Kronospan Low Carbon CHP Facility

Appendix 6G

Baseline Habitat Condition Survey

Prepared for: Kronospan

December 2025

DNS5-4-028

1.0 INTRODUCTION

1.1 Introduction

1.1.1 This report provides the results of a survey to establish current baseline condition of habitats at statutory and locally designated sites in the vicinity of the Kronospan wood-based panel factory at Chirk, Wales.

1.1.2 A key aim of the survey is to assess sensitivity of habitats to air quality impacts, through identification of plant communities, and investigating any indications of existing air quality impacts on vegetation. Data collected from this survey would then be utilised in the ecological interpretation of the air quality assessment undertaken to inform the development of a combined heat and power (CHP) facility at the Chirk site.

1.1.3 The report incorporates the following elements:

- Data search and collation of existing information about notified features, feature condition and existing pressures at statutory designated sites.
- Field identification of relevant woodland and grassland National Vegetation Classification (NVC) and European Nature Information System (EUNIS) plant communities.
- Assessment of nutrient status of woodland habitats using Ellenberg indicator values.
- Assessing baseline air quality of woodland and parkland trees using Lichen Indicator Scores.
- Assessing any visible signs of foliar injury and other potential indications of air quality impacts.

1.1.4 The results are interpreted to identify appropriate critical loads for nitrogen deposition for the plant communities present, in accordance with current guidance. Critical levels for ammonia are also identified, based on the presence of sensitive lower plant communities.

1.1.5 The Ellenberg indicator values derived from woodland vegetation, Lichen Indicator Scores and tree health indicators are interpreted to identify any existing pressures arising from baseline air quality.

2.0 SCOPE AND METHODOLOGY

2.1 Scope of Surveys

2.1.1 The survey scope was determined by the results of dispersion modelling of emissions undertaken by Fichtner Consulting Engineers. Four ecological receptors were identified as requiring further field survey:

- Chirk Castle and Parkland Site of Special Scientific Interest (SSSI);
- Nant y Belan and Prynela Woods SSSI;
- Canal Wood Local Wildlife Site (LWS); and
- Barracks Field LWS.

2.2 Desk Study

SSSI Information

2.2.1 Information on notified features, habitat condition and management advice for the two SSSI sites was obtained from published Natural Resources Wales (NRW) information, including site citations, and indicative condition assessments[1]. The Air Pollution Information Service (APIS) GIS App[2] was consulted for site-specific information on background air quality values, and the appropriate published nitrogen critical loads.

[1] *https://naturalresources.wales/evidence-and-data/research-and-reports/protected-sites-baseline-assessment-2020/?lang=en*
[2] *https://www.apis.ac.uk/app*

2.3 Survey Methodology

Identification of Plant Communities

2.3.1 Woodland plant communities were identified with reference to the National Vegetation Classification (NVC), using the authors experience of woodland plant communities, and with reference to the keys and descriptions in the NVC *Field Guide to Woodland*[3], supplemented if necessary by more detailed descriptions in *British Plant Communities*[4].

2.3.2 The primary purpose for identifying plant communities was to be able to assign the correct critical load class for nitrogen deposition, which is based on identification of the appropriate EUNIS plant community. These were converted from NVC communities using the correspondences in Strachan (2015)[5], and updated to the recently revised version of the EUNIS classification[6], using the Microsoft Excel habitat classification and crosswalk spreadsheet[7]. This version is in the process of being adopted by APIS, and is used in the APIS GIS App, although it does not appear on all of their advice at the time of writing.

Woodland Vegetation Sampling

2.3.3 Representative relevés were chosen within the target woodlands for later analysis of nutrient status using indicator species. These were chosen to represent typical vegetation of shaded habitats in each wood, while encompassing the range of variation in vegetation observed. Trees and shrubs were recorded within a nominal 20x20m area, and understorey flora (field and ground layers) were recorded in a 2x2m sample within this area. The simple 5-point Dafor scale (dominant/abundant/frequent/occasional/rare) was used to record relative abundance within the samples.

[3] *Hall, J.E., Kirby, K.J. & Whitbread, A.M. (2004). National Vegetation Classification: Field Guide to Woodlands. Joint Nature Conservation Committee, Peterborough*
[4] *Rodwell, J.S. (1991). British Plant Communities. Volume 1. Woodlands and scrub. Cambridge University Press*
[5] *Strachan, I.M. (2015). Manual of terrestrial EUNIS habitats in Scotland. Scottish Natural Heritage Commissioned Report No. 766*
[6] *Chytry M, Tichy L, Hennekens SM, Knollova I, Janssen JAM, Rodwell JS, Peterka T, Marceno C, Landucci F, Danihelka J, et al. (2020). EUNIS habitat classification: Expert system, characteristic species combinations and distribution maps of European habitats. Applied Vegetation Science **23**(4): 648-675*
[7] *https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification-1 (accessed 29/06/2023)*

2.3.4 Notes were made on the location of the relevé with respect to local topography and land-use, which can influence its nutrient status. Open clearings were not sampled, although notes were made on their dominant vegetation as a further indication of woodland nutrient status.

Lichen Indicator Species Sampling

2.3.5 Sampling of lichens followed the methodology published by the Field Studies Council[8], which records the presence of selected N-sensitive and N-tolerant lichens on oak and birch boles and branches.

2.3.6 After initial recording of open-grown oak boles and woodland-edge birch boles at Chirk Castle and Parkland SSSI produced few indicator species (positive or negative), the survey was confined to recording of branch lichens on oak tree branches accessible to ground level survey. Trees were selected in open locations (woodland edge, ride or clearing) where there was limited suppression of lichen growth by shade, and indicator species recorded in three zones along the branches (0-50cm; 50-100cm; & >100cm from tip). Five branches were recorded at each sample location, apart from one site where there were only four accessible branches. Lichens were identified with the help of a x20 using the FSC guide to N-tolerant and N-sensitive indicator species.

Tree Health Assessment

2.3.7 Observations were made in the course of the survey on woodland and tree health, noting any factors such as evidence of foliar injury/yellowing of leaves, crown dieback/thin canopies, dust deposition, or evidence of disease. The purpose was to identify any signs of poor tree health which would benefit from further investigation by an appropriately qualified arboricultural professional.

2.4 Assessment Methodology

Ellenberg Indicator Values (EIVs)

[8] *Centre for Ecology and Hydrology, Natural History Museum and University of Nottingham (undated). Guide to using a lichen based index to air quality. Field Studies Council. https://www.apis.ac.uk/nitrogen-lichen-field-manual#lichen%20field%20guide*

2.4.1 Vegetation samples were allocated to a NVC community (not sub-community) and EUNIS Level 5 habitat using the reference material described above. Ellenberg Nitrogen (Ellenberg N; EIV N) values[9] were allocated to each component species using adjusted values for British flora given in Hill *et al* (1999[10]) for vascular plants, and Hill *et al* (2007[11]) for bryophytes. Unweighted mean Ellenberg N values were calculated for each sample; weighted mean values which took into account five-point DAFOR-scale cover values were also calculated, based on the formula in Klaus *et al* (2012[12]) set out **at Image 2.1** below.

Image 2.1 – Klaus *et al* (2012) Formula

$$mE = \Sigma xi \times Ai / \Sigma Ai,$$

(with mE = mean Ellenberg value, xi = Ellenberg value of species i and Ai = cover of species i)

2.4.2 Although based on an assessment of individual species responses to soil fertility, they have been shown to correlate well at plant community level with measured soil nitrate levels[13]. However, evidence is more equivocal over the question of whether unweighted or weighted values provide a better fit with soil nitrate, so both are used here.

2.4.3 Values obtained were tabulated as a CSV file and imported to QGIS for plotting as points, colour-coded with weighted and unweighted EIV N values.

[9] Ellenberg, H. (1974). Zeigerwerte der Gefäßpflanzen Mitteleuropas; Verlag Erich Goltze KG: Göttingen.
[10] Hill, M.O., Mountford, J.O., Roy, D.B. & Bunce, R.G.H. (1999). ECOFACT 2a Technical Annex - Ellenberg's indicator values for British Plants. Centre for Ecology and Hydrology
[11] Hill, M.O., Preston, C.D., Bosanquet, S.D.S. & Roy, D.B. (2007). BRYOATT Attributes of British and Irish Mosses, Liverworts and Hornworts. NERC Centre for Ecology and Hydrology and Countryside Council for Wales
*[12] Klaus, V. H., Kleinebecker, T., Boch, S. Müller, J., Socher, S.A., Prati, D., Fischer, M., Hölzel, N. (2012). NIRS meets Ellenberg's indicator values: Prediction of moisture and nitrogen values of agricultural grassland vegetation by means of near-infrared spectral characteristics. Ecological Indicators, **14**: 82-86*
*[13] Carpenter, W., Goodenough, A. (2014). How robust are community-based plant bioindicators? Empirical testing of the relationship between Ellenberg values and direct environmental measures in woodland communities. Community Ecology, **15**, 1–11.*

Lichen Indicator Species Analysis

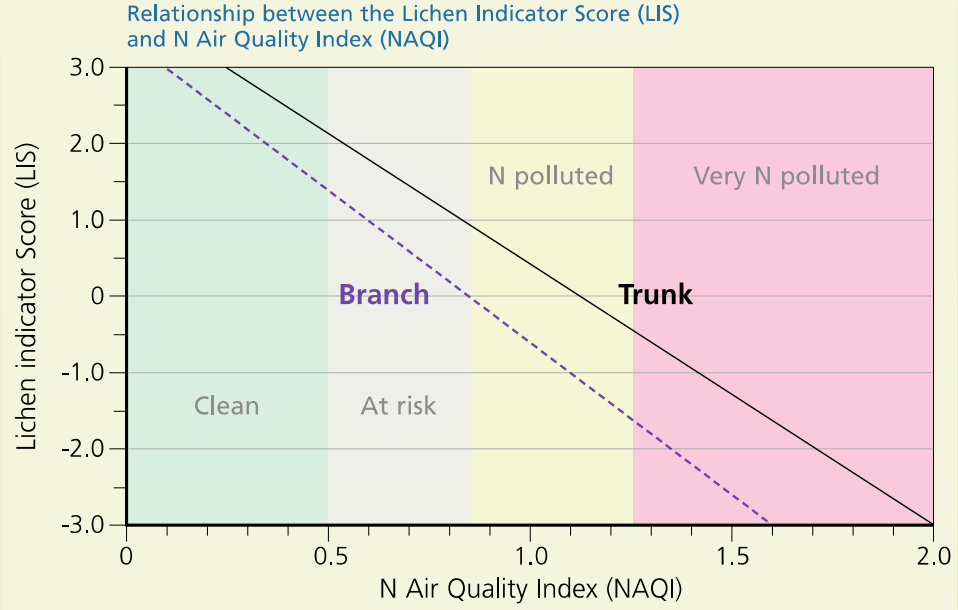
2.4.4 The presence or absence of N-sensitive and N-tolerant species was summed for the three branch sections and five branch samples per site; there was no weighting for numbers of species of one category, or for a greater abundance of a species. This gives a maximum potential score of 15 (3 branch length categories x 5 branches) for a site; averages are then calculated for N-sensitive and N-tolerant species.

2.4.5 The **Lichen Indicator Score (LIS)** is then calculated as follows:

LIS = (average N-sensitive) - (average N-tolerant).

2.4.6 The **Nitrogen Air Quality Index (NAQI)** is then read from a graph (see **Image 2.2** below) showing the relationship between the LIS and the NAQI:

Image 2.2 – Nitrogen Air Quality Index



2.4.7 The categories are defined as follows:

Table 2.1 – NAQI Inferred Air Quality Categories

LIS Range (approx.) for Branches	NAQI Range	Interpretation
3.0 - 1.4	0 - 0.5	Clean air
<1.4 - 0.0	>0.5 - 0.85	At risk

LIS Range (approx.) for Branches	NAQI Range	Interpretation
<0.0 - -1.6	0.86 - 1.25	N polluted
<-1.6	>1.25	Very N polluted

2.5 Personnel

2.5.1 The field survey, data analysis and reporting were undertaken by Kevin Honour MSc MCIEEM, a freelance ecologist and Director of Argus Ecology Ltd., with over 30 years' experience of habitat survey and assessment, and ecological impact assessment, including extensive experience in the ecological interpretation of air quality assessments. He is a competent field botanist, with an IdQ in Vascular Plants from the Natural History Museum, and previously taught air pollution ecology as a Senior Lecturer at Sunderland University.

2.6 Timing, Weather Conditions and Constraints

2.6.1 Dates and times of surveys are provided in **Table 2.2** below.

Table 2.2 – Survey Dates, Times and Weather Conditions

Date	Sites	Times	Temp.	Weather
13/06/23	Chirk Castle Canal Wood	10:00 - 16:20	26^{0}C	Dry, sun / hazy high cloud, light winds, cloud cover (CC) 2/8
14/06/23	Nant-y-Belan & Prynela Woods	09:18 - 18:33	24^{0}C	Dry, sunny, light winds, CC 0/8
15/06/23	Canal Wood Barracks Field	09:30 - 13:25	26^{0}C	Dry, sunny, light winds, CC 0/8

2.6.2 The habitat survey was undertaken at an optimal season for recording vascular plant species, particularly in woodland habitats, and assessing habitat condition. Some of the 'vernal' component of the woodland flora was dormant and less visible, but most species could still be discerned. Abundance values were adjusted upwards for these species (e.g. wood anemone *Anemone nemorosa*; wood garlic *Allium ursinum*), to account for any under-estimation of cover.

2.6.3 The lichen indicator species survey is relatively insensitive to season; winter is marginally better because of better illumination under the canopy and ease of viewing of bare twigs - however the presence of a full canopy did not significantly inhibit the survey, particularly as trees in well-lit woodland edge locations were required.

2.6.4 The canopy was in full leaf, which enabled signs of any senescence, disease or damage to be readily observed.

2.6.5 Chirk Castle and Canal Wood were accessed using public and permissive paths. Permission was obtained from the landowner to access Nant y Belan and Prynela Woods. Access was not obtained to Barracks Field, which was viewed from an adjoining public road.

3.0 RESULTS

3.1 Baseline Conditions

SSSI Notified Features and Condition Assessments

3.1.1 Chirk Castle and Parkland SSSI is designated for the following features, as listed in the *'Your Special Site and its Future*' publication by Natural Resources Wales:

- Veteran trees.
- Saproxylic (dead wood) invertebrates.
- Maternity colony of lesser horseshoe bats.
- Grassland fungi.

3.1.2 Neither this publication or the Site Citation mention woodlands within the SSSI as being notified features in their own right, although it does mention the importance of the woodlands for lesser horseshoe bat foraging and commuting.

3.1.3 Nant y Belan and Prynela Woods SSSI is designated for its semi-natural woodland habitat. The Site Citation states that this includes:

- areas of more acid soils with species such as bilberry (*Vaccinium myrtillus*) and great wood-rush (*Luzula sylvatica*);
- areas of deeper and more base-rich soils with species such as wood false-brome (*Brachypodium sylvaticum*), tufted hair-grass (*Deschampsia cespitosa*) and extensive areas of bramble (*Rubus fruticosus*); and
- extensive flush areas with large stands of pendulous sedge (*Carex pendula*).

3.1.4 The Condition Assessments for the SSSIs are summarised in **Table 3.1** below:

Table 3.1 – Summary of Notified features and Condition Assessment

Site	Notified Feature	Condition	Confidence
Chirk Castle	Grassland macrofungi assemblage	Favourable	Medium
	Lesser horseshoe bat	Favourable	High

Site	Notified Feature	Condition	Confidence
	Saproxylic invertebrate assemblage	Favourable	High
	Semi-natural woodland	Unknown	Not documented
Nant-y-Belan and Prynela Woods	Semi-natural woodland	Unfavourable	Low

Local Wildlife Sites

3.1.5 No information was available at the time of writing the reports with respect to the reasons for designation of the two Local Wildlife Sites (LWS).

3.1.6 It is understood that Canal Wood LWS is an ancient woodland site, and Barracks Field supports semi-improved grassland.

APIS Site-relevant Critical Loads

3.1.7 The APIS GIS App provides site-relevant critical loads for nitrogen deposition, based on recently updated recommendations. Ammonia critical loads are also published, depending on whether bryophytes and/or lichens are considered integral for the habitat.

Table 3.2 – Site-relevant Critical Loads (from APIS)

Site	Habitat	EUNIS Code	N-dep CL (kg/ha/yr)	NH3 CL (µg/m^3)
Chirk Castle	Broadleaved deciduous woodland (*as lesser horseshoe bat supporting habitat*)	T1	10 - 15	3
Nant-y-Belan and Prynela Woods	Semi-natural woodland	n/a	None available	n/a

3.1.8 There are no critical loads assigned for other habitats at Chirk Castle (veteran trees, saproxylic invertebrates, and grassland macrofungi).

Baseline Air Quality Data

3.1.9 The following 1km grid square baseline air quality modelling data for the latest available year (2020) were extracted from the APIS app for the sites in question. Both of the SSSI sites encompass a number of grid squares, so a range is given for the areas covered by the survey.

Table 3.3 – Background Air Quality Data

Site	Parts of Site Covered	N-dep	$NH3_3$
Chirk Castle	SE sector: Deer Park Wood / Deershed Wood	32.1	1.9
	SW sector: Garden Wood	31.3	1.7
	NE sector: Mynattyn Wood / parkland trees	32.0	1.8
	Chirk Castle area	31.1	1.7
Nant-y-Belan and Prynela Woods	Prynela Wood (E of stream)	35.3	2.6
	Prynela Wood (central & W section) ; Nant-y-Belan (most of wood)	34.4	2.4
	Nant-y-Belan (W section near viaduct)	33.4	2.2
Canal Wood	Northern and central section of wood	32.9	2.0
	South end of wood	33.0	2.0
Barracks Field	All of site	20.8	2.2

3.1.10 The heathland/grassland nitrogen deposition velocity is given for Barracks Field; all other sites are woodland deposition velocities, as is appropriate for the main habitat structure present.

3.2 Plant Communities

Chirk Castle SSSI

3.2.1 This comprises a number of different woodlands over a large site, interspersed with parkland (wood pasture) and more open areas of grassland. Areas visited were focussed on woodlands in the eastern part of the SSSI, closer to the emission source at Chirk. The location of individual woodlands is indicated on **Figure 1** (site boundaries); the following were visited on permissive paths within the National Trust land, or viewed from adjoining publicly accessible land:

- Mynattyn Wood.
- Garden Wood.
- Deer Park Wood.
- Deershed Wood.

Mynattyn Wood

3.2.2 As noted earlier, there is no public access to this wood, although the western edge could be viewed from National Trust land close to a permissive path.

3.2.3 The western part of the woodland appeared to be a clear example of NVC W10 oak-bracken-bramble woodland, with a pedunculate oak (*Quercus robur*), silver birch (*Betula pendula*) and sweet chestnut (*Castanea sativa*) canopy. It appeared to be relatively eutrophic, with elder (*Sambucus nigra*) in the shrub layer, over a dense bracken (*Pteridium aquilinum*) - bramble (*Rubus fruticosus*) - dominated field layer.

3.2.4 In terms of EUNIS habitats, it is an example of T1E *Carpinus* and *Quercus* mesic deciduous forest (previously G1.A Meso- and eutrophic *Quercus* and related woodland). In terms of higher level habitats, this and other T1E habitats are closest to T1E11 Mixed Atlantic *Quercus* forest with *Hyacinthoides non-scriptus* (mixed oak forest with bluebell).

Garden Wood

3.2.5 Garden Wood occupies a generally south-facing slope to the south-east of Chirk Castle. Its species composition is indicative of NVC W10 oak-bracken-bramble woodland, with sessile oak (*Quercus petraea*), sycamore (*Acer pseudoplatanus*) and wild cherry (*Prunus avium*) in the canopy, and wych elm (*Ulmus glabra*) in the understorey. It appears relatively eutrophic, with elder (*Sambucus nigra*) the most frequent component of the shrub layer. Brambles are abundant in the field layer, with occasional to frequent bracken; other species include enchanter's nightshade (*Circaea lutetiana*), stinging nettle (*Urtica dioica*), wood sedge (*Carex sylvatica*) and wood avens (*Geum urbanum*).

3.2.6 In terms of EUNIS habitats, it is another example of T1E *Carpinus* and *Quercus* mesic deciduous forest (previously G1.A Meso- and eutrophic *Quercus* and related woodland).

Deer Park Wood

3.2.7 Deer Park Wood is located to the south-east of Garden Wood, and is contiguous with it, occupying south-west facing slopes and flatter ground to the north. It supports an oak - silver birch canopy with occasional beech (*Fagus sylvatica*). It appears relatively eutrophic, with tall stinging nettles and brambles in more open areas; shaded areas are grassier with lower bramble cover.

3.2.8 In terms of NVC communities it is also an example of W10 oak-bracken-bramble woodland, corresponding to EUNIS habitat T1E *Carpinus* and *Quercus* mesic deciduous forest.

Deershed Wood

3.2.9 Deershed Wood mostly comprises a mixed plantation of very tall spruce and beech with occasional elder in the shrub layer, over a dense bracken field layer with stinging nettles and brambles. Its relationship to an NVC community is obscured by its planted canopy, but the field layer indicates its broad equivalence to W10 oak-bracken-bramble woodland, and thus EUNIS habitat T1E *Carpinus* and *Quercus* mesic deciduous forest.

3.2.10 A smaller area of the woodland is more obviously W10 community, with a denser canopy of oak over a bramble field layer, and other species including wood avens, enchanter's nightshade and wood millet (*Milium effusum*).

Nant-y-Belan and Prynela Woods SSSI

Nant y Belan Wood

3.2.11 The lower slopes of Nant y Belan were broadly similar in plant species composition to the contiguous Prynela Wood, and included extensive areas of pendulous sedge on damp convex slopes. These clearly fitted the NVC W8/EUNIS T1E22 communities.

3.2.12 An incised tributary stream flowing into the Dee bisects the wood, creating an isolated ridge on its right bank, between the stream valley and the Dee. This has created an area of locally leached, acidic soils with a sessile oak - birch canopy, over a shrub layer which includes rowan (*Sorbus aucuparia*), hazel and some invasive rhododendron (*Rhododendron ponticum*). The field layer is dominated by bilberry (*Vaccinium myrtillus*) with bracken and great wood-rush. This is small in area, giving way first to areas of wood-rush dominance, then to areas of more eutrophic woodland communities towards lower slopes and the upper woodland edge. In terms of NVC plant communities, it appears intermediate in some respects between the lowland W16 and western/upland W17 woodland. The lack of a well-developed bryophyte layer suggests W16, while the higher bilberry abundance indicates W16b: *Quercus spp. - Betula spp. - Deschampsia flexuosa* woodland, *Vaccinium myrtillus - Dryopteris dilatata* sub-community (oak - birch - wavy hair-grass woodland; bilberry - broad buckler-fern sub-community). Importantly from the perspective of nitrogen deposition sensitivity, in terms of EUNIS habitats it is an example of T1B1 Atlantic *Quercus robur - Betula* forests (formerly G1.81 Atlantic *Quercus robur - Betula* woods).

3.2.13 The northern edges of the woodland appeared more eutrophic in character, and are likely to be influenced by nutrient enrichment from surrounding agricultural land upslope of the woodland. The abundance of beech (*Fagus sylvatica*) in the canopy in this area results in low light levels on the woodland floor, masking any eutrophication effects by limiting growth of competitive, light-demanding species. Canopy gaps and areas of lighter shade (e.g. under an ash canopy) in these areas support tall brambles and stinging nettles.

3.2.14 Canopy trees include beech, ash, sessile oak and wych elm; hazel and hawthorn (*Crataegus monogyna*) are frequent in the shrub layer. The field layer in the most shaded areas supports abundant ivy (*Hedera helix*) with wood melick (*Melica uniflora*) and dog's-mercury. Bracken is dominant in places, with indicators of nutrient enrichment such as hogweed (*Heracleum sphondylium*).

3.2.15 In terms of plant communities the northern parts of Nant-y-Belan are closer to W10 oak-bracken-bramble woodland, although ash is abundant in the canopy. This is equivalent to EUNIS habitat T1E *Carpinus* and *Quercus* mesic deciduous forest.

Prynela Wood

3.2.16 Prynela Wood occupies steep slopes on the left bank of the River Dee. The topography is complex, with a deeply incised tributary stream bisecting the wood. The ground flora varies between drier, convex slopes, and concave slopes and flatter areas receiving downslope drainage and nutrients through colluvial downwash. This gives rise to significant variation in the field layer flora, below a canopy in which ash (*Fraxinus excelsior*), sessile oak and wych elm are most abundant, and a shrub layer with frequent hazel (*Corylus avellana*).

3.2.17 Concave slopes and flatter areas supported areas of abundant wood garlic (*Allium ursinum*) with dog's-mercury, with dense stands of pendulous sedge (*Carex pendula*) in wetter hollows. Drier, convex slopes had a more mixed field layer flora with ferns often abundant, and including scaly male-fern (*Dryopteris affinis*), broad buckler-fern (*Dryopteris dilatata*) and soft shield-fern (*Polystichum aculeatum*). Wood anemone (*Anemone nemorosa*) was abundant in the more shaded areas under a dense hazel shrub layer, while great wood-rush (*Luzula sylvatica*) dominated drier and slightly more leached areas, such as alluvial terraces above the Dee.

3.2.18 Despite variations in field layer species, the woodland can be classed as a W8 *Fraxinus excelsior - Acer campestre - Mercurialis perennis* (ash - field maple - dog's-mercury) woodland. This translates to EUNIS habitat T1E22 British *Fraxinus - Acer campestre - Mercurialis perennis* forest (formerly G1.A22).

Canal Wood LWS

3.2.19 Canal Wood is a small woodland bisected by a cutting of the Llangollen Canal. It occupies the slopes and top of the cutting, and is classed as an ancient woodland, although clearly disturbed in the past by canal construction.

3.2.20 The west side of the woodland supports a mixed broadleaved canopy, with sycamore, wych elm, ash and sweet chestnut (*Castanea sativa*) all frequent to abundant, together with occasional sessile oak and silver birch. The shrub layer is generally well developed with frequent hawthorn and hazel; other species include field rose (*Rosa arvensis*), wych elm and holly - elder is relatively rare. Where shade levels are relatively high tufted hair-grass (*Deschampsia cespitosa*) is frequent in the field layer, with a number of ancient or long-established woodland indicator species including wood anemone, dog's-mercury, wood melick, and enchanter's nightshade. More open areas of the west bank support a more rank, bramble dominated understorey, with occasional stinging nettle indicative of higher nutrient levels.

3.2.21 Aside from an area in the north-eastern part of the woodland, the east side of the canal is similar to the west. Ash is abundant in the canopy together with wych elm, sessile oak and sweet chestnut; the lighter shade cast by overtopping ash allows a multi-level understorey to develop. The shrub layer is generally less well developed, with frequent hawthorn and occasional hazel. The field layer is broadly similar to the west side of the canal, with ivy, wood anemone and enchanter's nightshade all abundant in places.

3.2.22 All of the above areas of woodland can be classed as a W8 *Fraxinus excelsior - Acer campestre - Mercurialis perennis* (ash - field maple - dog's-mercury) woodland/EUNIS habitat T1E22 British *Fraxinus - Acer campestre - Mercurialis perennis* forest.

3.2.23 The north-eastern section differs in supporting a canopy of abundant common alder (*Alnus glutinosa*), with occasional wych elm, and a poorly developed shrub layer with hawthorn and elder. The field layer appears very eutrophic, with abundant stinging nettle overgrowing a carpet of abundant ivy. The nutrient status of this part of the woodland is likely to be strongly influenced by the nitrogen-fixing capacity of alders.

3.2.24 In terms of NVC communities it is an example of W6 *Alnus glutinosa - Urtica dioica* (alder - stinging nettle) woodland, which translates to EUNIS habitat T121 Riverine *Alnus - Fraxinus* forest (previously G1.21); more specifically, it is equivalent to T12132 West European tall herb ash-alder forests.

Barracks Field LWS

3.2.25 Most of the field consisted of a rank, species-poor *Arrhenatherum* (false oat-grass) grassland, with shorter mown strips supporting a *Lolium perenne - Trifolium repens* (ryegrass - white clover) grassland. Neither of these plant communities can be regarded as being of high botanical interest.

3.2.26 Associated grass species in the tall grassland included cock's-foot (*Dactylis glomerata*) and Yorkshire fog (*Holcus lanatus*), with tall herbs such as hogweed, broad-leaved dock (*Rumex obtusifolius*) and cow parsley (*Anthriscus sylvestris*). Shorter areas supported creeping buttercup (*Ranunculus repens*) and ribwort plantain (*Plantago lanceolata*).

3.2.27 In terms of NVC communities the taller areas were examples of MG1 *Arrhenatherum elatius* grassland, which is equivalent to EUNIS habitat R2211 Atlantic *Arrhenatherum* grasslands (previously E2.211). The shorter mown areas are examples of MG7e, Lolio-Plantaginion leys and related grasslands, *Plantago lanceolata* sub-community. This is equivalent to EUNIS habitat R2111 Ryegrass pastures (previously E2.111).

3.3 Ellenberg N Results

Overview

3.3.1 A total of 23 woodland quadrat samples were taken across Chirk Castle and Parklands SSSI, Nant y Belan and Prynela Woods SSSI, and Canal Wood LWS. Locations are shown in **Figure 1**, and species composition/individual Ellenberg values given in **Appendix 1**. **Table 3.4** summarises the results, ordered from low to high abundance-weighted values.

Table 3.4 – Ellenberg N Values of Woodland Sample Quadrats

No.	Wood	X	Y	NVC	EUNIS	No. of spp.	Weighted Ellenberg N	Unweighted Ellenberg N
16	Nant y Belan	330066	341072	W17	T1B1	9	3.43	3.89
12	Prynela	330862	340417	W8	T1E22	10	4.88	4.80
6	Deer Pk	327393	337611	W10	T1E11	11	5.07	5.09
14	Prynela	331031	340309	W8	T1E22	16	5.17	5.00

No.	Wood	X	Y	NVC	EUNIS	No. of spp.	Weighted Ellenberg N	Unweighted Ellenberg N
1	Mynattyn	327652	338219	W10	T1E11	14	5.17	5.57
5	Deer Pk	327401	337721	W10	T1E11	11	5.27	5.45
22	Canal E	328253	338041	W8	T1E22	17	5.37	5.35
10	Prynela	330948	340770	W8	T1E22	16	5.38	5.38
18	Nant y Belan	330364	341109	W8	T1E22	18	5.43	5.50
15	Nant y Belan	329792	341002	W8	T1E22	16	5.49	5.50
8	Canal W	328481	338816	W8	T1E22	18	5.50	5.56
3	Garden	327129	337837	W10	T1E11	12	5.54	5.67
9	Canal W	328329	338582	W8	T1E22	18	5.60	5.61
13	Prynela	331123	340203	W8	T1E22	9	5.64	5.44
17	Nant y Belan	330232	341199	W8	T1E22	14	5.65	5.71
2	Garden	326868	337973	W10	T1E11	8	5.68	5.88
7	Deershed	327672	337727	W10	T1E11	11	5.76	5.64
4	Garden	327217	337721	W10	T1E11	10	5.77	5.90
21	Canal E	328353	338413	W8	T1E22	16	5.79	5.88
19	Nant y Belan	330462	341084	W8	T1E22	14	5.84	5.71
23	Canal W	328306	337801	W8	T1E22	16	5.84	5.75
11	Prynela	330874	340729	W8	T1E22	12	6.27	6.17
20	Canal E	328474	338816	W6	T12132	11	6.57	6.45

Interpretation of Ellenberg N values

Correlation with Plant Community and Nutrient Supply

3.3.2 The mean Ellenberg values can be interpreted to infer soil fertility (not necessarily relating just to nitrogen availability) as follows:

- 3.0 - <4.0 = moderately infertile sites;
- 4.0 - <5.0 = between moderately infertile and fertile;
- 5.0 - <6.0 = moderately fertile sites; and
- 6.0 - <7.0 = between moderately and richly fertile.

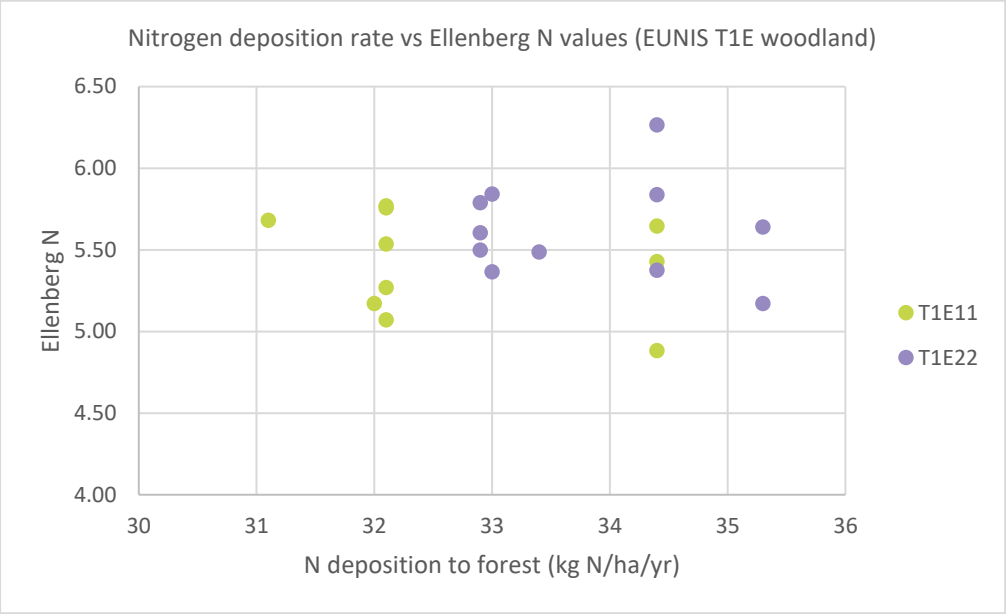
3.3.3 There is a very clear relationship between Ellenberg N value and plant community, which separates samples at EUNIS Level 3 habitat, which is entirely consistent with the expected nutrient status of each habitat. The T1B1 Atlantic *Quercus robur - Betula* forest from Nant y Belan as expected has the lowest value of 3.43, in the 'moderately infertile' category, with T12132 West European tall herb ash-alder forest from Canal Wood having the highest value of 6.57, between moderately and richly fertile. T1E *Carpinus* and *Quercus* mesic deciduous forest habitats samples are intermediate, almost all falling within the 'moderately fertile' range.

3.3.4 Ellenberg N values do not distinguish between the two Level 5 T1E communities. Based on descriptions of their relevant NVC communities it might be expected that T1E11 Mixed Atlantic *Quercus* forest with *Hyacinthoides non-scriptus* (NVC W10) would have a lower EIV N value than T1E22 British *Fraxinus - Acer campestre - Mercurialis perennis* forest (NVC W8). As **Table 3.1** illustrates, there is significant overlap between the two communities. Average values for T1E22 (5.56) are higher than for T1E11 (5.48), although this is not significant (Wilcoxon rank-sum test, $p>0.05$).

Correlation with Nitrogen Deposition Rates

3.3.5 Weighted mean Ellenberg values have been plotted against the most recently available (mid-year 2020) 1km grid-square nitrogen deposition rate available on the APIS GIS App, and are plotted on the Excel scatterplot below, categorised by EUNIS Level 5 community. Because of the obvious outliers from different plant communities, the data below is restricted to T1E *Carpinus* and *Quercus* mesic deciduous forest samples.

Image 3.1 – Nitrogen Deposition and Ellenberg N Values



3.3.6 Trendlines fitted by Excel show a weakly *negative* association of Ellenberg N values with background deposition rates, indicating that further statistical analysis would be very unlikely to produce a significant relationship. There is an apparent association of more nutrient-rich ash woodland (T1E22) with higher deposition rates, but this is very unlikely to have any real ecological meaning, since the plant communities present are to a great extent dependent on the position of the woodland in the landscape. With respect to Ellenberg N values, local topography and its effect on soil nutrient supply appears to be a much greater influence than atmospheric deposition rates.

3.4 Lichen Indicator Species analysis results

Sample Locations

3.4.1 A total of 13 suitable oak twig sample locations were located across the survey area, including at least one sample from each woodland; these are shown on **Figure 2**. No suitable trees were located in the closest area to the emission source on the east side of Canal Wood LWS, with the closest located on the west side of the woodland. All were located within the relevant designated sites, with the exception of one hedgerow tree just north of Prynela Wood. Some of the trees within Chirk Castle SSSI were open-grown parkland oaks set in lightly cattle-grazed pasture.

Results

3.4.2 **Table 3.5** below summarises the results of the indicator species analysis results. Full details of species recorded at each site are given in **Appendix 2**.

Table 3.5 – Lichen Indicator Species Analysis Results

No.	Site	X	Y	Count N_{sen}	Count N_{tol}	Sample Size	LIS	NAQI	Class
2	Castle Wood	327188	337885	6	13	5	-1.4	1.2	N polluted
1	Chirk Castle parkland north	327741	338081	5	15	5	-2	1.35	Very N polluted
4	Deer Park Wood N edge	327391	337619	4	13	5	-1.8	1.3	Very N polluted
3	Deer Park Wood	327483	337557	7	11	5	-0.8	1.05	N polluted
6	Chirk Castle parkland south	327905	337924	4	14	5	-2	1.35	Very N polluted
5	Deershed Wood	327701	337921	6	10	4	-1	1.1	N polluted
8	Prynela Wood NE	330714	340693	0	14	5	-2.8	1.9	Very N polluted
7	Prynela Wood N	330927	340856	4	15	5	-2.2	1.4	Very N polluted
10	Nant y Belan River Dee	330145	341004	7	0	5	1.4	0.45	Clean
9	Prynela Wood River Dee	330905	340375	7	4	5	0.6	0.7	At risk
12	Nant y Belan NW edge	329931	341309	0	2	5	-0.4	0.9	N polluted

No.	Site	X	Y	Count N_{sen}	Count N_{tol}	Sample Size	LIS	NAQI	Class
11	Nant y Belan N edge	329717	341074	1	5	5	-0.8	1.05	N polluted
13	Canal Wood W edge	328223	337891	1	13	5	-2.4	1.45	Very N polluted

3.4.3 All except one of the sites (no. 10) showed evidence of nitrogen enrichment through the presence of nitrogen-tolerant twig and branch lichens. This site, and one to the east (no. 9) were the only samples with a positive LIS score, indicating a greater frequency of nitrogen-sensitive species. Both were located adjacent to the River Dee, at the bottom of a deep wooded valley on the southern edge of Nant y Belan and Prynela Woods SSSI; in terms of NAQI score, they fell into the 'clean' and 'at risk' categories respectively. These were also distinctive in terms of their lichen flora, being the only sites which supported the nitrogen-sensitive *Graphis scripta*. This species was also noted on shaded oak boles nearby, within the area of woodland close to the river.

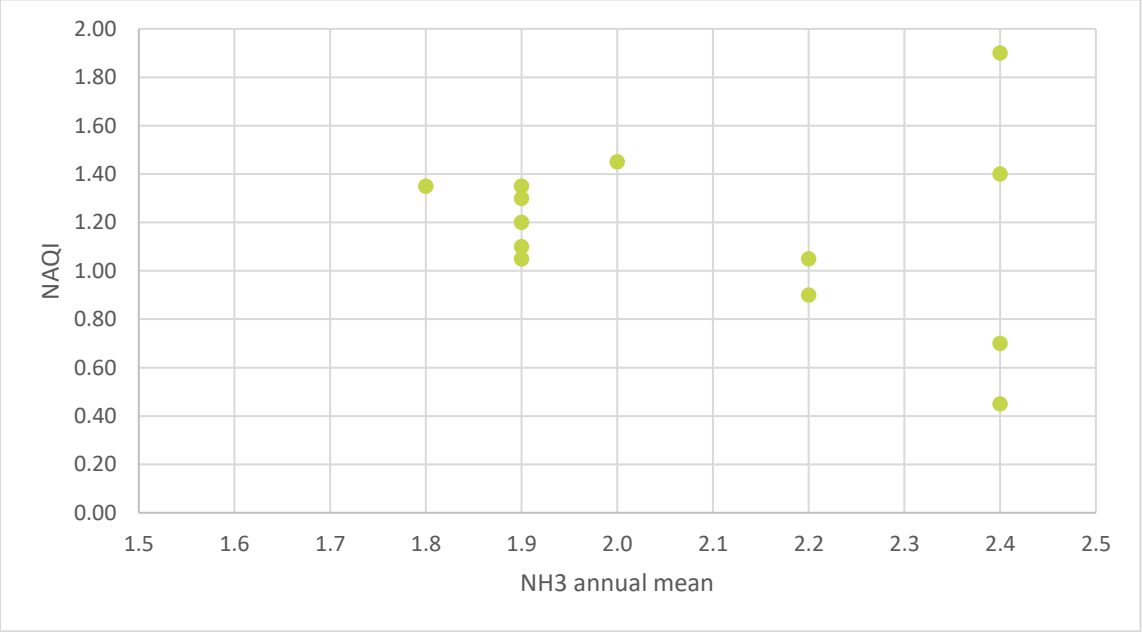
3.4.4 A further five sites fell into the 'N polluted' category, where the frequency of nitrogen-tolerant species exceeds N-sensitive species. These included sites at the edge of Castle Wood (no. 2); in an open area within Deer Park Wood (no. 3); the northern edge of Deershed Wood (no. 5); and sites on the northern and north-western edges of Nant y Belan Wood (nos. 11 & 12). *Physcia* spp. (*P. adscendens* and *P. tenella*) are the most frequent N-tolerant lichens in these samples, with *Parmelia* spp. and *Evernia prunastri* the most frequent N-sensitive taxa.

3.4.5 The remaining six sites fall into the 'very N polluted' category with NAQI scores of >1.25, where the frequency of nitrogen-tolerant species exceeds N-sensitive species by a larger margin. They include sites within parkland on the east side of Chirk Castle SSSI (nos. 1 & 6); the northern edge of Deer Park Wood (no. 4); the western edge of Canal Wood LWS (no. 13); and the northern edges of Prynela Wood (nos. 7 & 8). The N-tolerant lichen *Xanthoria parietina* is frequent in most of these samples, in some cases exceeding the frequency of *Physcia* spp.

Correlation with Air Quality Parameters

3.4.6 The Centre for Ecology and Hydrology guide to LIS and NAQI states that the indices correlate with concentrations of gaseous nitrogen compounds (i.e. dry deposition of NH_3 and NOx), rather than total nitrogen deposition, while other studies (including the thesis which underpinned the development of the LIS/NAQI indices) found a much greater impact of ammonia levels relative to oxidised nitrogen compounds. NAQI values have therefore been plotted against modelled background ammonia levels for the relevant 1km grid square (see **Image 3.2**), although there is a very high degree of inter-correlation with nitrogen deposition rates, as dry deposition of ammonia is an important component of these values.

Image 3.2 – Lichen Nitrogen Air Quality Index (NAQI) and Ammonia Background Levels



3.4.7 There is no apparent trend in these data, with the lowest (least polluted) NAQI scores associated with the highest modelled ammonia levels. Exclusion of these two values as outliers (justified on ecological grounds due to their sheltered valley-bottom location) did produce a positive trendline fit using Excel; however, application of a non-parametric rank correlation coefficient indicated that this was not statistically significant (Spearman $r^S = 0.204$, $p = 0.5$).

3.5 Tree Health Indicators

Disease Indicators

3.5.1 There were few apparent signs of poor tree health within the survey area, with the obvious exception of ash trees showing apical dieback in some areas, which may indicate the presence of Ash Dieback disease fungus (*Hymenoscyphus fraxineus*). These included two areas within Nant y Belan Wood - the south-west corner of the SSSI (near vegetation sample 15), and an area near the eastern edge (near sample 19).

3.5.2 Mature ash trees on the eastern edge of Canal Wood were in the process of being felled at the time of survey; it was unclear whether this was due to the presence of Ash Dieback disease in this part of the woodland.

Evidence of Pollutant-induced Stress

3.5.3 There is no indication that observed tree disease symptoms had any relationship to air quality. *Hymenoscyphus fraxineus* is an invasive non-native fungal species originating in Asia, and there is no current evidence that its symptoms or spread are worsened in areas with poorer air quality.

3.5.4 One indication of a potential stress on plant growth was apparent over a small area in the eastern section of Canal Wood, where there was a perceptibly high airborne particulate loading comprising wood fibres, close to stockpiles located on the opposite side of the rail track, within the existing facility. Significant deposition was observed on leaf surfaces, as shown in the photographs (**Image 3.3**) below.

Image 3.3 – Wood Fibre Deposition on Leaf Surfaces

3.5.5 The photos above show bramble and dog's-mercury leaves with wood fibre deposition, taken after a 2-day period of dry weather and easterly airflow. Although this is an inert material, the level of cover on the leaf surface is sufficient to affect photosynthetic efficiency and consequent growth, depending on the frequency of wash-off by rainfall. It should be stressed that the area of woodland visibly affected by fibre deposition was small.

4.0 DISCUSSION AND CONCLUSIONS

4.1 Sensitivity to Air Quality Impacts

Woodland Habitats

Nitrogen Deposition

4.1.1 Based on the plant communities present in the woodland, the following critical loads (**Table 4.1**) are appropriate for nitrogen deposition, based on the values given in Bobbink *et al* (2022).

Table 4.1 – Nitrogen Deposition Critical Loads for Woodland Habitats

Site	EUNNIS Level 3 Habitat	Critical Load (kg N/ha/yr)
Chirk Castle and Parkland SSSI (all woodlands)	T1E *Carpinus* and *Quercus* mesic deciduous forest	15 - 20
Nant y Belan and Prynela Woods SSSI (most of site)	T1E *Carpinus* and *Quercus* mesic deciduous forest	15 - 20
Nant y Belan Wood (leached acid soils)	T1B Acidophilous *Quercus* forest	10 - 15
Canal Wood LWS (most of site)	T1E *Carpinus* and *Quercus* mesic deciduous forest	15 - 20
Canal Wood LWS (NE section)	T121 Riverine *Fraxinus* - *Alnus* forest	not sensitive (see below)

4.1.2 With respect to alder (*Alnus glutinosa*) woodland, current guidance in Bobbink *et al.* (2022) does not separately identify this community, which can be interpreted as requiring application of the default 10 - 15 kg N/ha/yr critical load range for broadleaved deciduous forest broad habitat (EUNIS Level 2 T1). However, advice on the APIS GIS App for the equivalent European Annex I habitat (H91E0 Alluvial forests with *Fraxinus excelsior* and *Alnus glutinosa*) is that the feature is not sensitive to eutrophication. Alder trees support a nitrogen-fixing bacterium (*Frankia alni*) and are able to acquire most of their nitrogen requirements from atmospheric N_2 (Beaupied *et al,* 1990)[14]; alder leaves are nitrogen-rich, and have been estimated to contribute between 30 - 130 kg N/ha/yr to woodland soils at leaf fall (Moiroud, 1991)[15]. This is apparent in the high weighted EIV N value of 6.57 in the understorey in the alderwood section of Canal Wood (sample 20).

4.1.3 Aside from a small area in the north-east of Canal Wood which is not sensitive, and a small area on the ridge at Nant y Belan around sample 16 which has a lower critical load of 10kg N/ha/yr, the woodland sites should be assessed against a lower critical load for nitrogen deposition of 15kg N/ha/yr.

Ammonia Levels

4.1.4 Woodland habitats are normally assigned the lower critical level for ammonia of 1µg/m^3 annual mean, because bryophytes and lichens are frequently regarded as integral components of the habitat.

4.1.5 As Chirk Castle and Parkland SSSI is not notified for the presence of woodland habitats, or for bryophytes or lichens, it is appropriate to apply the higher 3µg/m^3 annual mean critical level for the protection of other ecosystem components.

[14] *Beaupied, H., Moiroud, A., Domenach, A., Kurdali, F., & Lensi, R. (1990). Ratio of fixed and assimilated nitrogen in a black alder (Alnus glutinosa) stand. Canadian Journal of Forest Research,* ***20****, 1116-1119.*
[15] *Moiroud, A., (1991). La symbiose fixatrice d'azote. Forêt Entreprise,* ***75****, 18-26.*

4.1.6 No information is provided by APIS for the woodland habitats at Nant y Belan and Prynela Woods SSSI. Field surveys did not indicate that the site supported important bryophyte or lichen communities, although there was evidence that some parts of the woodland along the River Dee retained epiphytic lichens typical of relatively unpolluted conditions. Conversely, other more exposed parts of the woodland supported a lichen flora typical of nitrogen enrichment. In addition, woodland bryophytes were poorly developed in habitats where they would be expected to be more prominent, such as the T1B acidophilous oak wood habitat. A precautionary approach would be to apply the 1µg/m^3 critical level for environmental assessment purposes.

4.1.7 Canal Wood LWS does not support important bryophyte or lichen habitats, and the 3µg/m^3 annual mean critical level would be appropriate here.

Grassland Habitats

Nitrogen Deposition

4.1.8 The R2211 Atlantic *Arrhenatherum* grassland habitat is a higher (Level 5) subdivision of R22 Low and medium altitude hay meadows habitat. The currently recommended critical load range is 10 - 20kg N/ha/yr. However, when interpreting the significance of any possible effects on this habitat, its apparently low conservation value (likely due to lack of management) should be taken into account.

4.1.9 No critical loads are given for R2111 Ryegrass pastures, but as a habitat typical of agriculturally improved sites, it can be considered to be less sensitive than semi-natural grasslands.

Ammonia Levels

4.1.10 The grassland habitats present are not important for bryophytes or lichens, and the 3µg/m^3 annual mean critical level is appropriate here.

4.2 Indicators of Air Quality Effects - Woodland Habitats

EIV N Values and Woodland Vegetation

4.2.1 The EIV N values did not provide unequivocal evidence of nutrient enrichment, with results within what could be regarded as the expected ranges for the plant communities.

4.2.2 The lack of ability to distinguish between NVC W10 / EUNIS T1E11 and W8/T1E22 communities in terms of EIV N values could possibly be interpreted as evidence of nutrient enrichment in the former sites. T1E11 oak woodland would typically be associated with soils with a lower nutrient supply than T1E22 ash woodland.

4.2.3 When the detailed species composition of samples is considered (see Appendix 1), there are a number of examples of species with high EIV N values (6 and over) within the T1E11 community, particularly from the Chirk Castle and Parkland SSSI woodlands. These include a high frequency of elder (*Sambucus nigra*: EIV N 7) in the shrub layer, together with frequent bramble (EIV N 6) under-scrub, and wood avens (*Geum urbanum*; EIV N 6) in the field layer. Stinging nettle (*Urtica dioica*; EIV N 9), a recognised indicator of eutrophication, was also found in several samples.

4.2.4 Bobbink *et al* (2022) also notes that bramble, whilst not having a particularly high EIV N value, has been shown to respond strongly to elevated nitrogen deposition rates; they quote a Swiss study showing a marked increase in bramble cover where deposition rates exceeded 25kg N/ha/yr[16]. Brambles dominate the understorey in more open areas of some of the Chirk Castle woodlands, such as Deer Park Wood, and are also abundant in other parts of the survey area - notably the T1E11 oak woodland community in the northern part of Nant y Belan Wood, and in the south-western part of Canal Wood in the T1E22 ash woodland. At Chirk Castle and Parkland SSSI, the APIS GIS App shows that background deposition rates to woodland have been modelled at over 30kg N/ha/yr since 2003 (the earliest year with data presented). At Nant y Belan and Prynela Woods SSSI values are slightly higher, with a minimum of over 32kg N/ha/yr over the same time period. It is therefore reasonable to assume that some of the observed indicators such as abundant bramble may be a consequence of elevated background deposition rates, in excess of the critical load.

[16] *Flückiger, W. and Braun, S. (2004). Wie geht es unserem Wald? Ergebnisse aus Dauerbeobachtungsflächen von 1984 bis 2004, Bericht 2, Schönenbuch: Institut für Angewandte Pflanzenbiologie, 67 pp.*

4.2.5 Variations in EIV N values within the T1E22 ash woodlands can be more readily explained by position in the landscape, i.e. whether the site is likely to receive nutrients and base cations from surrounding slopes, or is likely to leach nutrients downslope. Thus the highest EIV N value in the survey (sample 11 in Prynela Wood, EIV N 6.27) is located near the edge of the wood, where runoff enters downslope from an adjoining agricultural grassland. However, while the most abundant field layer species here - wood garlic (*Allium ursinum*) and dog's-mercury (*Mercurialis perennis*) - both have high EIV N values of 7, they are typical species of this plant community, and would not be regarded as undesirable indicators of eutrophication. Generally there are fewer clear indications of nutrient enrichment in the T1E22 ash woodland communities; in being more naturally nutrient-rich they could possibly be regarded as more resilient to additional atmospheric nitrogen deposition. Some indicators of nutrient enrichment do occur in this community - for example, nearby areas dominated by pendulous sedge (*Carex pendula*) on damp slopes also supported frequent stinging nettles - but they were not so apparent.

4.2.6 As noted in **Section 3.3** above, the T1B1 Atlantic *Quercus robur - Betula* forest from Nant y Belan has the lowest value of 3.43, as expected from its association with leached, nutrient and base-poor soils which have developed on a ridge-top location. Because of this naturally nutrient-poor status, it is regarded as being more sensitive to atmospheric nitrogen deposition, with a critical load of 10kg N/ha/yr recommended. There are some indications that background deposition rates may have had some effect on this community.

4.2.7 Although the weighted average EIV N value falls into the 'moderately infertile' category, a survey of a similar bilberry-dominated community elsewhere in Wales by the same author produced EIV N values ranging from 2.70 - 2.94, within the 'infertile' category. Oak - bilberry communities also typically have a well-developed bryophyte layer with some distinctive species; the paucity of bryophytes at this site may be indicative of higher atmospheric deposition rates (the other site has background rates currently modelled between 20 - 25kg N/ha/yr).

LIS and NAQI Values

4.2.8 The LIS and NAQI values indicate significant nutrient enrichment of the oak twig lichen flora, with the notable exception of the two samples located within the River Dee valley. There were no significant correlations in the values obtained with background air quality modelled at 1km grid level.

4.2.9 The use of an indicator derived from correlations with atmospheric ammonia levels might be expected to result in a stronger correlation with modelled values compared to a general nutrient supply indicator such as EIV N, which is influenced by soil fertility. However, the high deposition velocity of ammonia coupled with the spatial and temporal dispersion of potential sources in the agricultural landscape is likely to result in a higher spatial heterogeneity than can be captured in a 1km scale background model. The lack of a significant correlation is consequently likely to be due to local factors which mask or exacerbate exposure to proximal sources.

4.2.10 The effectiveness of trees in attenuating atmospheric ammonia emissions is well-established. Modelling of ammonia around agricultural emission sources indicates that 50m-wide tree belts can be the most effective measures in reducing ammonia levels on nature reserves, particularly where they form a buffer around the reserve rather than the emission source (Dragosits *et al*, 2009)[17]. The woodland which occupies both banks of the River Dee appears to act as a natural buffer to trees in the valley floor, explaining the greater abundance of nitrogen-sensitive lichens in this area.

4.2.11 Conversely, sites with highest NAQI values tend to be associated with areas adjoining agricultural land, where there may be affected by proximal ammonia sources from operations such as fertiliser spreading. The Canal Wood (sample 13) and Prynela Wood (samples 7 & 8) locations adjoin agriculturally improved grassland habitat, although the Chirk Castle parkland (samples 1 & 6) and Deer Park Wood locations (sample 4) adjoin what can be presumed to be less intensively managed pasture within the National Trust landholding and SSSI.

[17] *Dragosits, U., Theobald, M.R., Place, C.J., ApSimon, H.M., & Sutton, M.A. (2009). Spatial Planning as a Complementary Tool to Abate the Effects of Atmospheric Ammonia Deposition at the Landscape Scale. In Sutton, M.A., Reis, S, & Baker, S.M. (eds.). Atmospheric Ammonia. Detecting emission changes and environmental impacts. Springer*

4.2.12 While there may be no correlation with modelled background ammonia levels, the 1.8 - 2.4µg/m^3 range across the survey areas all exceed the 1.0µg/m^3 critical level for lichens. There is a reasonably high level of confidence in a this critical level; while some studies have indicated slightly higher values[18] [19] of 1.7µg/m^3 – 1.9µg/m^3, these are equalled or exceeded by modelled values in the survey area.

4.3 Tree Health Indicators

4.3.1 Bobbink *et al* (2022) describe a range of effects of elevated nitrogen deposition rates on tree health, resulting from changes in tree physiology. These include:

- increased frost sensitivity;
- increased drought sensitivity;
- increased susceptibility to insect herbivores; and
- increased susceptibility to fungal pathogens.

4.3.2 The overall effect of these stressors can lead to an increase in tree mortality.

4.3.3 Aside from possible symptoms in some areas of Ash Dieback disease, there were no clear indications of poor tree health in the woodlands surveyed. As nitrogenous pollutants act indirectly to exacerbate other stress factors, rather than being directly toxic, it is difficult to identify symptoms attributable to air quality impacts.

4.3.4 The only unequivocal example of an air quality impact which may be having an effect on vegetation was the localised area of wood fibre deposition in a small area on the east side of Canal Wood. As this is an inert material, any effects on plant growth would likely to be restricted to reduced growth rates caused by covering of leaf surfaces and consequently reduced rates of photosynthesis.

[18] Sutton, M.A., Wolseley, P.A., Leith, I.D., van Dijk, N., Tang, S.Y., James, P.W., Theobald, M.R. & Whitfield, C. (2009). Estimation of the Ammonia Critical Level for Epiphytic Lichens Based on Observations at Farm, Landscape and National Scales. In Sutton, M.A., Reis, S, & Baker, S.M. (eds.). Atmospheric Ammonia. Detecting emission changes and environmental impacts. Springer

*[19] Pinho, P., Theobald, M. R., Dias, T., Tang, Y. S., Cruz, C., Martins-Loucão, M.A., Máguas, C., Sutton, M., and Branquinho, C. (2012). Critical loads of nitrogen deposition and critical levels of atmospheric ammonia for semi-natural Mediterranean evergreen woodlands. Biogeosciences, **9**: 1-11.*

FIGURE 1 – SITE LOCATION PLAN

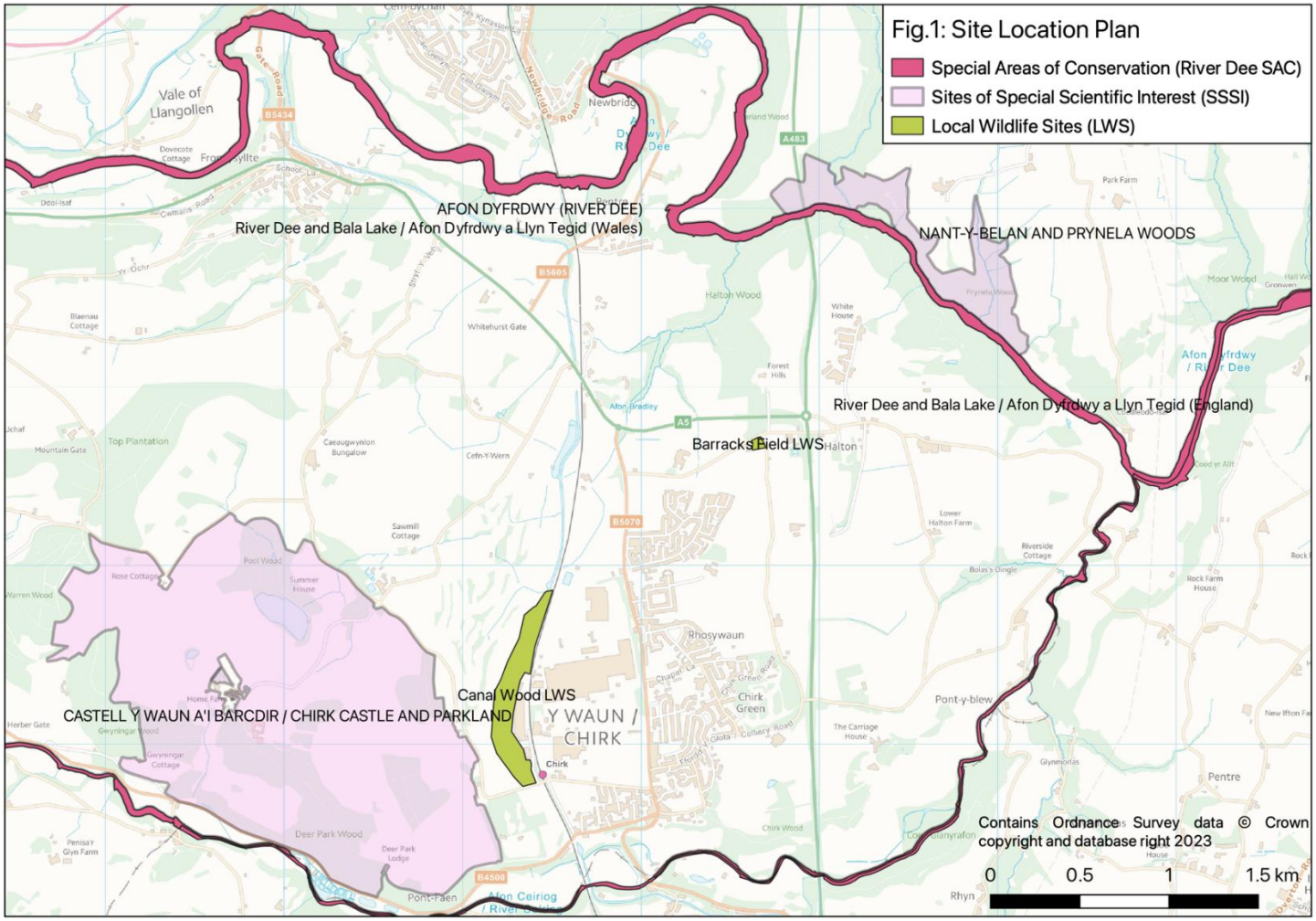


FIGURE 2 – ELLENBERG N VALES (WOODLAND HABITATS)

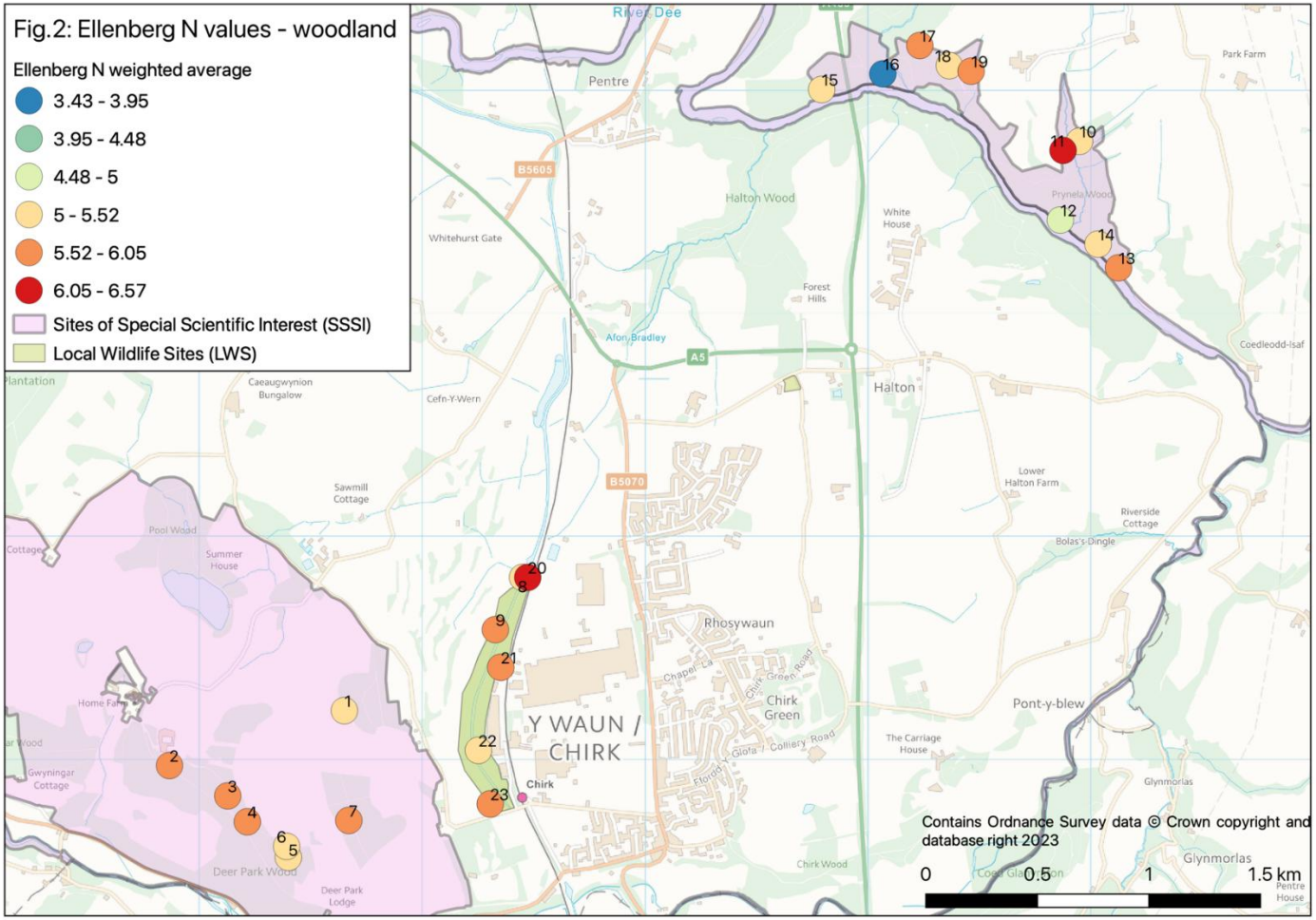
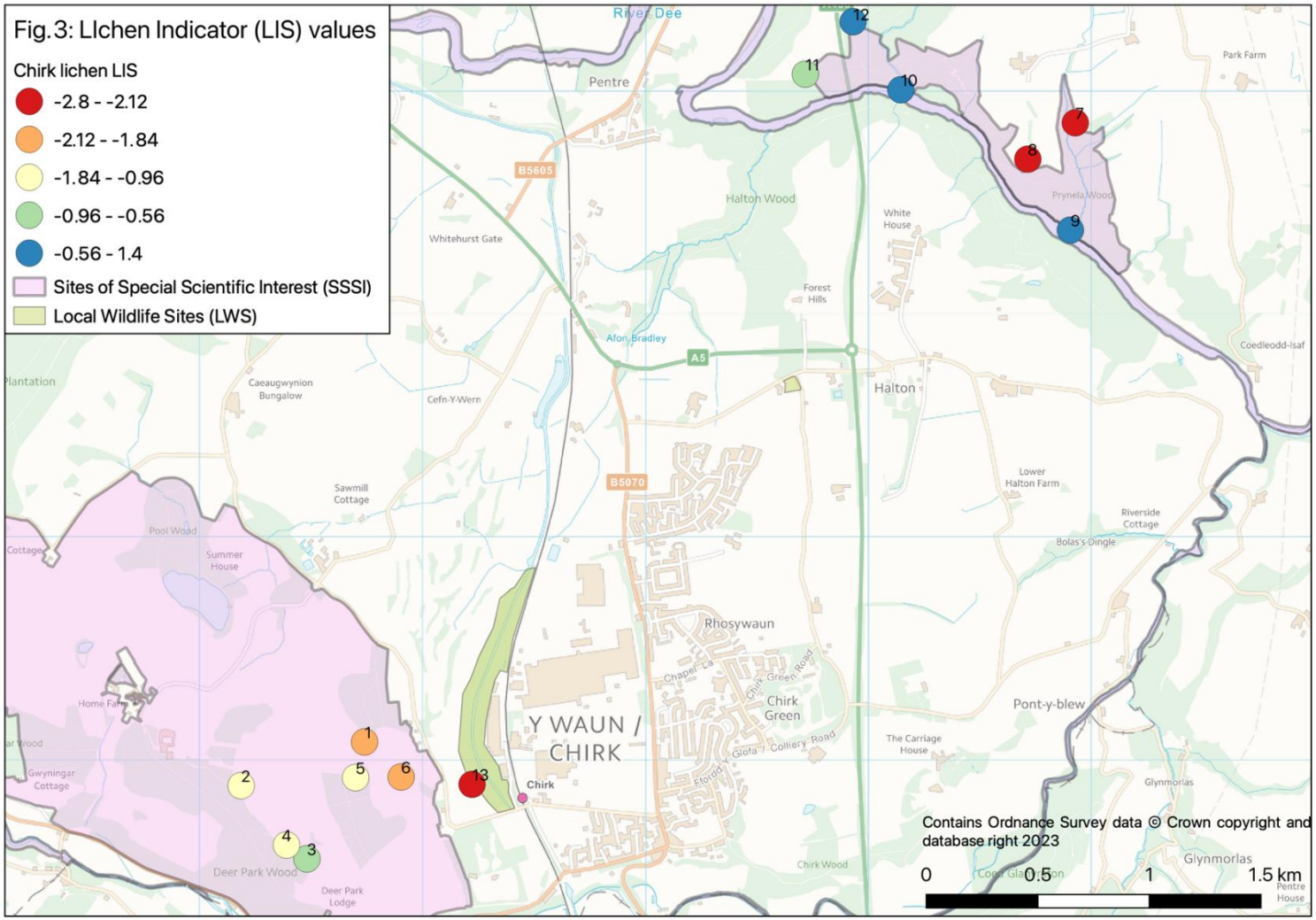


FIGURE 3 – LICHEN INDICATOR SPECIES (LIS) VALUES



APPENDIX 1 – WOODLAND RELEVÉS WITH ELLENBERG N (EIV N) VALUES

	Sample no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Canopy													
Acer pseudoplatanus	**6**			4					3	4	4	4	3
Alnus glutinosa	**6**												
Betula pendula	**4**	4					2	2					
Castanea sativa	**5**	3								4			
Fagus sylvatica	**5**							3					2
Fraxinus excelsior	**6**									4	4		
Prunus avium	**6**			1	3						2		

	Sample no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Quercus petraea	**4**	4	5	4	5	5	4	4	2				3
Ulmus glabra	**6**								3			3	
Shrub layer													
Acer pseudoplatanus	**6**	2											
Corylus avellana	**6**								2		3	2	3
Crataegus monogyna	**6**								3	3			
Fagus sylvatica	**5**												
Fraxinus escelsior	**6**												

	Sample no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Ilex aquifolium	**5**								1		2		
Prunus avium	**6**								1				
Rhododendron ponticum	**3**												
Ribes uva-crispa	**6**												
Rosa arvensis	**5**								3				
Salix caprea	**7**	2											
Sambucus nigra	**7**	3	1	2	3	1	2						
Sorbus aucuparia	**4**												
Taxus baccata	**5**												

	Sample no.	1	2	3	4	5	6	7	8	9	10	11	12
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Ulmus glabra	**6**			2									
Field layer													
Allium ursinum	**7**											4	
Anemone nemorosa	**4**								3				
Arrhenatherum elatius	**7**												
Athyrium filix-femina	**6**								1				
Brachypodium sylvaticum	**5**				1				2	2			
Bromopsis ramosa	**7**									1			

	Sample no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Carex pendula	**6**											1	
Carex remota	**6**		3										
Carex sylvatica	**5**			2									
Chamerion angustifolium	**5**	2					2						
Circaea lutetiana	**6**				2		2	2		2		3	
Deschampsia cespitosa	**4**		1						3	3	3	2	2
Dryopteris affinis	**5**	1				1					3		
Dryopteris dilatata	**5**		3	1		2		1		1	3		2

	Sample no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Dryopteris filix-mas	**5**	1		1				2		3			2
Epilobium montanum	**6**												
Galium aparine	**8**							4					
Geum urbanum	**7**		3	2	2		2	3	3	3	2	3	
Hedera helix	**6**								2	3	2		
Heracleum sphondylium	**7**									1			
Holcus lanatus	**5**												
Holcus mollis	**3**					2							

	Sample no.	1	2	3	4	5	6	7	8	9	10	11	12
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Hyacinthoides non-scripta	**6**						3						
Juncus effusus	**4**						1						
Lapsana communis	**7**												
Lonicera periclymenum	**5**												
Luzula sylvatica	**4**												5
Melica uniflora	**5**												
Mercurialis perennis	**7**	2							3			4	
Milium effusum	**5**							2					

	Sample no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Oxalis acetosella	**4**						1						
Phyllitis scolopendrium	**5**									1			
Poa nemoralis	**5**					3							
Poa trivialis	**6**											2	
Polystichum aculeatum	**5**												
Polystichum setiferum	**6**										2		
Primula vulgaris	**4**												

	Sample no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Pteridium aquilinum	**3**	5		3	2	2	4						1
Ranunculus repens	**7**				2								
Rubus fruticosus	**6**	4	4	4	4	4	5	4	3	3			3
Rumex obtusifolius	**9**					2							
Rumex sanguineus	**7**	1				2			1			1	
Silene dioica	**7**	1						2					
Urtica dioica	**8**		2	2	2								

	Sample no.	1	2	3	4	5	6	7	8	9	10	11	12
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Vaccinium myrtillus	**2**												
Veronica montana	**6**					2					1	1	
Viola riviniana	**4**								3		2		
Bryophytes													
Atrichum undulatum	**5**									2			
Eurhynchium striatum	**5**									1			
Kindbergia praelonga	**5**										3		
Mnium hornum	**4**												

	Sample no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Wood	Mynattyn	Garden	Garden	Garden	Deer Pk	Deer Pk	Deershed	Canal W	Canal W	Prynela	Prynela	Prynela
	X		326868	327129	327217	327401	327393	327672	328481	328329	330948	330874	330862
	Y		337973	337837	337721	337721	337611	337727	338816	338582	340770	340729	340417
	NVC	W10	W10	W10	W10	W10	W10	W10	W8	W8	W8	W8	W8
	EUNIS	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E11	T1E22	T1E22	T1E22	T1E22	T1E22
Species	**EIV N**												
Plagiomnium undulatum	**5**									2	2		
Thuidium tamariscinum	**4**										2		
n		**14**	**8**	**12**	**10**	**11**	**11**	**11**	**18**	**18**	**16**	**12**	**10**
Weighted EIV N		5.17	5.68	5.54	5.77	5.27	5.07	5.76	5.50	5.60	5.38	6.27	4.88
Unweighted EIV N		5.57	5.88	5.67	5.90	5.45	5.09	5.64	5.56	5.61	5.38	6.17	4.80

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Canopy												
Acer pseudoplatanus	**6**	3	3	3				2			3	4
Alnus glutinosa	**6**								5			
Betula pendula	**4**				3						3	3
Castanea sativa	**5**										2	2
Fagus sylvatica	**5**					4	4				3	
Fraxinus excelsior	**6**	4	3	3			3	4		4		
Prunus avium	**6**											
Quercus petraea	**4**	2	2		4	3	2	2		2	2	

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Ulmus glabra	**6**		3			2		2	2	3		
Shrub layer												
Acer pseudoplatanus	**6**								1	2		
Corylus avellana	**6**	5	5	4	1	4	2	2			1	
Crataegus monogyna	**6**			2		4		2	1	3		
Fagus sylvatica	**5**				1							
Fraxinus escelsior	**6**										2	
Ilex aquifolium	**5**		2	1								

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Prunus avium	**6**											
Rhododendron ponticum	**3**				2							
Ribes uva-crispa	**6**					1						
Rosa arvensis	**5**	2	2			2						
Salix caprea	**7**											
Sambucus nigra	**7**								1	1		
Sorbus aucuparia	**4**				1							
Taxus baccata	**5**						2					
Ulmus glabra	**6**											1

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Field layer												
Allium ursinum	**7**							3				
Anemone nemorosa	**4**		4							4		
Arrhenatherum elatius	**7**						1					
Athyrium filix-femina	**6**											
Brachypodium sylvaticum	**5**						1					
Bromopsis ramosa	**7**			1								
Carex pendula	**6**	5		4								

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Carex remota	**6**											
Carex sylvatica	**5**						1					
Chamerion angustifolium	**5**											
Circaea lutetiana	**6**						1	2		3	4	3
Deschampsia cespitosa	**4**		2	2			2					
Dryopteris affinis	**5**		1	2								
Dryopteris dilatata	**5**	2	2					2			3	

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Dryopteris filix-mas	**5**			3					2	2	3	
Epilobium montanum	**6**										2	
Galium aparine	**8**								3	1		2
Geum urbanum	**7**						3		3	3	2	3
Hedera helix	**6**		2	2		4	3		4	4		
Heracleum sphondylium	**7**						4					
Holcus lanatus	**5**											2
Holcus mollis	**3**											

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Hyacinthoides non-scripta	**6**											
Juncus effusus	**4**											
Lapsana communis	**7**						2					
Lonicera periclymenum	**5**	1		2								
Luzula sylvatica	**4**			1	2							
Melica uniflora	**5**					3						4
Mercurialis perennis	**7**			1		2	2	4		2		
Milium effusum	**5**						2					

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Oxalis acetosella	**4**											1
Phyllitis scolopendrium	**5**											
Poa nemoralis	**5**											
Poa trivialis	**6**											
Polystichum aculeatum	**5**					1		2				
Polystichum setiferum	**6**									1		
Primula vulgaris	**4**									1	1	

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Pteridium aquilinum	**3**		1		4		4					
Ranunculus repens	**7**											
Rubus fruticosus	**6**	1		4		1		5	2	2	3	3
Rumex obtusifolius	**9**											
Rumex sanguineus	**7**					2						2
Silene dioica	**7**											3
Urtica dioica	**8**								4			2

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Vaccinium myrtillus	**2**				5							
Veronica montana	**6**					1					2	
Viola riviniana	**4**						3					2
Bryophytes												
Atrichum undulatum	**5**		1								2	
Eurhynchium striatum	**5**		1									
Kindbergia praelonga	**5**							4			3	
Mnium hornum	**4**											1

	Sample no.	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
	Wood	Prynela	Prynela	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Nant y Belan	Canal E	Canal E	Canal E	Canal W
	X	331123	331031	329792	330066	330232	330364	330462	328474	328353	328253	328306
	Y	340203	340309	341002	341072	341199	341109	341084	338816	338413	338041	337801
	NVC	W8	W8	W8	W16/17	W8	W8	W8	W6	W8	W8	W8
	EUNIS	T1E22	T1E22	T1E22	T1B1	T1E22	T1E22	T1E22	T12132	T1E22	T1E22	T1E22
Species	**EIV N**											
Plagiomnium undulatum	**5**		1					1				
Thuidium tamariscinum	**4**			4								
n		**9**	**16**	**16**	**9**	**14**	**18**	**14**	**11**	**16**	**17**	**16**
Weighted EIV N		5.64	5.17	5.49	3.43	5.65	5.43	5.84	6.57	5.79	5.37	5.84
Unweighted EIV N		5.44	5.00	5.50	3.89	5.71	5.50	5.71	6.45	5.88	5.35	5.75

APPENDIX 2 – LICHEN BRANCH SAMPLE SUMMARY

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13
Site	Chirk Castle parkland 1	Castle Wood	Deer Park Wood	Deer Park Wood N edge	Deershed Wood	Chirk Castle parkland 2	Prynela Wood N	Prynela Wood NE	Prynela Wood River Dee	Nant y Belan River Dee	Nant y Belan N edge	Nant y Belan NW edge	Canal Wood W edge
X	327741	327188	327483	327391	327701	327905	330927	330714	330905	330145	329717	329931	328223
Y	338081	337885	337557	337619	337921	337924	340856	340693	340375	341004	341074	341309	337891
N-sensitive													
Bryoria fuscescens													
Evernia prunastri	1	4	4	4	5		1						
Graphis spp.									7	7			
Hypogymnia spp.											1		
Ochrolechia androgyna													
Parmelia spp.	4	6	6	1	4	4	3				1		1
Pseudevernia furfuracea													
Sphaerophorus globosus													
Usnea spp.		1	1										
Total Nsens	**5**	**6**	**7**	**4**	**6**	**4**	**4**	**0**	**7**	**7**	**1**	**0**	**1**

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13
Site	Chirk Castle parkland 1	Castle Wood	Deer Park Wood	Deer Park Wood N edge	Deershed Wood	Chirk Castle parkland 2	Prynela Wood N	Prynela Wood NE	Prynela Wood River Dee	Nant y Belan River Dee	Nant y Belan N edge	Nant y Belan NW edge	Canal Wood W edge
X	327741	327188	327483	327391	327701	327905	330927	330714	330905	330145	329717	329931	328223
Y	338081	337885	337557	337619	337921	337924	340856	340693	340375	341004	341074	341309	337891
N-tolerant													
Armandinea punctata													
Arthonia radiata					2				3				
Candelariella reflexa													
Lecidella elaeochroma		1									1		3
Physcia adscendens/tenella	14	8	11	11	9	12	9	12	1		5	2	10
Punctelia subrudecta													
Xanthoria parientina	14	9	3	5	1	11	12	11					7
Xanthoria polycarpa/ucrainica	1			1									
Total Ntol	**15**	**13**	**11**	**13**	**10**	**14**	**15**	**14**	**4**	**0**	**5**	**2**	**13**