BRIDGEND COLLEGE, PENCOED CAMPUS

ECOLOGICAL APPRAISAL

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SUMMARY

Soltys Brewster Ecology were commissioned by Bridgend College to undertake an ecological appraisal of land surrounding its Pencoed Campus to inform suitability and capacity of the land for development, and feed into high level masterplanning of the site. To inform this assessment, a combination of desk study and Extended Phase 1 Habitat Survey was undertaken in February 2017.

The combination of desk study and field survey confirmed that the site is not covered by, or located in close proximity so as to be of ecological relevance, to any form of nature conservation designation. Similarly, no records of protected or notable flora & fauna were specifically associated with the site itself, although records of several protected and notable species were identified in the surrounding area including Dormouse *Muscardinus avellanarius*, Great Crested Newt *Triturus cristatus,* reptiles, birds and bats.

The Extended Phase 1 Habitat survey confirmed a range of habitats at the site, primarily intensively managed semi-improved and amenity grassland within a network of native hedgerows with small areas of plantation woodland, ruderal vegetation, bracken and scrub. A stream bordered by semi-natural broadleaved woodland forms part of the eastern site boundary and a number of small ponds are also present. The main campus area comprises amenity grassland, hard standing/buildings and areas of introduced shrubs along with scattered broadleaved and coniferous specimen trees and several small nature conservation areas.

The areas of amenity grassland and closely grazed, poor semi-improved grassland are considered to be of low ecological value and represent the most appropriate areas for any future development. The remaining habitat features e.g. the wooded stream corridor, nature areas (including ponds), network of hedgerows, plantation woodland etc. are of value for a range of species and it is recommended that these are retained and enhanced as far as practical and incorporated into a Green Infrastructure network in accordance with Bridgend County Borough Council's Supplementary Planning Guidance (SPG19: Biodiversity and Development) as part of any site masterplan.

The site has some limited potential to support a number of protected species, most notably Great Crested Newt and Dormouse. Whilst the likelihood of either species being present is considered to be relatively low, if either or both species are confirmed on site, licences from Natural Resources Wales (NRW) and appropriate mitigation measures would be required prior to any development and this is likely to result in some loss of developable area given the requirement for habitat retention/enhancement associated with licencing.

Given that the presence of Dormice and/or GCN is likely to affect the area available for development, further surveys to confirm the presence or likely absence of these species are recommended in order to determine the requirement for licencing and inform any developing masterplan.

Additional surveys for reptiles and bats are also recommended prior to any planning application, although these would not be required to inform a masterplan, provided the design adopts the green infrastructure approach outlined above. The scope of these surveys would be guided by the proposed layout at a later stage e.g. bat surveys to determine the presence or absence of bat roosts in trees or buildings would not be required if these features could be retained and suitably protected within the development layout.

The site also presents opportunities for ecological enhancements which could be incorporated into the design at an early stage. Habitat connectivity is currently poor from east to west across the site and along the western and southern boundaries. Provision of a broad woodland/habitat corridor in these areas, ideally linking the Ewenny River to the west of the site with the existing areas of plantation woodland and Ewenni Fach corridor to the east would significantly improve habitat connectivity, benefiting a variety of species and providing screening from the adjacent roads. If dormice or GCN are present on site, provision of this corridor along with the incorporation of a robust and well connected green infrastructure as described above would go some way to towards the mitigation likely to be required and may allow some of the internal hedgerows to be translocated, providing some compensation for the likely reduction in developable area.

1.0. INTRODUCTION

1.1 Soltys Brewster Ecology were commissioned by Bridgend College to undertake an ecological appraisal of land surrounding its Pencoed Campus.. The College is considering the suitability and capacity of the land for development and inform the high level masterplanning of the site To inform this assessment, a combination of desk study and Extended Phase 1 Habitat Survey was undertaken in February 2017.

1.2 The site is located on the eastern fringe of Pencoed at SS 9675 8195 bordered by the A473 to the north and west, Felindre Road to the south and agricultural land to the east. The survey area incorporates the existing Pencoed Campus buildings and associated sports pitches along with a small golf course and several fields currently used for pasture and equestrian activities (see plan in Appendix I).

1.3 The current report describes the findings of a desk study and Extended Phase 1 Habitat Survey undertaken in February 2017 for the entirety of the College land holding at Pencoed (i.e. Green line boundary as shown in Appendix I). The report describes the existing ecological conditions and any constraints/opportunities associated with any future development.

2.0 METHODOLOGY

2.1. In order to establish the baseline ecological conditions on site and in the adjoining habitats, a combination of desk-based consultation and ecological site survey were undertaken in February 2017.

Desk study

2.2. This element of the work primarily involved consultation with the South East Wales Biodiversity Record Centre (SEWBReC) to identify any records of rare, protected or notable flora and fauna within the proposed development site boundary and surrounding 1 km area. The search criteria also included information relating to the location and citation details (where available) for any sites designated for their nature conservation interest such as Sites of Special Scientific Interest (SSSIs).

Ecological Field Survey

2.3 The fieldwork was undertaken on 24 February 2017 by a suitably experienced ecologist[1] and followed standard Phase 1 Habitat Survey protocol (JNCC, 1990) as amended by the Institute of Environmental Assessment (1995). All habitats within the site were classified and mapped as accurately as possible. Habitats considered to have potential to support rare, protected or otherwise notable species of flora and fauna were noted, as were any direct signs of these species (e.g. Eurasian Badger *Meles meles* setts and dung-pits). Incidental observations of birds on or flying over the site were also recorded and any stands of invasive plant species, such as Japanese Knotweed *Fallopia japonica* or Himalayan Balsam *Impatiens glandulifera* noted.

2.4 A map of habitats was drawn up and target notes were used to identify features of ecological interest. Where possible, habitats were cross-referenced to any relevant priority habitats listed under Section 7 of the Environment (Wales) Act, 2016..

2.5 In addition any trees present were assessed for their potential to support roosting bats and were categorised in relation to the bat roosting features (BCT, 2016). The categories are as follows:

- **Known or confirmed roost**
- **High** - A tree with one or more potential roost sites that are obviously suitable for use by larger numbers of bats on a more regular basis and potentially for longer periods of time due to their size, shelter, protection, conditions and surrounding habitat.
- **Moderate** – A tree with one or more potential roost sites that could be used by bats due to their size, shelter, protection, conditions and surrounding habitat but unlikely to support a roost of high conservation status.

[1] Associate Member of the Chartered Institute of Ecology and Environmental Management.

- **Low** -A tree of sufficient size and age to contain Potential Roost Features (PRFs) but with none seen from the ground or features see with only very limited roosting potential.
- **Negligible** – Negligible habitat features on site likely to be used by roosting bats.

3.0 RESULTS

Desk Study

3.1 The data provided by SEWBReC confirmed that the site did not contain any statutory or non-statutory nature conservation designations. The Brynna a Wern Tarw Site of Special Scientific Interest (SSSI) is located approximately 550m to the northeast of the site. Brynna a Wern Tarw SSSI is of special interest for its extensive area of mixed, species-rich lowland grassland, including significant areas of marshy and dry neutral grassland, and for the association of these habitats with others including broadleaved woodland and heath. It also supports several uncommon plants including Whorled Caraway *Carum verticillatum*, Petty Whin *genista anglica* and Royal Fern *Osmunda regalis* as well as being a core area of habitat on which a meta-population of Marsh Fritillary Butterfly *Euphydryas aurinia* is centred. The Brynau Gwynian Site of Importance for Nature Conservation (SINC) is also located approximately 450m to the northeast of the site. This SINC is designated due to the marshy grassland, broad-leaved semi-natural woodland, semi-improved neutral grassland, wet heath/acid grassland mosaic and sphagnum blanket bog it supports.

3.2 Given the habitats present at the site and the physical separation from the designated sites by existing development and infrastructure, the SSSI and SINC were considered of little or no ecological relevance to any future development proposals.

3.3 A number of records of protected or otherwise notable flora and fauna were recorded within or directly adjacent to the current site including Common Frog *Rana temporaria*, Barn Owl *Tyto alba*, Long-tailed Tit *Aegithalos caudatus*, Coal Tit *Periparus ater*, Goldfinch *Carduelis carduelis*, Grey Heron *Ardea cinerea*, Stinking Iris *Iris foetidissima*, Chiffchaff *Phylloscopus collybita* and Blackbird *Turdus merula*. Other records associated with the surrounding 1km area include Nightjar *Caprimulgus europaeus*, Redwing *Turdus iliacus*, Lesser Redpoll *Acanthis cabaret*, Goshawk *Accipiter gentilis*, Skylark *Alauda arvensis*, Little Ringed Plover *Charadrius dubius*, Hen Harrier *Circus cyaneus*, Cuckoo *Cuculus canorus*, Lesser Spotted Woodpecker *Dendrocopos minor*, Lapwing *Vanellus vanellus*, Swift *Apus apus*, Common Pipistrelle *Pipistrellus pipistrellus*, Soprano Pipistrelle *Pipistrellus pygmaeus*, Noctule *Nyctalus noctula*, Brown Long-eared bat *Plecotus auritus*, Badger *Meles meles*, Slow Worm *Anguis fragilis*, Grass Snake *Natrix natrix*, Common Toad *Bufo bufo*, Grass Rivulet *Perizoma albulata*, Marsh Fritillary Butterfly *Euphydryas aurinia* and Bluebell *Hyacinthoides non-scripta*. Other species recorded outside

the 1km search buffer include Hazel Dormouse *Muscardinus avellanarius*, Lesser Horseshoe bat *Rhinolophus hipposideros*, Great Crested Newt *Triturus cristatus* and Adder *Vipera berus*.

3.4 Records of invasive non-native species including Japanese Knotweed *Fallopia japonica*, Canadian Waterweed *Elodea canadensis* and Canada Goose *Branta canadensis* were also associated with the surrounding 1km area.

3.5 Records of mobile species such as birds and bats in the surrounding area were considered of some ecological relevance to the site, although those with specific habitat requirements, such as the Marsh Fritillary butterfly, were not considered relevant based on a combination of physical separation and the absence of suitable habitat features on site. Given the potentially suitable habitats present at the site, records of reptiles, amphibians and dormice were also considered of some relevance to any future development proposal. A copy of the SEWBReC summary maps for designated sites and protected/notable species are provided in Appendix II.

Extended Phase 1 Habitat Survey

3.6 The distribution and extent of habitats within and adjacent to the site is illustrated in Appendix III along with associated target notes. The site supports a range of habitats dominated by semi-improved and amenity grassland with a network of native hedgerows, blocks of plantation woodland and small areas of tall ruderal vegetation, bracken and scrub. A stream bordered by semi-natural broadleaved woodland forms part of the eastern site boundary and a number of small ponds are also present. The main campus area comprises of amenity grassland, hard standing/buildings and areas of introduced shrubs along with scattered broadleaved and coniferous specimen trees.

Amenity Grassland

3.7 This habitat occupies large areas of the site including the majority of the golf course and sports pitches along with small verges and lawns around the campus buildings. These consist of closely mown, intensively managed swards with a low number of grass species characteristic of amenity seed mixtures including Perennial Rye Grass *Lolium perenne*, Smooth-stalked Meadow Grass *Poa pratensis*, Red Fescue *Festuca rubra agg.* and fine-leaved Bent-grass cultivars *Agrostis* spp. and very few herbs including Daisy *Bellis perennis,* White Clover *Trifolium repens*, Creeping Buttercup *Ranunculus repens*, Yarrow *Achillea millefolium* and Dandelion *Taraxacum officinale* (Plate 1).

Plate 1. Amenity grassland typical of golf course and sports pitches

Species Poor Semi-improved Grassland, Tall Ruderals and Bracken

3.8 Species poor semi-improved grassland occupies the majority of the southern half of the site and consists of pasture closely grazed by sheep and/or horses (Plate 2). The sward was found to be relatively species poor dominated by Perennial Rye-grass with Common Bent *Agrostis capillaris,* Yorkshire Fog and occasionally Smooth Meadow Grass. Herb cover was limited to a few species present at low frequency including Common Mouse Ear *Cerastium fontanum,* Daisy, Common Cat's Ear *Hypochaeris radicata* and Creeping Buttercup *Ranunculus repens* in damper areas. Bulbous Buttercup *R. bulbosus* was also locally abundant in some areas of disturbed ground, indicating generally dry conditions.

Plate 2. Species-poor semi-improved pasture in the south of the site.

3.9 Smaller areas of less intensively managed poor semi-improved grassland were also noted in several small nature areas around the campus (Target Notes 2, 4 & 21), rough margins around the golf course (e.g. Target Note 6) and unmanaged corner around the fringes of the campus. These were found to primarily consist of coarse grasses such as Cock's Foot *Dactylis glomerata,* Yorkshire Fog and Timothy *Phleum pratense* with occasional Red Fescue *Festuca rubra.* All areas were lightly managed at the time of survey and in some areas had begun to develop a tussocky structure, although this varied depending on the frequency of cutting/management (Plate 3, Target Note 6). These areas were generally recorded in association with small areas of Bracken *Pteridium aquilinum* and/or tall ruderal vegetation consisting of species such as Broad-leaved Dock *Rumex obtusifolius,* Hogweed *Heracleum sphondylium,* Common Nettle *Urtica dioica* and willowherbs *Epilobium* spp.

Plate 3. Northern boundary of golf course with poor semi-improved grassland & tall ruderals (Target Note 6)

Semi-natural Broadleaved Woodland

3.10 This habitat occupies a narrow corridor along the stream on the eastern boundary of the site and consists predominantly of mature and semi-mature Oak *Quercus robur* and Alder *Alnus glutinosa* with a sparse understorey of Hazel *Corylus avellana* and Holly *ilex aquifolium.* Ground flora along much of the length of the stream was found to be dominated by Ivy *Hedera helix* and scattered Bramble *Rubus fruticosus* with woodland species limited to occasional Lesser Celandine *Ficaria verna* and Lords and ladies *Arum maculatum.* A slightly wider section of the woodland adjacent to the public footbridge at Target Note 8 (Plate 4) supported a more diverse ground flora including native Bluebells *Hyacinthoides non-scripta*, Pignut *Conopodium majus*, Greater Stitchwort *Stellaria hostiana*, Remote Sedge *Carex remota*, Soft Shield Fern *Polystichum setiferum*, Common Male Fern *Dryopteris filix-mas* and Black Spleenwort *Asplenium adiantum-nigrum.*

Plate 4. Semi-natural broadleaved woodland bordering stream (Target Note 8)

Plantation woodland and scattered trees

3.11 Several areas of plantation woodland are present at the site. These generally comprise relatively young (<15 years) stands of planted broadleaved trees located across the golf course and to the south-west of the site. The majority of these areas consist of Ash *Fraxinus excelsior* with Oak, Hazel, Alder and occasionally Field Maple *Acer campestre* Blackthorn *Prunus spinosa* or Dogwood *Cornus sanguinea* with an understorey of dense or scattered bramble (Plate 5). Ground flora was generally found to be species poor in these areas, dominated by Ivy with occasional Lesser Celandine and/or Lords and Ladies with occasional patches of cultivated daffodils.

3.12 The majority of plantations within the golf course were set within poor-semi improved grassland with no notable understorey or woodland ground flora but were included in this habitat category on the basis of their canopy cover (>30%). This also applies to two more established plantations consisting of Ash, Lime *Tilia x europaeus* and Horse Chestnut *Aesculus hippocastanum* either side of the main entrance.

Plate 5. Young plantation woodland

3.13 An area of more established mixed plantation is present at Target Note 1 (Plate 6). This was found to consist predominantly of European Larch *Larix decidua* and ornamental cypresses with some Alder, Elder *Sambucus nigra* and Cherry Plum *Prunus cerasifera.* The understorey was found to be very sparse, consisting of low growing bramble and self-set Ash seedlings. Cultivated daffodils and snowdrops were frequent with native woodland ground flora limited to occasional Lesser Celandine and Lords and Ladies.

3.14 An area of older broadleaved plantation was also recorded directly to the west of the stables (Target Note 2) contiguous with the mixed plantation described above. This consisted predominantly of semi-mature Beech *Fagus sylvatica* and Ash with an open understorey and ground flora characterised by Ivy and scattered Bramble interspersed with cultivated daffodils and snowdrops.

3.15 Scattered broadleaved and coniferous trees are frequent around the campus buildings, sport pitches and golf course. These consist of a variety of species including Beech, Oak, Horse Chestnut, Lime, Sweet Chestnut *Castanea sativa*, Silver Birch *Betula pendula,* Monkey Puzzle *Araucaria araucana*, Cedar *Cedrus* sp. Eucalyptus *Eucalyptus* sp., Scot's Pine *Pinus sylvestris* and ornamental Cypresses. A number of mature Lime and Ash were also noted in association with hedgerows in the south of the site, either within the hedge lines or directly adjacent.

Plate 6. Mixed plantation woodland (Target Note 1)

Plate 7. Established broadleaved plantation west of stables

Hedgerows and scrub

3.16 The site supports a network of native hedgerows. The majority of these were found to be species poor, predominantly comprised of Hazel or Blackthorn with varying amounts of Holly, Oak, Hawthorn *Crataegus monogyna,* Elder *Sambucus nigra* and Ash. Several of the hedgerows to the south of the site contained occasional mature Lime, Ash or Beech trees. Hedgerow ground flora was found to be relatively poor across the majority of the site consisting of coarse grasses or Bracken with woodland species generally limited to occasional Lesser Celandine, Lords and Ladies and Common Male Fern although native Bluebells were occasional.

3.17 The majority of internal hedges around the site are regularly managed to a height approximately 2.5-3m (Plate 8) with boundary hedgerows less frequently managed, particularly in hedges with frequent trees e.g. around the stable buildings. Occasional areas of intensive management carried out by adjacent landowners were also noted (Plate 9).

Plate 8. Species poor hedgerow typical of much of the site

Plate 9. Intensively managed hedgerow on southern boundary

3.18 Small areas of dense and scattered scrub, consisting of Blackthorn and/or Bramble and occasionally Hazel were noted in less frequently managed areas around the edges of the golf course. Larger areas of scrub are associated with the roads with a belt of dense Blackthorn, Gorse *Ulex europaeus* and Hazel occupying the A473 road embankment on the northern site boundary and a narrow strip of Bramble runs along the western site boundary.

Introduced shrubs

3.19 Beds of introduced shrubs are a frequent component of the landscaping around the main campus. Species include ornamental dogwoods *Cornus* spp. Cherry Laurel *Prunus lauraceous,* Oregon Grape *Mahonia aquifolium* and Rhododendron *Rhododendron* sp.

Ponds and ditches

3.20 A series of artificial ponds are present at the site, located within dedicated nature/conservation areas around the edges of the campus and around the golf course (Target Notes 2, 3, 4, 9, & 21). An additional pond outside the site boundary at Target Note 17 was also surveyed given its connectivity to the main site. The majority of ponds were found to be butyl lined and either held very little water or were choked with vegetation such as Common Reed *Phragmites australis,* Great Reed-mace *Typha latifolia* and Yellow Flag Iris *Iris pseudacorus* or Common Duckweed *Lemna minor* leaving very little or no open water at the time of survey. Exceptions to this were the ponds at Target Notes 4 (Plate 10), 17 and 21. Frogspawn was noted at Target Notes 4, 9, 17 and 21.

Plate 10. Establishing pond within nature conservation area (Target Note 4)

3.21 A small drainage ditch is present within the road verge directly adjacent to the southern and western site boundaries. This was found to be dry and choked with bramble scrub at the time of survey.

Stream

3.22 A small stream (the Ewenni Fach: Plate 11, Target Note 7) runs within the narrow wooded corridor along the eastern boundary of the golf course. This was found to be shallow and fast flowing with a rocky and sandy

substrate. No aquatic or marginal vegetation was visible at the time of survey, with adjacent vegetation dominated by the woodland ground flora of ivy and scattered bramble.

Plate 11. Stream on eastern site boundary (Target Note 7)

Invasive Non-native Plant Species

3.23 Small patches of Himalayan Balsam *Impatiens glandulifera* were noted in several areas around the site at Target Notes 8, 21 and 22. No stands of Japanese Knotweed were identified during the current survey.

Fauna

3.24 In the course of the extended Phase 1 Habitat Survey, a search of field signs for protected or notable species was undertaken and the potential of the habitats to support these species considered. In the context of this report notable species were those considered to meet any of the following criteria:

- Species protected by British or international law;
- Priority Species under Section 7 of the Environment (Wales) Act or local BAP species;
- Nationally rare or nationally scarce species;
- Species of Conservation Concern (e.g. JNCC Red List, RSPB/BTO Red or Amber Lists).

Badgers

3.25 The woodland, scrub and hedgerows across the site are suitable for sett construction and the grassland habitats across the site offer good foraging opportunities for badgers. However, no setts or other field signs of badger were recorded within the site or 30 m of its boundaries. No desk study records of Badgers were identified within the 1km search area although incidence of road casualty was recorded along the M4 at Junction 35 (ca. 1.8km to the south).

Bats

Woodland, scattered trees and scrub

3.26 Trees with potential roost features (PRF) such as cracked limbs, rot holes, flaking bark etc. were recorded at Target Notes 13, 19 and 20 and were assessed as being of moderate potential to support roosting bats. Several bat boxes were also noted on trees in the conservation areas at Target Note 5.

Plate 12. Ash with moderate roost potential (Target Note 13)

3.27 The majority of the more mature trees at the site, whilst displaying no obvious PRF, were assessed as low potential for roosting bats on the basis of their size and age and/or dense ivy cover e.g. the larger Limes, Oaks and Horse Chestnuts, Target Notes 10,11,14,15,16 and mature trees along the stream corridor collectively.

3.28 The remainder of trees within and directly adjacent to the site boundary were found to be generally of a relatively young age and lacked features suitable for roosting bats such as cracks, rot holes or flaking bark and were therefore considered to be of negligible roost potential collectively (trees with no potential to support roosting bats).

3.29 The woodland, hedgerows, scrub and ponds within and around the site were considered likely to provide some foraging and commuting habitat for bats locally, with the stream corridor to the east likely to provide the most valuable commuting/foraging resource.

Buildings

3.30 It is understood that the majority of buildings in the main campus area would remain unaffected by the proposed development and these were therefore not inspected in detail. However, in general the majority of the agricultural buildings (stables, sheds & greenhouses) and the newer buildings consisting of mostly prefabricated materials were considered to be of negligible potential for roosting bats. The older and more traditionally constructed buildings (e.g. those with slate roofs) are more likely to support bats and, although not inspected in detail, were considered likely to be of low or moderate roost potential.

3.31 A small stone building currently used for storage was recorded at Target Note 5 (Plate 13). Whilst this was considered to be of low potential for roosting bats due to the pre-fabricated roof covering and ingress of light/draughts given the door is apparently left open, this building has internal wooden beams and was considered suitable for use as a night roost for species such as Lesser Horseshoe Bat. Records of this species were revealed in the surrounding area as part of the SEWBReC desk study. No droppings or other evidence of use by bats was recorded during the current survey.

Plate 13. Interior of potential night roost (Target Note 5)

Birds

3.32 The site was considered likely to support a limited range of bird species associated with woodland, hedgerow and suburban habitats in the locality. The assemblage of birds noted during this survey included House Sparrow *Passer domesticus*, Blackbird *Turdus merula*, Jackdaw *Corvus monedula*, and Great Tit *Parus major*. A full species list of birds seen on site is given in Appendix III.

3.33 The species present at the time of the survey are not representative of the full spectrum of species that the site could potentially support (i.e. overwinter/passage) but the assemblage recorded was considered largely representative of that likely to breed on and in the vicinity of site. This assemblage was dominated by common

and widespread species although House Sparrow appears on the Red List of Birds of Conservation Concern in the UK (Eaton et al., 2015) and on the Amber list in Wales (Johnstone et al., 2012).

Dormice

3.34 The majority of the woodland, hedgerows and scrub around the site are considered to be sub-optimal for dormice given they are species poor, regularly managed and have relatively poor habitat connectivity, all factors which are known to reduce the likelihood of the species being present. The areas of plantation woodland are also sub-optimal for dormice due to their young age and sparse understorey which provides limited refuge and foraging opportunities for the species. However, previous records of dormice, attributed to woodland at Llanilid (approximately 1.2km to the east) were revealed during the desk study and this area is connected to the site via a network of hedgerows and the semi-natural woodland on the eastern site boundary. It is therefore possible, albeit unlikely, that dormice could make use of the woodland, hedgerow and scrub habitats within the site.

Great Crested Newt

3.35 The ponds at Target Notes 4 (Plate 10), 17 and 21 were considered to be suitable to support breeding Great Crested Newt (GCN) *Triturus cristatus* and the surrounding mosaic of lightly managed semi-improved grassland, tall ruderals and scrub provides good terrestrial habitat for this species. Whilst the overall area of suitable terrestrial is small and limited to the nature areas and unmanaged boundaries of the golf course, the hedgerow network provides some connectivity between ponds/terrestrial habitat allowing animals to disperse around the site. The species has been recorded in the surrounding area (closest records associated with grid square SS 95 81, over 1km to the west) and whilst the roads and stream surrounding the site are likely to act as barriers to dispersal, some connectivity remains and the presence of the species cannot be ruled out.

3.36 The remaining ponds on site were considered to be unsuitable for breeding GCN due to their small size, lack of open water due to drying out, encroaching vegetation or lack of any vegetation in some cases. However, several of these ponds are likely to support common amphibians including Common Frog *Rana temporiana*, the presence of which was confirmed by the presence of frogspawn noted during the survey.

Reptiles

3.37 The majority of the grassland habitats on site, away from the field edges, were mown or grazed short and considered generally unsuitable for reptiles. The rougher margins of the golf course, conservation areas and area around the garden centre were considered suitable to support common species of reptile such as Slow Worm and records of this species were revealed in the surrounding area as part of the SEWBReC desk study.

Other Species

3.38 No habitat suitable for Marsh Fritillary was found within the site boundary and no further consideration of this species would be considered necessary as part of the current assessment. Whilst there is some potential for Otter *Lutra lutra* to commute along the stream on an occasional basis no evidence of this species (spraint, footprints etc.) was recorded during the survey. Given the limited cover and likely level of level of disturbance from the golf course and adjacent public footpath the presence of holts or daytime layups is considered extremely unlikely. Standard measures for the protection of wildlife corridors and root protection areas i.e. sensitive lighting (see Appendix IV), appropriate buffer zones etc. would be recommended as part of any future development and will allow the continued use of the stream as a commuting corridor by Otter (if present).

4.0 CONCLUSIONS & RECOMMENDATIONS

Suitability for development

4.1. The combination of desk study and Extended Phase 1 Habitat survey revealed that the site supports a range of habitats dominated by semi-improved and amenity grassland within a network of native hedgerows, plantation woodland and small areas of tall ruderal vegetation, bracken and scrub. A stream bordered by semi-natural broadleaved woodland forms part of the eastern site boundary and a number of small ponds are also present. The main campus area comprises of amenity grassland, hard standing/buildings and areas of introduced shrubs along with scattered broadleaved and coniferous specimen trees and number of small nature conservation areas.

4.2. The areas of amenity grassland and closely grazed poor semi-improved grassland which make up the majority of the site are considered to be of low ecological value and represent the most appropriate areas for development.

4.3. The wooded stream corridor, nature areas (including ponds), network of hedgerows & mature trees, blocks of plantation woodland and unmanaged areas around the golf course and campus are of value for a range of species and it is recommended that these features are retained and enhanced as far as practical and incorporated into a Green Infrastructure network in accordance with SPG19 (Biodiversity and Development).

Potential constraints

4.4. The site has potential to support a number of protected and notable species, most notably Great Crested Newt and Dormouse, although the likelihood of either species being present is considered to be relatively low based on the quality of the habitats present and/or poor connectivity to the wider landscape. Both species

are fully protected under the Conservation of Habitats and Species Regulations 2010 (as amended) and are an important consideration in term of site development.

4.5. If either or both species are confirmed on site, licences from Natural Resources Wales (NRW) and appropriate mitigation measures would be required prior to any development. This would presume the retention, protection and enhancement of the majority of suitable habitat for these species (ponds and rough grassland for GCN and hedgerows, woodland and scrub for dormouse), retention/improvement of existing habitat connectivity between features and the provision of new or translocated habitat within the site layout to compensate for any loss. Whilst the presence of either dormice or GCN on site does not preclude development it is is likely to result in a net loss of developable area.

4.6. However, a layout design incorporating a robust and well connected green infrastructure as described above would go some way towards the mitigation likely to be required should either dormice or GCN be present. This approach will also cater for other species groups likely to be present e.g. reptiles, bats, birds and common amphibians.

Initial recommendations

4.7. Given that the presence of Dormice and/or GCN is likely to affect the area available for development, further surveys to confirm the presence or likely absence of these species are recommended in order to determine the requirement for licencing and inform any masterplan/viability assessment.

4.8. Additional surveys for reptiles and bats are also recommended prior to any planning submission, although these would not be required to inform a masterplan provided the design adopts the green infrastructure approach outlined above. The scope of these surveys would be guided by the proposed layout at a later stage e.g. bat surveys to determine the presence or absence of bat roosts in trees or buildings would not be required if these features are retained and suitably protected within the development layout.

4.9. The site also presents opportunities for ecological enhancements which could be incorporated into the design at an early stage. Habitat connectivity is currently poor from east to west across the site and along the western and southern boundaries. Provision of a broad woodland/habitat corridor in these areas, ideally linking up with the Ewenny River to the west of the site with the existing areas of plantation woodland and Ewenni Fach corridor to the east would significantly improve habitat connectivity at the site and be of benefit to a variety of species whilst also providing screening from the adjacent roads. If dormice are present on site, provision of this corridor could allow some of the internal hedgerows to be translocated, providing some compensation for the likely reduction in developable area.

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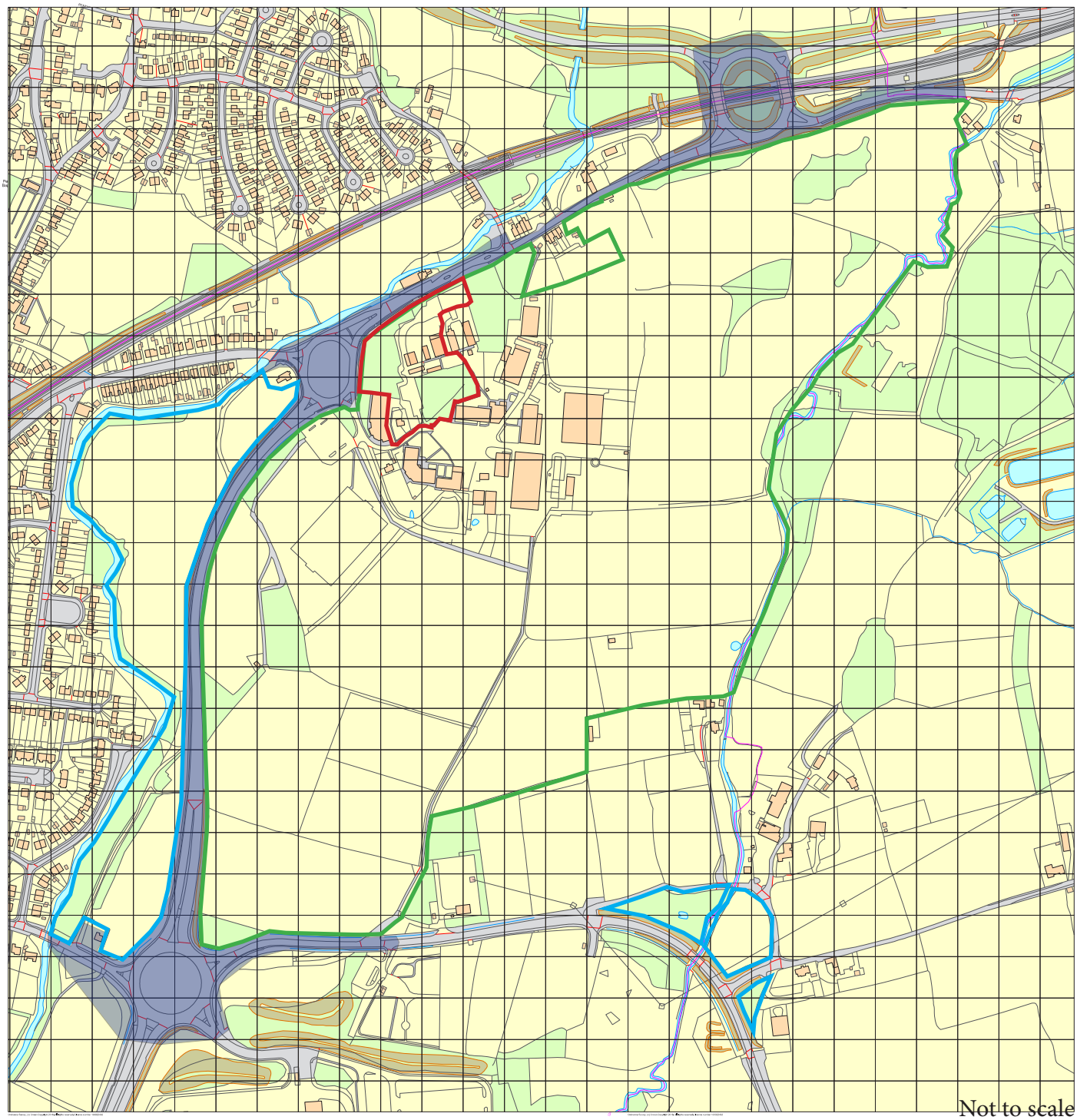
APPENDIX I SITE LOCATION & SURVEY BOUNDARY PLAN

Bridgend College
Study Areas for Surveys



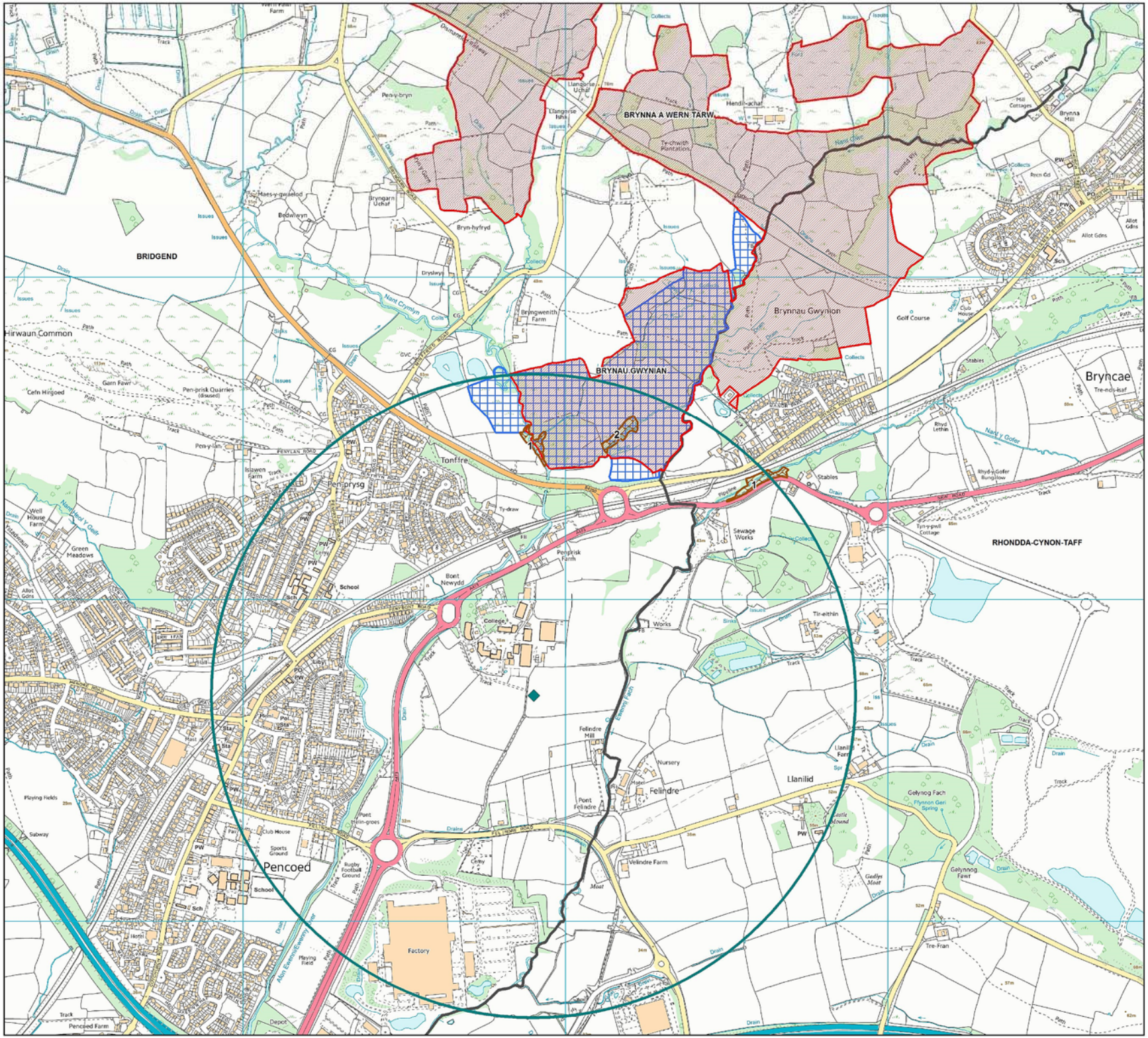
New Teaching Building Study Area

Wider Pencoed Campus Study Area

Other land owned by Bridgend College (for reference)

Additional Highway Land to be included in scope of topographical survey

APPENDIX II DESK STUDY INFORMATION RECEIVED FROM SEWBReC



BIODIVERSITY INFORMATION SEARCH (DESIGNATED SITES):

LAND AT BRIDGEND COLLEGE SS9690081700

- Centre of Search Area
- 1km Search Buffer
- Site of Special Scientific Interest
- Site of Importance for Nature Conservation
- Ancient Woodland
  1: ASNW; 2: RAWS; 3: PAWS; 4: AWSU
  See report for full descriptions
- Unitary Authority Boundary

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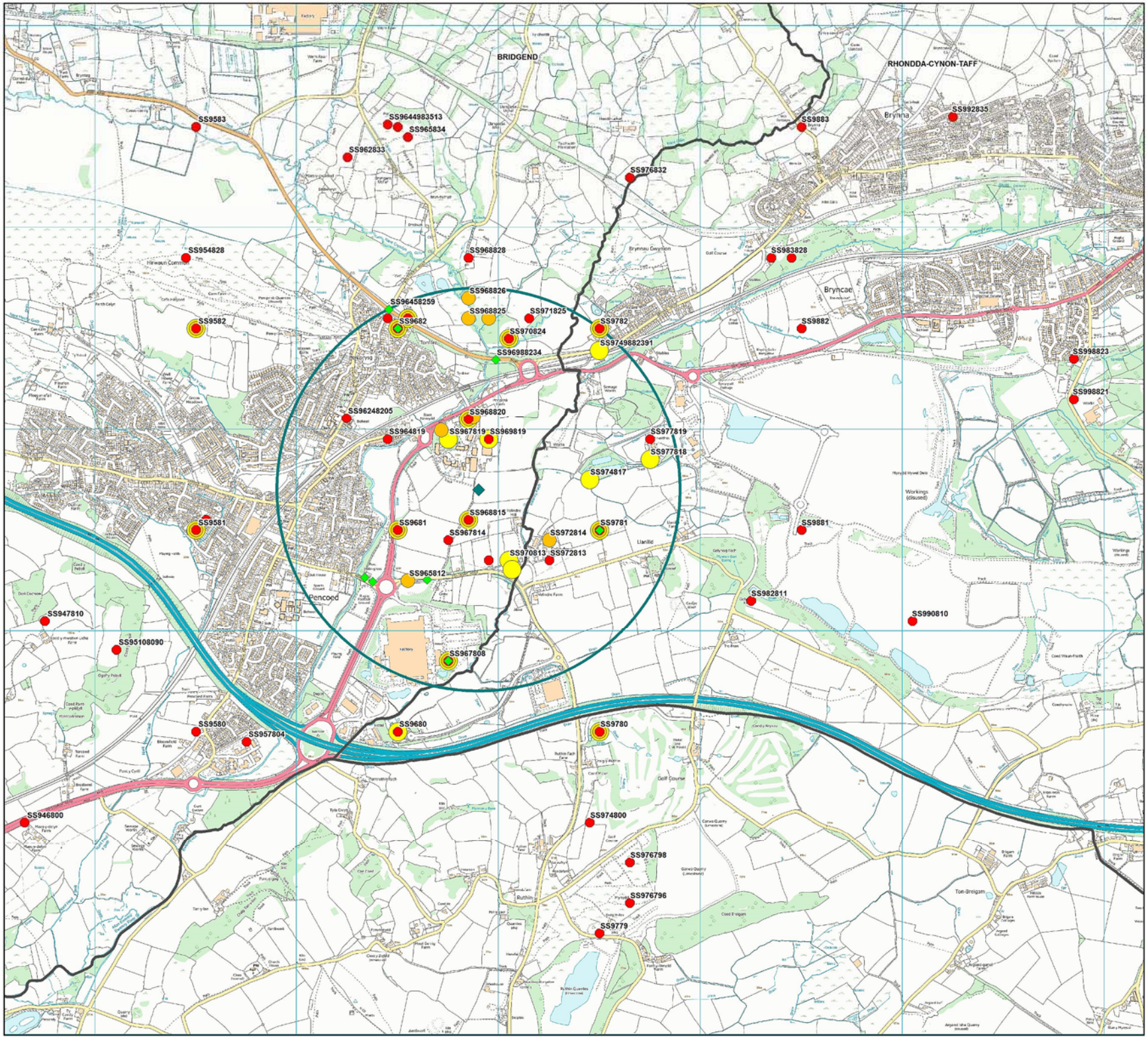
SEWBReC
SOUTH EAST WALES BIODIVERSITY RECORDS CENTRE
CANOLFAN GOFNODION BIOAMRYWIAETH DE DDWYRAIN CYMRU



BIODIVERSITY INFORMATION SEARCH (SPECIES):

LAND AT BRIDGEND COLLEGE SS9690081700

- Centre of Search Area
- 1km Search Buffer
- Priority and Protected Species
- Other Species of Conservation Concern
- Species of Local Conservation Concern
- Invasive Non-Natives
- Unitary Authority Boundary

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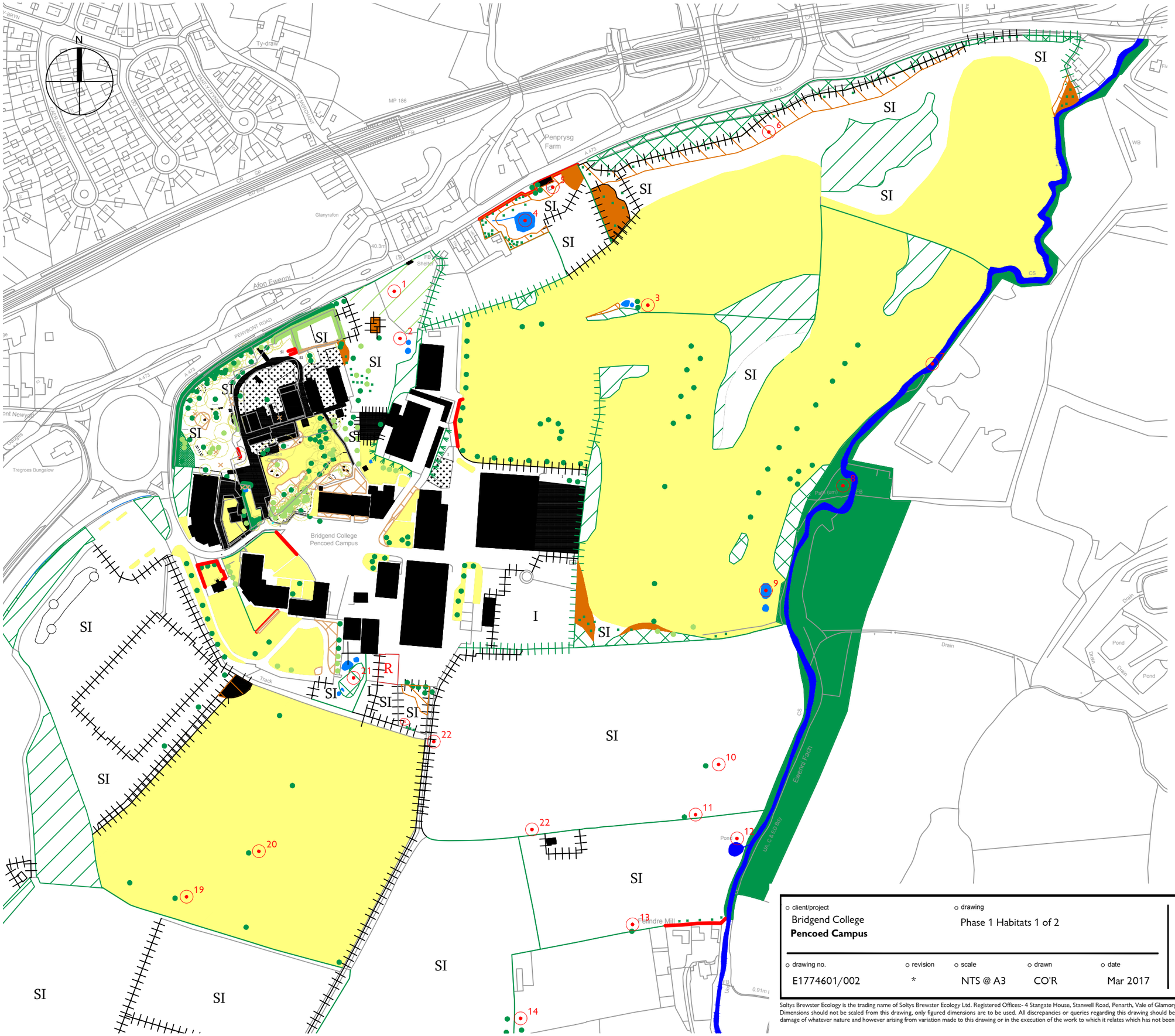
SEWBReC
SOUTH EAST WALES BIODIVERSITY RECORDS CENTRE
CANOLFAN GOFNODION BIOAMRYWIAETH DE DDWYRAIN CYMRU

APPENDIX III PHASE 1 HABITAT MAP & TARGET NOTES

Target Note	Description/comment
Bird species seen/heard: House Sparrow, Blackbird, Jackdaw, Great Tit, Treecreeper, Pied Wagtail. Songthrush, Wood Pigeon, Robin, Dunnock, Magpie, Lesser Black-backed Gull, Blue tit, Long-tailed Tit, Chaffinch.	
1	Block of mixed plantation woodland comprising Larch, Cypresses and Alder with some Cherry Plum and self-set Ash. Understorey generally open and dominated by low-growing bramble & ivy. Cultivated daffodil and snowdrop species present along with some native woodland species noted at low frequency (Lords & Ladies, Lesser Celandine) Native Bluebells noted along bank of hedge bordering footpath.
2	2 no. small artificial ponds with butyl liner. One relatively new with open water and exposed liner to perimeter with log & stone piles alongside and aquatic/marginal vegetation limited to patches of Pendulous Sedge. 2nd pond smaller but more established & choked with Reeds, yellow Iris & duckweed leaving no open water. Unlikely to be suitable for GCN, some potential for common amphibians but no frog/toad spawn noted. Wider area surrounding ponds comprised of poor semi-improved grassland of coarse grasses (Cock's Foot/Yorkshire Fog/Perennial Rye Grass & Red Fescue etc.) areas of tall ruderals (Nettles & Broad-leaved Dock). And scattered broadleaved & coniferous specimen trees (Beech, Cedars, Spruce, and Cypresses). Strip of established broadleaved plantation to east bordering stables of predominantly Beech. Open structure with ground flora consisting mostly of cultivated daffodil and snowdrop species and ivy.
3	Cluster of 3 no. small ponds with butyl liners set in rough area of poor semi-improved grassland and tall ruderals (Epilobium) alongside hedge. Holding a few cm of water but largely choked with Great Reed-mace, Common Reed and Yellow Flag Iris. Small patch of Marsh Marigold present. Unlikely to support GCN but suitable for low numbers of common amphibians & reptiles in surrounding terrestrial habitat. Connectivity to wider landscape along hedge.
4	Small conservation area including recently created pond with butyl liner (10x10m approx.). Vegetation still establishing & mostly consists of Soft Rush around margins with some Water forget-me-not. Water murky at time of survey and no macrophytes visible. Fed by small ditch to N/W. Pond surrounded by a mixture of tall ruderals (nettles & willowherbs), bracken, scattered bramble scrub and occasional Hazel bushes. Several log/brash piles present & drystone wall borders area to N. Area suitable for GCN, common amphibians (several clumps of frog spawn noted) and reptiles.

Target Note	Description/comment
5	Small field shelter used for storage. Blockwork construction to W/E & N sides with some small gaps in mortar & gaps between wall & pre-fab metal sheet roof & facias. Wall to S side has been replaced 7 is breezeblock construction with no obvious gaps (except open door). Wooden beams present inside & multiple gaps in mortar throughout. Low potential for roosting bats but potentially suitable for a night roost (LHS recorded in area). Small group of mature Ash & Beech present to W of building of low/negligible roost potential but with bat boxes attached.
6	Area of poor semi-improved grassland bordering golf course. Generally comprised of Cock's Foot, Timothy and Yorkshire Fog with some patches of red fescue, lightly managed and beginning to form a tussocky structure. Grades into tall ruderal (Creeping Thistle, Hogweed & Broad-leaved Dock and then to scattered bramble scrub and denser bramble/blackthorn/gorse scrub to highways embankment to north. South facing & good potential for reptiles.
7	Small, fast flowing stream with rocky/sandy substrate & no visible aquatic or marginal vegetation. Bordered by narrow strip of Alder/Oak woodland with some overhanging roots. Relatively open structure with some Hazel and Holly and ground flora mostly limited to ivy, scattered bramble and common ferns. Trees collectively low or negligible potential for roosting bats with a few of moderate roost potential (cracked limbs, small rot holes etc.) scattered throughout. Some potential for otter to commute but holts/layups unlikely due to limited cover and high level of disturbance likely from golf course & adjacent public footpath.
8	Slightly wider section of woodland bordering meander/public footbridge supporting a better range of woodland ground flora with native Bluebells, Pignut, Greater Stitchwort, Remote Sedge, Lords and Ladies, Soft Shield Fern, Common Male Fern, Black Spleenwort and Lesser Celandine. Small area of Himalayan Balsam adjacent to footbridge.
9	2 no. small artificial ponds with butyl liners set in amenity grassland close to wooded stream. Both ponds held >20cmn of water in places but were mostly choked with vegetation including Common reed, Yellow-Flag Iris, Soft Rush and alder saplings with no open water. Unlikely to be suitable for GCN but suitable for common amphibians (frogspawn noted in northernmost pond).
10	Isolated mature oak with no visible PRF. Low bat roost potential.
11	Mature Ash within hedge. No visible PRF. Low bat roost potential.
12	Small pond created by excavation of stream bank, presumably for watering livestock. Heavily grazed and poached at margins with

Target Note	Description/comment
	marginal or aquatic vegetation limited to small amounts of floating sweet-grass and Water Forget-me-not. Water turbid, silty and flowing quickly in and out from stream. Unsuitable for GCN.
13	Mature Ash within hedgerow. Hollow branch to N side, several small limb splits and moderate ivy cover. Moderate bat roost potential.
14	3 no. mature Lime (1 no. within site boundary). No visible PRFs low bat roost potential collectively.
15	1 no. mature Lime, no visible PRF but much of trunk obscured by epicormic growth. Low bat roost potential.
16	Mature Scot's pine at junction of access track and main road. 1 large broken limb & several smaller splits visible but no large cavity/rot visible. Moderate ivy cover. Low bat roost potential.
17	Medium sized pond with butyl liner set within off-site nature area connected to main site along hedgerow network and stream corridor. Liner visible around some of margin but more established than other ponds on site with abundant Broad-leaved pondweed and Water Forget-me-not and marginal vegetation of Great Reed-mace, Soft Rush and Tufted Hair-grass. Pond surrounded by poor semi-improved grassland of coarse grasses (mostly Cock's Foot, Tufted Hair Grass & Yorkshire Fog) with scattered bramble scrub. Good terrestrial habitat and potential for GCN, common amphibians and reptiles.
18	Shallow roadside drainage ditch running around S and W boundary. Dry and choked with bramble at time of survey.
19	Mature Oak with large, hollow hazard beam to N/E side and several small areas of lifted bark and small horizontal limb splits. Moderate bat roost potential.
20	Mature Horse Chestnut with 1 rot hole to S side & several small rot holes resulting from dropped limbs. Moderate bat roost potential.
21	Small nature area with poor semi-improved grassland, hazel scrub, relatively young native hedges to boundaries and a cluster of small, butyl lined ponds. Cluster of 3 no. small ponds to S of hazel stand 1 dry & overgrown with Yellow Flag Iris, 1 very small (0.5x0.5m) holding a little water but mostly leaf litter and common duckweed and a 3rd holding some water but no aquatic or marginal vegetation present & bare liner visible on all sides. All three unlikely to be suitable for GCN. Two additional ponds to N. Medium sized pond holding approx. 10-15cm of water with a little Yellow Flag Iris around the margins. Frogspawn present. Smaller pond to east of footbridge holding 10-15cm of water and covered with Common Duckweed with no open water. Himalayan balsam noted in muck heap adjacent to east.
22	Himalayan balsam seedling frequent along field boundaries.



KEY

- Broad-leaved Semi-Natural Woodland
- Broad-leaved Plantation Woodland
- Mixed Plantation Woodland
- Dense/ Continuous Scrub
- Scattered Scrub
- Scattered Broad-leaved Trees
- Scattered Coniferous Trees
- I — Improved Grassland
- SI — Poor Semi-improved Grassland
- Continuous Bracken
- Tall Ruderal
- Standing Water
- Running Water
- S — Spoil
- R — Refuse Tip
- A — Amenity Grassland
- Ephemeral/ Short Perennial Vegetation
- Introduced Shrubs
- Intact Native Species-rich Hedge
- Intact Species-poor Hedge
- Defunct Native Species-rich Hedge
- Defunct Species-poor Hedge
- Native Species-rich Hedge and Trees
- Species-poor Hedge and Trees
- Fence
- Wall
- Dry Ditch
- Earth Bank
- Buildings
- Bare Ground
- Target Note

client/project: Bridgend College **Pencoed Campus**		drawing: Phase 1 Habitats 1 of 2		
drawing no.	revision	scale	drawn	date
E1774601/002	*	NTS @ A3	CO'R	Mar 2017

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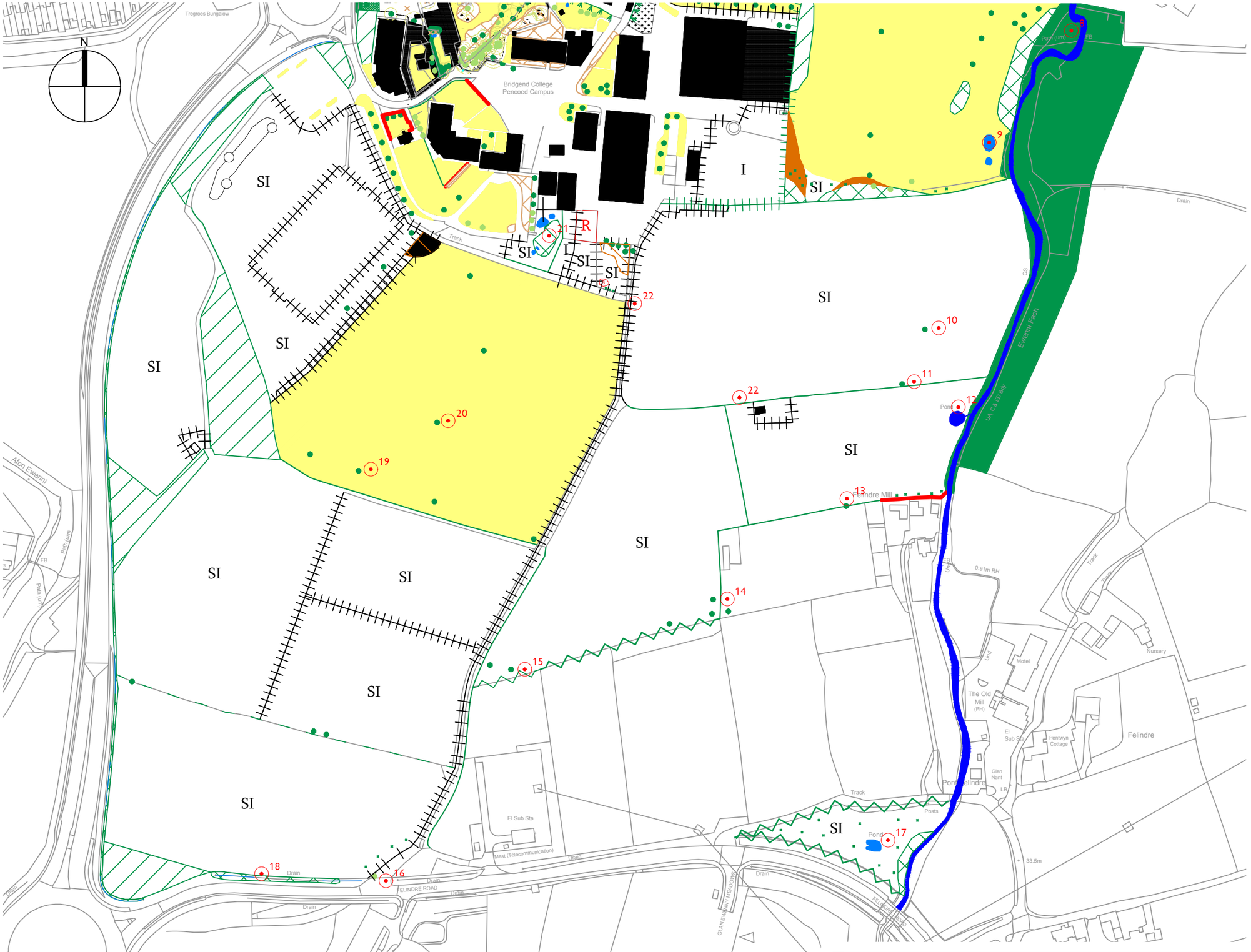

KEY

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- Species-poor Hedge and Trees
- Fence
- Wall
- Dry Ditch
- Earth Bank
- Buildings
- Bare Ground
- Target Note

client/project: Bridgend College **Pencoed Campus**		drawing: Phase 1 Habitats 2 of 1		
drawing no.	revision	scale	drawn	date
E1774601/002	*	NTS @ A3	CO'R	Mar 2017

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APPENDIX IV ADVICE NOTE ON BATS & LIGHTING (2014)

The following advice in relation to Bats and lighting provides a summary of the review of available evidence compiled by the Bats and Lighting Research Project at the University of Bristol. The full report should be reviewed for further information on any of the summary points identified below. The citation for the full report is:

> ***Stone, E.L. (2013) Bats and lighting: Overview of current evidence and mitigation guidance. Lighting Research Project, University of Bristol.***

Introduction

Urbanisation and development affect bat habitats, either through direct loss or disturbance from light and noise pollution or human activities. Changes in habitat affect the quantity, quality and connectivity of foraging, drinking and roosting resources available to bats. Linear landscape features such as hedgerows, river banks and canals are important for bats, often being used for foraging and commuting (Limpens & Kapteyn 1991; Verboom *et al.* 1999).

Bat habitats and roosts are under increasing pressure and disturbance from suburban development and its associated artificial lighting. Connectivity of habitat and foraging areas to roosts is fundamental to the survival of many bat populations (Verboom & Huitema 1997). Lighting schemes can damage bat foraging habitat directly through loss of land and spatial exclusion of bats due to high illuminance, or indirectly by severing commuting routes from roosts, through light spillage polluting hedgerows, tree lines and watercourses (Racey 2006). Lighting around roosts has also been shown to delay emergence, causing bats to miss the peak in insect prey abundance (Downs *et al.* 2003).

Legislation pertaining to lighting in Britain

There is no legal duty for a lighting authority to illuminate roads in Britain and lighting is installed because the perceived benefits outweigh the negatives. Recent research by The Highways Agency (in England) found that the safety benefits of motorway lighting were 1/3 lower than previously thought. Additional field trials to switch-off lights on motorways have found lower numbers of accidents when lights were off than when illuminated (http://www.highways.gov.uk/knowledge/30236.aspx). A number of authorities have been trialling part night lighting solutions and even complete removal. The results have been mixed but a significantly large number of projects have shown no detriment from implementation of these changes.

Street lighting (A roads, B roads, pedestrian lighting)

There are over 7.5million street lights in the UK (Anon. 2009). Common light types used for external applications in the UK.

Common types of street light used in the Britain.

	Colour	% UV	Correlated colour temperature (k)[2]	Approx % of UK Lighting stock
Low pressure sodium (LPS / SOX)	Yellow/orange	0.0	1807	44%
High pressure sodium (HPS / SON)	Pinkish / off white	0.3	2005-2108	41%
Compact fluorescent	Warm white	0.5-1.0	2766-5193	15%
Metal Halide (e.g. Philips CosmoPolis)	Blue-white	2.0-7.0	2720-4160 CosmoPolis 2720	N/A
Light emitting diode (LED)	White/warm - white	0.0	2800-7000	N/A

Predicting the impacts of lighting on bats

There are many aspects of ecological light pollution which are yet to be investigated, and so a precautionary approach is important. It is important to consider the following when predicting the impacts of lighting on bats:

i. Impacts may be cumulative
Lighting is one of many anthropogenic impacts on bats and so it is important to consider impacts of lighting in the context of the site and other conditions affecting the species or colony. For example even a small amount of lighting may have a disproportionate impact on bats at sites where there are already high levels of disturbance, therefore impacts must be assessed in the context of other disturbances on the colony/roost in question.

ii. Impacts will vary according to site, species and behaviour
The impacts of lighting on bats is species specific and varies according to the specific behaviour being affected. Impacts on a site by site basis can be based on knowledge of the species involved and the type of behaviour affected.

iii. Impacts may occur over different temporal scales
Some impacts may occur over very short time frames making them more obvious (e.g. spatial avoidance) and therefore more likely to be recorded. However, lighting may impact behaviours over longer time scales (e.g. reduced breeding success) and may be harder to record and therefore underestimated.

iv. Impacts may occur at both the individual or population level
Lighting may impact on a few individuals in a colony or population, i.e. causing temporary avoidance of a commuting route used by a small percentage of bats occupying a roost. However, there may be effects at the population level, e.g. reduced juvenile growth rates due to reduced foraging or delayed emergence caused by lighting (e.g. see Boldogh *et al.* 2007).

[2] refers to the colour appearance of the light emitted by a light source and is measured in degrees Kelvin (K). The CCT of a light source is calculated by relating the colour of the lamp to the light colour of a reference source when heated to a particular temperature. CCT gives a general measure of the "coolness" or "warmth" of the light source: CCT ratings below 3200K are considered warm whereas ratings above 4000K are considered cool. CCT gives an indication of the general appearance of the light, but not its spectral power distribution, and so two lamps that appear the same may have different colour rendering properties.

v. Impacts may be indirect occurring at the ecosystem or community level
Lighting can impact bats via changes at the ecosystem level. Lighting may lead to a competitive advantage for some species which benefit from the increased foraging opportunities provided by moths attracted to lights with high UV content. This may lead to competitive exclusion of those species unable to take advantage of new artificially illuminated areas (Arlettaz *et al.* 2000). Indirect effects include effects on bats' insect prey. Bats have a competitive advantage over moths at street lights (Svensson & Rydell 1998), which interferes with the relationship between predator and prey.

A summary of the key impacts per species according to behaviour types is provided in Table 5.1. These are based on current knowledge and may change as more evidence emerges, so are given as guidance only and specific levels of impact will vary on a site by site basis. Low impact does not mean there is no impact, but suggests that impact is likely to have a negligible impact on the population. Further research is required to have high confidence in many of these predictions and therefore they should be used as guidance only.

Table 5.1 Summary of predicted impacts of lighting according to bat behaviour.

Impact / Behaviour	High	Medium	Low
Maternity roost	All species	-	-
Night roost	*Rhinolophus hipposideros* *Rhinolophus ferrumequinum* *Myotis* spp. *Plecotus* spp.	*Pipistrellus* spp. *Nyctalus* spp. *Eptesicus serotinus* *Barbastella barbastellus*	-
Emergence	All species	-	-
Foraging	*Rhinolophus hipposideros* *Rhinolophus ferrumequinum* *Myotis* spp. *Plecotus* spp.	-	*Pipistrellus* spp. *Nyctalus* spp. *Eptesicus serotinus* *Barbastella barbastellus*
Commuting	*Rhinolophus hipposideros* *Rhinolophus ferrumequinum* *Myotis* spp. *Plecotus* spp.	-	*Pipistrellus* spp. *Nyctalus* spp. *Eptesicus serotinus* *Barbastella barbastellus*
Swarming	All species	-	-
Hibernation	All species	-	-

Key messages and recommendations:

Emergence and roosting

- Current evidence demonstrates that external light disturbance at emergence and return will have negative impacts for bats (especially *Rhinolophus*, *Myotis*, and *Plecotus* spp.) and should be avoided.
- Internal illumination of roosts is likely to impact negatively on long-term population growth and survival and should be avoided for all species.

- Direct illumination of a roost exit/entrance may cause roost abandonment for all species (particularly for *Rhinolophus* and *Myotis* spp.) and should be avoided.

Commuting

- Light disturbance along commuting routes will cause avoidance behaviour for *R. hipposideros* and *Myotis* spp. and should be avoided.

Foraging

- Light disturbance can reduce the availability of foraging areas for some species.
- A precautionary approach must be taken and illumination of foraging areas avoided, particularly for light sensitive species.

Hibernation

- There is limited evidence of the impact of lighting on hibernating bats. However illumination of hibernation sites should be avoided during the hibernation period.

Swarming

- There is a lack of evidence regarding the impact of lighting on bat swarming behaviour and so illumination of known or potential swarming sites should be avoided under the precautionary principle.

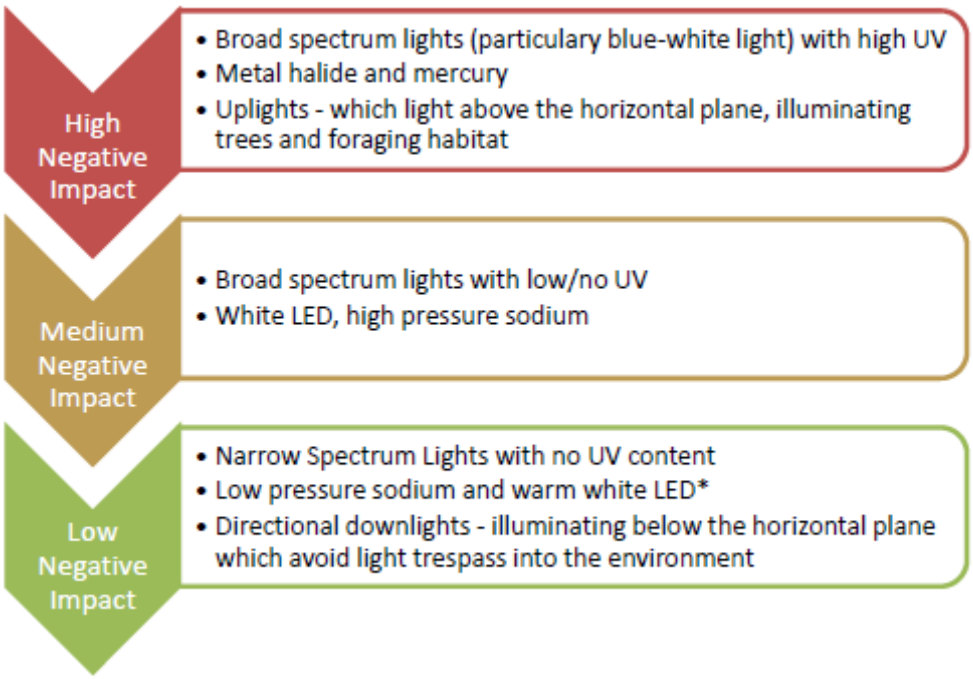
Summary of impacts of light types on bats

Light technology is rapidly developing and new light types are being installed and trialled across the UK. There is a general trend towards white light due to the increased colour rendering and increased perceived brightness for the human eye. Humans perceive white light as brighter than yellow light and so lower light intensities can be used to achieve the same perceived brightness. Commonly used emerging lamps include white LED (Philips Stela and DW Windsor Monaro), warm-white LED, and ceramic metal halide (e.g. Philips 5. CosmoPolis). Some companies are testing new light types to find a wildlife friendly lamp which has little or no impact on wildlife e.g. QL Philips Clearsky lamps which are said to prevent migrating birds from colliding with offshore platforms. To date no such product has been rigorously tested on bats. However, there is little evidence of the comparative impacts of different light types on different bat species and behaviours.

The figures overleaf provides a general summary of the **relative** impacts of light types on bats. However, there is a lack of evidence regarding the comparative impacts of different light types on bats and these summaries should be considered general rules of thumb until more detailed information is available.

Summary of the current evidence of the relative impacts of different light types on bats

Light type	Species	Impact	Evidence
White LED	*Rhinolophus hipposideros* and *Myotis* spp.	Reduced activity and spatial avoidance of commuting routes	Stone *et al.*, 2012
Warm white LED	Unknown at present	Unknown - though likely to have less impact on light sensitive species than white light types	
Low pressure sodium	*Nyctalus noctula*	Increased activity and foraging	Rydell & Baagoe 1996
	Pipistrellus spp.	No significant increase in activity compared to dark areas	Blake *et al.*, 1994
High pressure sodium	*Rhinolophus hipposideros and Myotis* spp.	Reduced activity and spatial avoidance of commuting routes; delayed commuting time	Stone *et al.*, 2009; 2011
	Pipistrellus spp., *Nyctalus noctula, Eptesicus serotinus*	Increased activity and foraging	Rydell & Baagoe 1996
Compact fluorescent	Unknown at present	Unknown - though likely to have a similar impact on light sensitive species as other white light types	
Mercury vapor lamps	*P. pipistrellus and Pipistrellus* spp. *Eptesicus* spp.	Increased activity (Rydell (1991) recorded increased activity of *Eptescius nilssoni* (a species not present in the UK) at mercury vapor lamps in Sweden in spring April – May)	Haffner & Stutz 1985; Blake *et al.* 1994, Rydell & Racey 1995.

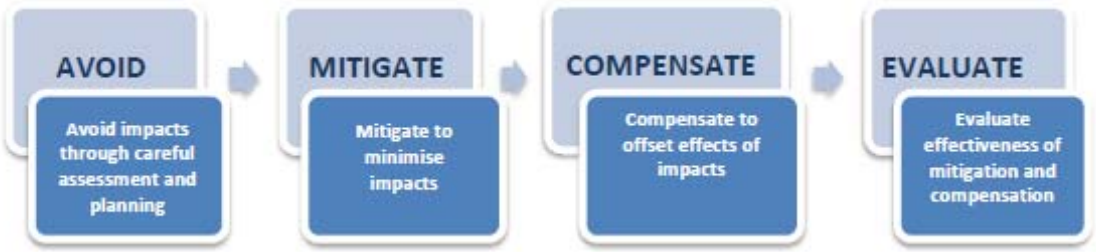


Approach to mitigation of artificial lighting

When mitigating the impacts of artificial lighting on bats it is important to ask the following key questions:

1. Do we need to light?
2. Where does the light need to be?
3. What is the light required for?
4. How much light is actually needed to perform the tasks required ?
5. When is the light required?

The following approach should be taken when developing a mitigation strategy:



Mitigation Strategies
Mitigation strategies will vary on a site by site basis according to the required level of lighting, use of the area, the surrounding habitat, the species of bat and specific behaviour affected.

No light
Where possible the ideal scenario would be to have no light at all at locations used by bats. This may be possible with good planning and involvement of lighting engineers at the survey and pre-planning stage. This may involve switching off existing units on site and ensuring areas used by bats have no new light units installed and will have no light trespass from nearby lights. If possible sites should contain light exclusion zones (dark areas) which are interconnected to allow bats to move freely from their roosts along commuting routes to their foraging grounds without being subject to artificial illumination.

Variable lighting regimes (VLR)
In many cases it is not feasible to have light exclusion zones in all in the areas occupied by bats at a site. In such cases new generation lighting controlled by CMS systems may be preferable to enable variable lighting regimes (VLR) to suit both human and wildlife use of the site. VLR involve switching off or dimming lights for periods of the night. Many county councils are adopting VLR using CMS controlled units, switching off/dimming lights when human activity is low (e.g. 12.30 – 5.30am). This technology could also be used to create a lighting regime that switches off lights during periods of high bat activity, such as commuting or emergence. Lights can also be dimmed (e.g. to 30% power) for periods of the night to reduce illumination and spill. The exact regime of lighting at a site will depend on the nature of public use and type and amount of bat activity, and will therefore vary between sites.

Habitat creation

- **Light barriers**: vegetation can be planted (e.g. hedgerows or trees) to reduce light spill so acts as a light barrier. Careful consideration should be given to the minimum size of the habitat required to restrict any light trespass when used as a light barrier. The size and depth of the corridor will vary according to the distance from the light source, light intensity, light spread and light type.

- **Dark corridors**: dark corridors can be created to encourage/guide bats away from lit areas or around lit obstacles (such as roads). Corridors should be placed with consideration for the use of the landscape as a whole in relation to key commuting routes, linking foraging sites and roosts. Corridors can be composed of man-made or natural materials (e.g. fences, brick walls, tree lines or hedges). Corridors with outgrown vegetation are preferable as they create dark fly ways sheltered from predators and the elements. Heavily clipped low hedges or tree-lines are less suitable. To increase their effectiveness dark corridors should be:

i. Well-connected within the bat landscape – linking to existing flight paths, roosts or foraging areas;
ii. Outgrown with mature vegetation providing shelter for bats from the weather and predators as they fly;
iii. Planted with native species to encourage insect populations, thereby allowing bats to forage along the corridors;
iv. Located away from roads to avoid traffic noise which will reduce the foraging efficiency of passive listening bats (Schaub 2008); and
v. Monitored/maintained long-term to ensure they remain functional, e.g. have not been removed or altered in a way that will reduce effectiveness.

Spacing and height of units

Increasing the spacing between light units can reduce the intensity and spread of the light to minimise the area illuminated and give bats an opportunity to fly in relatively dark areas between lights. Reducing the height of light units will keep the light as close to the ground as possible, reducing the volume of illuminated space. This will also give bats a chance to fly over the light units in the dark area above the light (as long as the light does not spill above the vertical plane). There are many low level lighting options for pedestrian and cycle path lighting which minimise spill and reduce overall illumination including: low level illuminated bollards, down-lights, handrail lighting or footpath lighting.

Reducing intensity

Reducing light intensity will reduce the overall amount and spread of illumination. For some bat and insect species this may be sufficient to minimise disturbance or the magnitude of any negative impacts. However, some species may require very low light levels to have little/no impact on bat behaviour. Stone *et al*., (2012) found that levels as low as 3.6lux caused spatial avoidance of a preferred commuting route by *Rhinolophus hipposideros.* Average light levels recorded along preferred commuting routes of *Rhinolophus hipposideros* under natural unlit conditions were 0.04 lux across eight sites (Stone 2011). When mitigating the impacts of lighting for such species very low lux levels may not be suitable for human needs. In such cases reducing intensity may not be an option and alternative strategies may be preferable (e.g. dark corridors or light barriers). A "light threshold" below which there is little impact on bats may not exist for some species which may be light averse regardless of intensity (e.g. possibly *Rhinolophus hipposideros*). Light intensity can be reduced by:

- *Dimming*: CMS technology can be used to reduce the power of lights on request (e.g. by 80%) and can be used as part of a VLR for periods of high bat activity;
- *Changing the light source:* new technologies such as ceramic metal halide (e.g. Philips CosmoPolis, 45 watts) often have a lower wattage compared to old lamp types (e.g. HPS, 75 watts), and can be used to reduce light intensity. However, there is a trade-off between reduced intensity and the pattern of light distribution. Some older light types such as HPS, produce a heterogeneous light environment whereby light intensity declines steeply away from the light source. However some new technologies such as LEDs produce a uniform light distribution resulting in a loss of dark refuges between the lamps (Gaston *et al.* 2012). In such cases it may be preferable to increase the spacing between the units to create dark refuges. In addition when changing the light source it is important to consider the effects of the spectral content of the light; or
- *Creating light barriers:* light intensity can be reduced at a particular site by creating a light barrier which restricts the amount of light reaching the sensitive area. Barriers can be in the form of newly planted vegetation walls, fences or buildings.

Changing the light type

When selecting a light type it is important to consider the colour appearance and rendering of the lamps in relation to human and bat vision. Different light types are likely to have different effects on bats, and these effects will be species and behaviour specific. Choosing the light type (colour/spectral distribution) will inevitably be a compromise between

the environmental and public requirements. Currently there is a lack of evidence of the comparative impacts of light types on bats. However, the following key principles can reduce potential negative impacts on bats and wildlife in general:

- *Avoid blue-white short wavelength lights*: these have a significant negative impact on the insect prey of bats. Use alternatives such as warm-white (long wavelength) lights as this will reduce the impact on insects and therefore bats
- *Avoid lights with high UV content:* (e.g. metal halide or mercury light sources), or reduce/completely remove the UV content of the light. UV has a high attractiveness to insects leading to direct insect mortality at street lights thereby reducing the availability of insect prey (Bruce-White & Shardlow 2011). Use UV filters or glass housings on lamps which filter out a lot of the UV content.

Reducing spill

Lighting should be directed only where it is needed to avoid trespass (spilling of light beyond the boundary of area being lit). Attention should be paid to avoid the upward spread of light near to and above the horizontal plane to minimise trespass and sky glow. Trespass can be minimised either prior to installation with careful lighting design and selection of appropriate lamp units, or post installation using a range of lamp modifications to restrict and direct light.

Prior to installation:

- Ensure a low beam angle of the lights (ideally less than 70° above the horizontal) (ILP, 2011)
- Install full horizontal cut off units (with no light more than 90° above the horizontal)
- Avoid the use of upward light (e.g. ground recessed luminaires or ground mounted floodlights up-lighting trees, buildings and vegetation)
- For security lighting use 'variable aim' luminaries which allow you to change the beam angle by moving the lamp
- LED lamps allow for directional lighting as individual/groups of LED bulbs can be switched off to direct light to specific angles and most luminaires are full cut off

Post installation:

- Install directional accessories on existing light units to direct light away from sensitive areas and minimise spill (e.g. baffles, hoods and louvres)
- Where possible change the angle of the lamp housing to reduce the angle of the beam below 70°

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