoring for use of [REDACTED] by S41 species and other species such as deer would be undertaken annually in years one to five post-construction, to gather data and monitor effectiveness of the bridge designs.
 - ii. A suitably experienced ecologist would provide a robust monitoring plan that is likely to include the use of infra-red cameras and thermal imaging cameras (for bat usage) to monitor wildlife use of the above structures.
 - iii. Bat boxes would be monitored at one year, three years and five years post-construction, and replaced where necessary as part of the EPS licence commitments.
 - iiii. The bat structures will be monitored to check for the uptake by roosting bats and to inform any further management if required. During the first five years after construction there will be a winter inspection to check for usage by hibernating bats by a licenced bat ecologist. Summer usage will be recorded by visual inspections, static detection methods or activity survey. Frequency of bat usage monitoring will be annual winter inspection and a survey period in summer during the first five years. Results including usage of interior fittings will be reviewed after five years and if necessary, improvements to interior fittings will be carried out to encourage usage.
 - iv. Monitoring of the three badger culverts and the artificial sett would be required post construction completion to ensure use and ensure the functionality of the structures, in accordance with the Natural England Licence conditions (period and frequency of monitoring of the artificial setts would be detailed in the Licence method statement). The three badger culverts would require an annual check to confirm that the entrances are

- draining appropriately and are not becoming impassably overgrown or being deliberately blocked. The artificial sett would be monitored on an annual basis to determine that the sett is in use. A suitably experienced ecologist will specify the monitoring strategy including provision of camera traps, and in line with the Natural England badger licence.
- iv. Bird boxes would be installed prior to the bird nesting season (March to August, inclusive) and would be inspected once a year outside of the nesting bird season and damaged boxes would be replaced or repaired where necessary.
 - lvi. Monitoring of the new road for any barn owl mortalities would be undertaken once a month during the first three years of the new road being operational. Monitoring would be undertaken to assess the effectiveness of mitigation measures implemented such as tree planting and verge management.
 - lvii. Habitat creation measures for great crested newts, reptiles, terrestrial invertebrates and Roman snails such as log piles and hibernacula would be monitored on an annual basis to determine that there are no issues with regards to flooding or vandalism.
 - lviii. Receptor sites for reptiles would be monitored post construction, as per survey guidelines for presence/absence surveys and/or population assessment surveys. This would be in agreement with relevant stakeholders such as GWT. Monitoring would be undertaken at one year, three years and five years post construction.
 - lix. 
 - lx. Aquatic invertebrate monitoring surveys of the realigned tributary of Norman's Brook both upstream and downstream, new outflows, and potentially additional locations within the catchment, based on the outcome of ongoing surface water flow and quality monitoring. Monitoring would be undertaken at one year, three years and five years post construction.
 - lxi. Post-construction fish monitoring (electric fishing) surveys would be required within Norman's Brook, both upstream and downstream. Monitoring would be undertaken at one year, three years and five years post construction.
 - lxii. Post-construction fish monitoring (electric fishing) surveys may be required in other locations within the catchment, based on the outcome of ongoing surface water flow and quality monitoring. Monitoring would be undertaken at one year, three years and five years post construction.
 - lxiii. Habitat enhancement and compensatory habitat planting would be monitored, and maintenance regimes implemented, to ensure establishment to high quality habitat and intended functionality is being delivered, including translocated habitats (trees, hedgerows and turf/topsoil) and compensatory tufa habitat. This would include habitat connectivity across Gloucestershire Way crossing, Cowley overbridge and Stockwell overbridge, woodland planting or new calcareous grassland creation. Calcareous grassland monitoring for a target NVC community will inform ongoing management of the habitat. Similarly, woodland will be monitored annually during the growing season until it reaches target condition. Detailed frequency and duration of monitoring would be confirmed for the final iteration of the LEMP.

5 Other ecological structures and habitats

5.1 Attenuation Basins

5.1.1 A total of 11 attenuation basin areas (some containing more than one basin) are proposed throughout the scheme, as shown on General Arrangement and Section Plans (Document Reference 2.6). Although these basins are designed not to be permanently wet due to the landscape character of the Cotswolds and underlying geology and to maintain functionality, any marginal or seasonally wet areas will be beneficial to wildlife providing additional foraging habitat for bats, birds, invertebrates and other wildlife.

5.1.2 Wildlife would be discouraged from basins within junction arrangements with habitat management but attracted to other features set back from the road alignment with additional landscaping and planting design to benefit biodiversity.

5.2 Overbridges

5.2.1 The Gloucestershire Way crossing at Chainage 2+690, is 37m wide multi-purpose crossing to provide essential mitigation [REDACTED] and provide a safe crossing point for other wildlife including barn owl and badgers. The crossing will comprise the following features to create the wildlife area:

- calcareous grassland along the length of the bridge, 25m wide
- native species-rich hedgerows, 2m wide by 3m tall

5.2.2 Two smaller overbridges which are 11m wide are located at Cowley Lane (Ch 4+000) and Stockwell Lane (Ch 4+501). These overbridges will include minimum 3m wide grass verges and native species-rich hedgerow on both and one side respectively in order to maintain habitat connectivity for many species, within the currently arable landscape.

5.2.3 Grassland and hedgerows on the above overbridges would be created following the habitat creation, management and monitoring prescriptions described in the above specifications.

5.3 Existing A417

5.3.1 The existing A417 would be de-trunked. This road would not be open to vehicles except for a short section to provide access to two properties but would provide a footpath and cycleway for public use.

5.3.2 Calcareous grassland and woodland habitat of high ecological value within the existing verges would be retained and protected during construction. For example, this would include a grassland verge with musk orchid near Barrow Wake. Any losses would be restricted to essential works required to establish the new recreational route.

5.3.3 Habitats of lower ecological value within the existing verges would be enhanced or replaced to provide wide calcareous grassland verges with hedges and trees which would restore habitat connectivity in an east to west and north to south direction for wildlife, providing foraging and commuting habitat for bats, barn owls and other bird species, reptiles, badgers and invertebrates.

5.3.4 Scattered broadleaf trees of native species would be replanted along the de-trunked sections of the existing A417 as shown in ES Figure 7.11 Environmental Masterplan (Document Reference 6.4).

- 5.3.5 A section of the existing A417 road to be removed and landscaped would provide replacement Special Category Land (Common Land) and compensatory habitat for the loss of grassland within Barrow Wake SSSI. This would be adjacent to Barrow Wake and comprise calcareous grassland of at least the same quality as that lost.
- 5.3.6 Planting would be designed to segregate the footpath from the verges to ensure habitat is protected from trampling and disturbance.
- 5.3.7 The creation of the re-purposed A417 would require the protection of existing verge habitat. This would include fencing of areas of higher ecological value and pollution prevention measures such as dust control, as documented in the EMP (design).

5.4 Bat structures

- 5.4.1 A small bat barn would be provided at the [REDACTED] site as mitigation for the demolition and loss of the lesser horseshoe and brown long-eared day roosts in Building 28 in the same location. This would be created and monitored in accordance with a Natural England Licence.
- 5.4.2 The scheme includes the provision of enhancements to a derelict World War II structure (building 91B, [REDACTED]). The final design of the enhancements would be agreed by a suitably experienced bat ecologist and following approval by Natural England that enhancement works can proceed. A Natural England licence may be required and therefore consultation with Natural England prior to any construction works will be required.
- 5.4.3 Enhancements are likely to include repair to damaged parts of the structure to consolidate its construction and provide increased thermal stability and therefore suitability as a roost site. Provision of materials to provide roosting locations may include installation of bat boxes, wooden roosting ledges, bat bricks or crevices within mortar/stones within the internal areas of the structure. Roosting locations would include provision of crevice roosts suitable for crevice-dwelling bat species recorded in the area. Bat access locations would be enhanced if necessary. A locked gate or door would be fitted to ensure that human interference is avoided but designed so that bats can enter and exit the structure.
- 5.4.4 In addition, the construction/retrofitting of an artificial roost using the existing stone-built bus stop which will be decommissioned as part of the detrunking of the A417 addresses the cumulative loss of roosting features.
- 5.4.5 The structures are not expected to require regular internal maintenance, but they will need periodic internal inspection. The best time for such an inspection is late summer/early autumn when bats will not be hibernating. Since the intention is that these structures would be used by roosting bats, they would be legally protected through the provisions of the Conservation of Habitats and Species Regulations 2017 and any structural inspection visit shall be undertaken by a suitably experienced ecologist who holds a Natural England bat survey licence.
- 5.4.6 As part of the ongoing management and maintenance, the exterior of the structures would be inspected at least twice per year to ensure no vandalism, damage or blockage of access has occurred. Since these visits will be strictly external they can take place at any time of year and a licensed bat worker will not need to be present. Any damage or blockage would be rectified as soon as possible (relevant Natural England licence to be obtained if required). Management of vegetation would be carried out around the entrances as

necessary under advice from a suitably experienced ecologist to ensure a clear flight path for bats and maintain access to the structures for interior inspections.

5.5 Bat tree roost features

- 5.5.1 Existing bat tree roost features would be retained, where practicable. Sections of the tree with the roost feature would be cut and then strapped to retained mature trees growing within Highway England ownership land and located as close as possible to their original site. Suitability of roost features, method of attachment and location/orientation of the roost feature will be undertaken following consultation with a suitably experienced ecologist.
- 5.5.2 Use of veteranisation techniques to create habitats in younger trees that are otherwise found on older more mature trees would be undertaken as approved by a suitably experienced ecologist and an arboricultural consultant.
- 5.5.3 A mix of bat boxes on retained trees within the vicinity of roosts likely to be disturbed by construction activity would be provided to compensate for disturbance to these roosts.

5.6 Bat underpass

- 5.6.1 An underpass specifically designed for bats would be constructed under the scheme (Ch1+085) to address fragmentation impacts. The underpass will be a minimum of 3m x 3m and 50m long at a skewed angle (due to engineering constraints on both sides). The underpass will be unlit.
- 5.6.2 Landscape planting would include vegetation management at the entrances of the underpass to ensure that bats are guided into the underpass rather than up the embankments and over the new road.
- 5.6.3 Landscape planting would also be designed to provide a buffer between lit working areas during construction, and light spill from headlights at night during operation of the scheme.
- 5.6.4 Maintenance would include an annual inspection of the underpass structure to ensure it has not become blocked with vegetation or litter.
- 5.6.5 Management would be minimal but include clearance of debris from within the underpass. In addition, tree and scrub height on either side of the underpass would be maintained at an optimum height to encourage bats to commute through the underpass, and not be left to grow so tall that it would push the bats over and onto the A417 carriageway.

5.7 Wildlife culverts

- 5.7.1 The use of wildlife culverts and underbridges as wildlife crossings are proposed within the scheme design to maintain connectivity for animal dispersal across the landscape and reduce wildlife use of the road, reducing animal fatalities.
- 5.7.2 The scheme includes three small wildlife culverts, of minimum 600mm in diameter (both width and height), that have been positioned within existing badger territories and as near as practicable to known badger paths as identified during badger surveys, which would be severed by the scheme.
- 5.7.3 The designs follow standard industry practice and will all be a minimum of 600mm in diameter (both width and height) and all designed so that the tunnel and approach to the tunnel would remain dry with suitable approach gradients. The

opportunities for location of wildlife culverts were limited due to steep cuttings, but all are within 250m of existing badger routes and setts.

- 5.7.4 Landscape planting has been designed so that badgers would be encouraged to follow hedgerows and tree lines that lead into the culverts and underpasses.
- 5.7.5 Wildlife culverts will be constructed to provide safe crossing points underneath the new road. These would be created at the following locations:
- [REDACTED]
 - [REDACTED]
 - [REDACTED]
- 5.7.6 Wildlife fencing for badgers has been included throughout the entire length of the scheme along with strategic planting of hedgerows, scrub and woodland. This is designed to funnel badgers and potentially other species through the wildlife crossings and overbridges. This reduces the risk of mortality from road traffic incidents through potential entry onto the road network, for example, via side roads or property access roads. One-way gates would be provided where this is considered to be a risk, so that badgers can exit the road network. Badger fencing is in most cases synonymous with the highways fencing location and is shown on ES Figure 7.11 Environmental Masterplan (Document Reference 6.4).
- 5.7.7 The scheme is in cutting for much of its length which reduces the risk of mortality of birds and bats that may fly over the new road corridor. In addition, the provision of false cuttings, typically 2m or more in height, for landscape and noise purposes also act as mitigation to reduce the risk of mortality by encouraging birds and bats to fly above the height of most vehicles.
- 5.7.8 Wildlife culverts require little maintenance other than an annual check to confirm that the entrances are draining appropriately and are not becoming impassably overgrown or being deliberately blocked. If they are, the vegetation would be cut back and any blockages impeding drainage or access removed.
- 5.7.9 Ecological monitoring would also be undertaken to determine whether wildlife culverts and multi-purpose crossings are in use post-construction. A suitably experienced ecologist would provide a robust monitoring plan that is likely to include the use of camera traps and thermal imaging cameras (for bat usage) to monitor wildlife use of the structures.

5.8 Badgers

- 5.8.1 An artificial badger sett will be constructed to replace a main sett. Maintenance of the sett would be minimal following installation. An annual check to confirm that the entrances are draining appropriately and are not becoming impassably overgrown or being deliberately blocked. If they are, the vegetation would be cut back and any blockages impeding drainage or access removed.
- 5.8.2 The specification of the badger fencing (gauge and hole diameter) would be taken from the latest Highways England guidance at the time of construction.

5.9 Breeding Birds

- 5.9.1 Vegetation management would be timed to avoid the nesting bird season (March to August inclusive) where practicable. If vegetation management is required during this time, nesting bird checks by a suitably experienced ecologist would be undertaken. If active nests are recorded, the ecologist would recommend a buffer for the works to ensure the birds are not disturbed. Following confirmation from an

ecologist that the young have fledged and are no longer dependant on the nest site, vegetation management works can proceed.

- 5.9.2 Arable and pasture land (and field margins) provides suitable foraging ground for ground nesting bird species. Clearance of arable, pasture and field margins would be timed to avoid the nesting bird season (March to August inclusive) where possible. If ground clearance is required during this time, nesting bird checks by a suitably experienced ecologist would be undertaken. If active nests are recorded, the ecologist would recommend a buffer for the works to ensure the birds are not disturbed. Following confirmation from an ecologist that the young have fledged and are no longer dependant on the nest site, vegetation management works can proceed.
- 5.9.3 Nesting bird boxes would be provided for a range of species including marsh tit, spotted flycatcher, tawny owl, kestrel and stock dove. The specifications, number and locations of boxes would be developed following consultation with a suitably experienced ecologist and finalised in the LEMP (construction stage).
- 5.9.4 Boxes would be installed prior to the bird nesting season (March to August, inclusive) to provide opportunities for birds displaced from loss of breeding habitat to relocate and nest where possible.
- 5.9.5 Where ground-nesting species have lost habitat, e.g. skylark, areas of open grassland would be created in advance and managed sympathetically with consideration of nesting birds, i.e. no cutting of grassland until birds have fledged.

5.10 Barn Owls

- 5.10.1 Vegetation management would only proceed following consultation with a suitably experienced ecologist to ensure that barn owl nest sites within trees or buildings are not disturbed or destroyed. Habitats that occur around Shab Hill are generally considered to be of the highest value to foraging barn owls.
- 5.10.2 Strategic planting of woody species, including dense structure planting to include shrubs and five-year-old trees characteristic of the local area, would be introduced alongside the scheme where it is at grade and on embankment, particularly near areas of rough grassland between the Shab Hill and Nettleton areas, where collision risk is likely to be greatest. Planting height will be at least 3m to encourage barn owls to fly over the scheme at a safe height above traffic.
- 5.10.3 The width of grass verges in high risk areas would be reduced to approximately 2m where possible and the sward mown regularly. This will reduce the potential for the habitat to support barn owl prey species and therefore decrease the foraging potential and collision risks to barn owls.

5.11 Dormouse

- 5.11.1 No confirmed presence of dormouse was recorded within the study area, therefore, no direct or indirect impacts during construction of the scheme upon dormouse are anticipated.
- 5.11.2 However, dormice are known to be present within 2km of the scheme. Therefore, as an enhancement opportunity to allow for future colonisation, landscape planting would contain species favoured by dormouse such as hazel and honeysuckle to allow future colonisation from nearby populations.
- 5.11.3 Engagement with local stakeholders including Gloucestershire Wildlife Trust to help maximise the potential for future colonisation would be undertaken.

5.11.4 Management of the planted hedgerows will follow the specifications detailed in section 2.10. Practices such as cutting only one side of a hedgerow at a time will leave valuable autumn food resource such as berries for dormice and other wildlife.

5.12 Great Crested Newt

5.12.1 Features beneficial to GCN including hibernacula and log piles would be installed in suitable terrestrial habitat within 200m of the breeding ponds situated at Bentham and Crickley Hill.

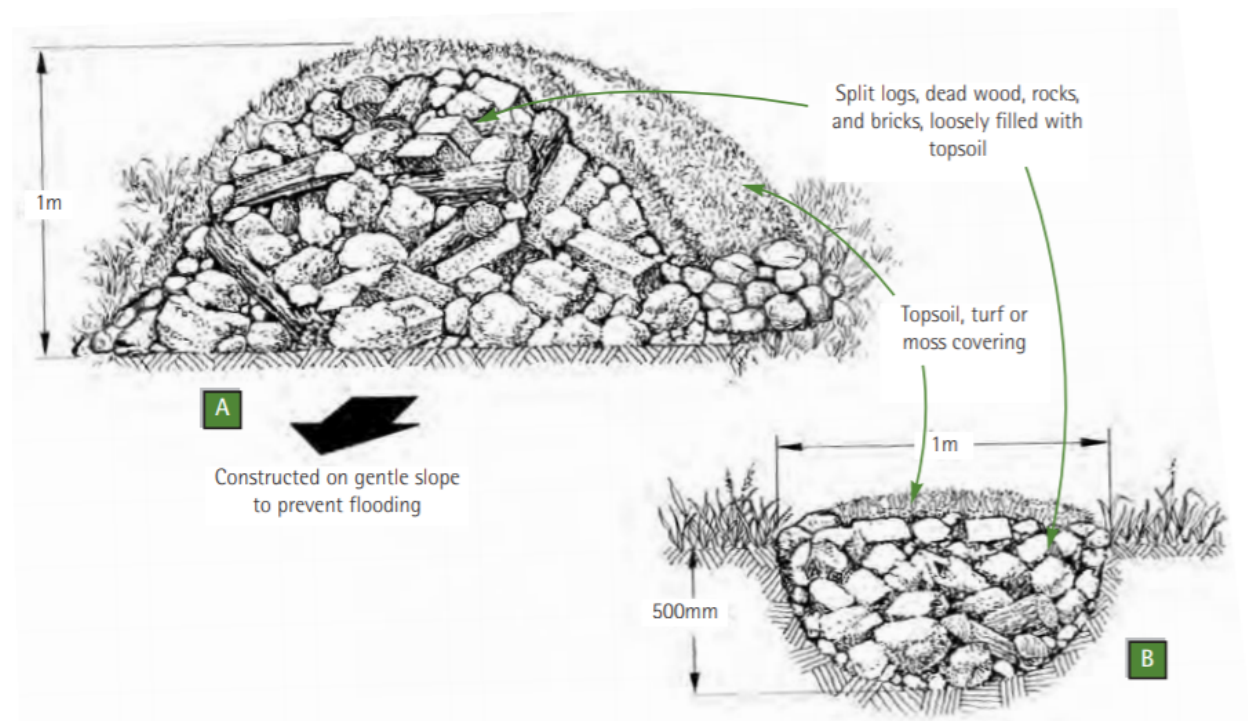
5.12.2 A total of 10 log piles and two hibernacula would be constructed as shown in Graphic 6.1, within existing woodland or scrub habitat to ensure an existing litter layer is present. If the litter layer at the site is less than 100mm thick, additional deciduous bark would be added to the site prior to construction of the refuge. All refuges would be placed on a gentle slope and in areas of free draining soil to avoid flooding.

5.12.3 Fallen deadwood or arisings from tree clearance would be used to create the log piles and hibernacula along with stone from the local area or dismantled stone walls.

5.12.4 Log piles would be laid onto the surface of the litter substrate. Dimensions would be 2m to 8m long by 1m to 1.5m high.

5.12.5 Hibernacula would be dug into the ground to a depth of at least 1.5m and a height above ground of 1m to ensure frost free conditions within the centre.

5.12.6 Log piles and hibernacula would be covered in a layer of soil, turf or moss to ensure a stable humidity of the environment within the structure.



Graphic 6-1 Great Crested Newt refuge – example construction^{16 2}

² Note: (A) for impermeable (B) for free-draining soils

5.13 Reptiles

- 5.13.1 Landscaping would incorporate features beneficial to reptiles such as hibernacula and log piles.
- 5.13.2 Creation of log piles and hibernacula will broadly follow the methods detailed within the GCN refuges. Reptile hibernacula would be located within the reptile receptor site at the south of the scheme on a south facing slope with well-drained soil. The underground chamber would be an excavation approximately 2m to 4m in diameter, and 0.5m deep. The chamber would be lined with sand and gravel, filled with a mixture of large logs, rocks and stones. The final structure would be covered with soil and turf. Log piles would be created within retained habitat throughout the scheme where vegetation clearance occurs and would also be created on the Gloucestershire Way crossing to provide additional reptile habitat.

5.14 Terrestrial Invertebrates

- 5.14.1 Mitigation measures would include habitat creation designed to incorporate features beneficial to invertebrates in areas such as the Gloucestershire Way crossing and adjacent habitat between Barrow Wake and Crickley Hill, verge habitat along the Air Balloon Way and within the reptile receptor site adjacent to Birdlip Quarry. Habitat creation would include species-rich calcareous grassland of local provenance with species beneficial to insects including pollinators. Species mixes would include plants that provide a food source for scarce species identified such as cowslip and blackthorn. Habitat creation would include south facing slopes, log piles, deadwood and sheltered areas for invertebrates.

5.15

[Redacted content]

5.16 Fish and aquatic macroinvertebrates

- 5.16.1 The detailed design of the new river habitat in the diverted channel would be agreed in consultation with EA specialists. The detailed design would focus on balancing the habitat requirements (substrate, depth, flow types and refuges) of aquatic communities present, with returning the river to a more natural step-pool habitat that would have existed prior to modification of the river by numerous weirs.
- 5.16.2 The new channel would also seek to improve connectivity of habitat for aquatic species. The requirements for fish passage through this channel may be further refined following pre-construction fish surveys.
- 5.16.3 Once the realigned brook has been created, flow would be redirected to the new channel. Bankside and in-channel vegetation would be allowed to regenerate

naturally. It is advised that suitable vegetation is also planted along the new channel to promote establishment of functional habitat for aquatic species as well as stabilising bank and marginal habitats.

- 5.16.4 Assessment and monitoring of habitat and species would be undertaken post construction as detailed in section 4.3. After five years, it is not be deemed necessary to consider the effects of the scheme. Monitoring the recolonization of communities once found in the waterbody, allows for mitigation measures to be adjusted accordingly.

6 Handover of maintenance and monitoring obligations

- 6.1.1 The works described in this LEMP (design stage) and production of the later iterations of the LEMP as described in section 1.1 shall be undertaken by the contractor and suitably qualified specialist landscape and ecological consultants.
- 6.1.2 For the initial five-year period following completion of construction, the LEMP (End of Construction) would be prepared by the contractor and set out post construction requirements at handover to HE.
- 6.1.3 Whilst the nature of the maintenance operations set out would typically be repeated year on year, the frequency of such operations would be flexible in order that appropriate responses can be made to any change in circumstances necessary to achieve the landscape design purpose and ecological target outcomes as required by ES Figure 7.11 Environmental Masterplan (Document Reference 6.3) and the LEMP.
- 6.1.4 The maintenance schedule would be reviewed on an annual basis to determine the exact requirements to suit the longer-term management objectives.
- 6.1.5 In some instances, departure from standard specifications may be needed to achieve the landscape design or ecological target outcomes and advice would be sought from Highways England in these instances.

References

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- ⁹ Highways England, Transport Scotland, Welsh Government, and Department for Infrastructure, “Design Manual for Roads and Bridges Sustainability and Environment Appraisal LA 108 Biodiversity Revision 1,” 2020.
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- ¹² Shawyer, C. R. (2011). Barn Owl *Tyto alba* Survey Methodology and Techniques for use in Ecological Assessment: Developing Best Practice in Survey and Reporting. IEEM, Winchester.
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- ¹⁶ Langton, T.E.S., Beckett, C.L., and Foster, J.P. (2001), Great Crested Newt Conservation Handbook, Froglife, Halesworth.