Tillbridge Solar

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PEI Report Volume II Appendix 9-3: Aquatic Ecology Baseline Report

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1. Executive summary

1.1.1 AECOM was commissioned to undertake surveys to provide an investigation into the ecological quality of watercourses and ponds within proximity to the Tillbridge Solar Principal Site, including assessment of Water Framework Directive (WFD) status, to establish the potential impacts of the Scheme.

1.1.2 Surveys comprised an aquatic walkover survey of the site, collection of physio-chemical variables (electrical conductivity (µS), pH, temperature (°C), concentration (% saturation) and dissolved oxygen) and benthic macroinvertebrates samples on six watercourses within the WFD catchments of the River Till, Fillingham Beck and Eau de Source of North Beck, within North Lincolnshire. Five ponds within the Scheme Boundary were similarly surveyed for macroinvertebrates, macrophytes and assessed for the same aforementioned physico-chemical variables for a Pond Predictive System for Multimetrics (PSYM) assessment. All surveys and the resulting analyses were completed using appropriate methodologies compliant with standardised procedures by suitability qualified surveyors.

1.1.3 Elevated phosphates, decreased dissolved oxygen, heavy channel modification and other priority hazardous chemical substances are known issues in the WFD catchments containing the watercourses within the project's boundaries.

1.1.4 Aquatic macroinvertebrate survey results indicated all watercourses are subject to low habitat diversity and water quality pressures which decrease further in autumn. Average Score Per Taxon (ASPT) (Whalley, Hawkes, Paisley & Trigg (WHPT)) scores indicate that all watercourses suffer from Very Poor, Polluted water quality. The aquatic macroinvertebrate communities present were of Low to Moderate conservation value at all survey Reaches, except for one site in the north of the Principal Site in spring, where a Nationally Scarce aquatic beetle was identified. The presence of the non-native, non-invasive New Zealand mud snail and Freshwater Amphipod were also confirmed, as found within the desk study. Impacts of low flow and sedimentation were evident in all watercourses, demonstrated by Proportion of Sediment-Sensitive Invertebrates (PSI) and Lotic-invertebrate Index for Flow Evaluation (LIFE) scores, reflecting heavily sedimented to sedimented conditions and low to moderate sensitivity to reduced flows throughout.

1.1.5 Macrophyte assessments demonstrated low diversity with WFD classifications across all survey Reaches of Unclassified to Moderate. Assemblages were highly suppressed due to shading from agricultural hedgerows and terrestrial herbs, with high levels of eutrophication, sedimentation, prolonged periods of channel drying and channel modification. No protected macrophyte species were identified within the watercourses.

1.1.6 Pond Predictive System for Multimetrics (PSYM) assessment found low biological quality within the assessed water bodies, being classified as Poor to Moderate in quality. Macroinvertebrate communities were heavily dominated by taxa associated with poor water quality and high levels of organic enrichment. Additional records of two species of macrophyte Invasive Non-Native Species (INNS), New Zealand pigmyweed and Nuttall's

waterweed, were found present in one of the pond groups. None of the surveyed water bodies were classed as priority ponds.

1.1.7 The utilisation of good industry practice construction methods should be implemented to prevent sediment run-off into surface waters within the project's boundaries, to reduce impact on already poorly polluted habitats. Best practice biosecurity measures should also be implemented if works are undertaken near water bodies where macrophyte INNS are currently present, to reduce their spread in the aquatic environment and in line with national legislation.

2. Introduction

2.1 Project Overview

2.1.1 The Tillbridge Solar (hereafter referred to as 'the Scheme') aquatic ecological investigations were completed to evaluate the ecological quality of water bodies within the Scheme Boundary to establish potential impacts. This included assessment of Water Framework Directive (WFD) status for each site in relation to biological water quality, and water quality impact assessment.

2.1.2 Surveys undertaken include:

- Aquatic walkover surveys and habitat appraisals;
- Physico-chemical variables (electrical conductivity (µS), pH, dissolved oxygen concentration (% saturation), temperature (°C));
- Benthic macroinvertebrates;
- Macrophytes; and
- Pond Predictive System for Multimetrics (PSYM), comprising macroinvertebrate and macrophyte surveys.

2.2 Background

2.2.1 AECOM was commissioned to undertake surveys to provide an investigation into the ecological quality of the area of the Principal Site, within its designated boundary, including assessment of WFD status for each surveyed Reach in relation to biological water quality, and water quality impact assessment. This included physio-chemical water quality variables, benthic macroinvertebrates, macrophytes and Pond PSYM surveys.

2.3 Study Area

2.3.1 The Scheme is located in North Lincolnshire between Springthorpe and Ingham. The Scheme Boundary resides within the Witham Upper Operational Catchment, crossing Fillingham Beck (WFD water body ID: GB105030062490), River Till (GB105030062411) and Eau de Source to Northorpe Beck (GB104028057970).

2.3.2 The Cable Route Corridor is crossed by further catchments including:

- Till (Witham) (GB105030062500)
- Fillingham Beck (GB105030062490)
- Tributary of the Till (GB105030062480)
- Skellingthorpe Main Drain Water Body (GB105030062390)
- Marton Drain Catchment (Tributary of Trent) (GB104028057840)
- Trent from Carlton-on-Trent to Laughton Drain (GB104028058480)
- Seymour Drain Catchment (Tributary of Trent) (GB104028058340)
- Eau from Source to Northorpe Beck (GB104028057970)

- A complex network of unnamed drains, ditches, and tributaries flowing into the larger watercourses associated with the agricultural nature of this location, including Carr Drain (SK 82726 80440).

2.4 Purpose and Scope of Aquatic Surveys

2.4.1 A desk study was undertaken to review the current WFD status of the water bodies within the Principal Site Boundary. This was to inform the results of the surveys, as well as review relevant biological survey records within the survey area.

2.4.2 An aquatic walkover survey of water bodies (watercourses, ditches, and ponds) within the Principal Site Boundary was completed to appraise the various habitats, hydromorphological characteristics, and the overall composition of watercourses to inform scoping of further detailed surveys.

2.4.3 Aquatic macroinvertebrate samples were collected to identify the conservation value of aquatic macroinvertebrate communities and record the presence of any protected, notable, or Invasive Non-Native Species (INNS). This supported an assessment of overall water and habitat quality.

2.4.4 Further aquatic macroinvertebrate samples were collected in conjunction with aquatic macrophyte surveys of five ponds using the PSYM methodology as per Freshwater Habitats Trust (FHT) guidance. This considers macroinvertebrate and macrophyte species to calculate the overall ecological quality of each pond.

2.4.5 Macrophyte surveys were undertaken in concurrence with Pond PSYM surveys to characterise water and habitat quality and to record the presence of any protected or notable species, or INNS.

2.4.6 Survey locations for the Principal Site are illustrated in Figure 1 in the appendices.

2.5 Legislation

2.5.1 This assessment has been undertaken within the context of some or all of the following relevant legislative instruments, planning policies and guidance documents:

- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the ‘Habitats Directive’) (Ref. 7-1);
- Council Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the ‘Water Framework Directive’ or WFD) (Ref. 7-2);
- The Bern Convention (1979) also known as the Convention on the Conservation of European Wildlife and Natural habitats (Ref. 7-3);
- Convention on Wetlands of International Importance (‘Ramsar convention’) (Ref. 7-4);
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (Ref. 7-5);

- The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 (Ref. 7-6);
- Wildlife and Countryside Act 1981 (as amended) (the 'WCA') (Ref. 7-7);
- Salmon and Freshwater Fisheries Act (SAFFA) 1975 (Ref. 7-8);
- Section 41 of the NERC Act (2006) provides a list of habitats and plant species of principal importance for nature conservation in England (Ref. 7-9);
- The Conservation of Habitats and Species Regulations 2010 (as amended) (Ref. 7-10);
- Nitrate Vulnerable Zones/Nitrates Directive (The Nitrates Directive 1991) (Ref. 7-11);
- Regulation 1143/2014 on invasive alien species (Ref. 7-12); and
- UK Post-2010 Biodiversity Framework (Ref. 7-13).

3. Methodology

3.1 Desk Study

3.1.1 A desk-based review of current status for WFD water bodies within the Principal Site Boundary and connected water bodies (where applicable) was undertaken using the Environment Agency Catchment Data Explorer. The Scheme crosses the boundaries of eight catchments. Four catchments are within the basin for the Witham including The Tributary of the Till, The Till (Witham), Fillingham Beck and Skellingthorpe Main Drain. An Additional catchment of the River Eau, a tributary of the Trent, is also within the vicinity of the Scheme to the north-eastern boundary in the Eau from Source to Northorpe Beck catchment. The Cable Route Corridor also crosses the Trent from Carlton-on-Trent to Laughton Drain, and the tributaries of the Trent Marton Drain and Seymour Drain (the latter including Carr Drain). The Environment Agency ecological survey data within 2 km of the Scheme Boundary from the last 10 years was reviewed using the EA Ecology and Fish Data Explorer. Finally, commercially available historic crayfish records were reviewed using NBN Atlas (where EA crayfish records are held)

3.2 Aquatic Habitat Walkover Surveys

3.2.1 Aquatic habitat walkover surveys were undertaken on 25 May 2022 by two suitably qualified and experienced ecologists. The walkover survey encompassed walking throughout the Principal Site to identify suitable watercourses for habitat appraisals and subsequent detailed surveys (refer to Figure 1 and Appendix A). Weather conditions during the surveys were warm, with some cloud cover. The presence of INNS was noted as part of the habitat appraisal.

3.2.2 The water body naming system was based on the three WFD catchments within the Scheme Boundary: River Till (RT), Fillingham Beck (FB), and Eau de Source to Northorpe Beck (ESN). A total of thirty-five watercourses were identified during preliminary studies, however twenty-one were removed from consideration due to contraction of the Scheme Boundary.

3.2.3 The remaining suitable sites were identified within the Principal Site Boundary, where surveys were completed over three seasons (see Table 3.1).[1]

[1] https://environment.data.gov.uk/catchment-planning/
[1] https://environment.data.gov.uk/ecology/explorer/
[1] https://nbnatlas.org/

3.3 Aquatic Macroinvertebrate Surveys

3.3.1 Spring aquatic walkover surveys and habitat appraisals were completed between 25 and 27 May 2022 by two suitably qualified surveyors at watercourses with the Principal Site Boundary (see Table 3.1).

Table 3.1 Locations of aquatic walkover surveys for habitat appraisals

Site ID	WFD Catchment	NGR	Habitat Appraisal Survey
ESN1	Eau de Source to Northorpe Beck	SK 92149 90363	25/5/22
ESN2	Eau de Source to Northorpe Beck	SK 90705 90399	25/5/22
ESN3	Eau de Source to Northorpe Beck	SK 91147 89399	25/5/22
FB3	Fillingham Beck	SK 93484 87328	26/5/22
FB4	Fillingham Beck	SK 93325 87707	26/5/22
FB5	Fillingham Beck	SK 92553 87857	26/5/22
FB7	Fillingham Beck	SK 92662 86671	26/5/22
FB8	Fillingham Beck	SK 91500 87431	26/5/22
ESN4	Eau de Source to Northorpe Beck	SK 92415 89327	27/5/22
ESN5	Eau de Source to Northorpe Beck	SK 92550 89140	27/5/22
ESN6	Eau de Source to Northorpe Beck	SK 91703 89303	27/5/22
ESN7	Eau de Source to Northorpe Beck	SK 91688 89337	27/5/22
ESN8	Eau de Source to Northorpe Beck	SK 92195 88998	27/5/22
ESN9	Eau de Source to Northorpe Beck	SK 91606 88719	27/5/22
ESN10	Eau de Source to Northorpe Beck	SK 90461 88158	27/5/22
ESN11	Eau de Source to Northorpe Beck	SK 90652 88375	27/5/22
RT12	River Till	SK 89379 88607	27/5/22
RT13	River Till	SK 88906 88404	27/5/22
FB9	Fillingham Beck	SK 93048 88928	27/5/22
ESN12	Eau de Source of North Beck	SK 92653 90007	27/5/22
ESN13	Eau de Source of North Beck	SK 92200 90083	27/5/22

3.3.2 Access to some water bodies was limited due to steep-sided banks and consequently assessments were predominantly undertaken from the banktops.

3.3.3 Further aquatic surveys were performed at several sites, based on results of the walkover surveys. The results of these additional surveys are detailed in this report.

3.4 Aquatic Macroinvertebrate Surveys

3.4.1 Spring aquatic macroinvertebrate surveys were undertaken on 25 to 27 April 2022, in conjunction with habitat appraisals (Figure 1). Macroinvertebrate surveys were undertaken (Table 3.2) following habitat appraisals when surveyors deemed a water body suitable for sampling in the context of its location and potential impacts. Autumn surveys were conducted on 3 November 2022. No surveys were undertaken during or immediately following periods of high flow in accordance with best practice guidance.

3.4.2 A total of six macroinvertebrate sample sites were removed from consideration due to early changes to the Principal Site Boundary, resulting in eight sites remaining for consideration (Table 3.2).

Table 3.2 Aquatic macroinvertebrate survey locations

Site ID	Season	NGR	Survey completed
ESN1	Spring and Autumn	SK 92149 90363	25/5/22 and 03/11/22
ESN2	Spring and Autumn	SK 90705 90399	25/5/22 and 03/11/22
ESN3	Spring and Autumn	SK 91147 89399	25/5/22 and 03/11/22
FB4	Spring and Autumn	SK 93325 87707	26/5/22 and 03/11/22
FB5	Spring and Autumn	SK 92553 87857	26/5/22 and 03/11/22
FB7	Spring and Autumn	SK 92662 86671	26/5/22 and 03/11/22
FB8	Spring and Autumn	SK 91500 87431	26/5/22 and 03/11/22
ESN12	Spring and Autumn	SK 92653 90007	27/5/22 and 03/11/22

Aquatic Macroinvertebrate Survey Methodology

3.4.3 The macroinvertebrate survey method followed the aquatic macroinvertebrate sampling procedures standardised by the Environment Agency (Ref. 7-14), which conforms to BS EN ISO 10870:2012 Water Quality – Guidelines for the selection of sampling methods and devices for benthic macroinvertebrates in fresh waters. These methods allow characterisation of aquatic macroinvertebrate communities and can be used to determine whether rare or notable species or communities are present. The samples were taken using a standard Freshwater Biological Association (FBA) pattern pond net (mesh

size: 1 mm). The habitats present were sampled through a combination of kick sampling and sweep sampling for three minutes followed by a one-minute hand search of larger substrates in accordance with the standard methods. The samples collected were subsequently preserved in Industrial Methylated Spirit (IMS) for laboratory processing.

3.4.4 Each of the samples collected was sorted and analysed in a laboratory setting by suitably trained and experienced aquatic ecologists. Lists of the aquatic macroinvertebrate taxa present were produced in line with Environment Agency guidance (Ref. 7-14 and Ref. 7-15). The aquatic macroinvertebrate samples were identified to 'mixed taxon level' using a stereo-microscope. Most groups were identified to species level (where practicable), with the exception of the following:

- Worms (Oligochaeta) which were identified to sub-class;
- Marsh beetles (Scirtidae) which were identified to family;
- True-fly larvae, which were identified to the maximum resolution possible; and
- Immature or damaged specimens, which were identified to the maximum resolution possible on a case-by-case basis.

3.4.5 The survey data was then used to calculate metrics that can be used to inform an assessment of relative nature conservation value and general degradation.

Community Conservation Index (CCI)

3.4.6 A CCI (Ref. 7-16) was calculated for each surveyed Reach[2] as detailed in Appendix B. The CCI classifies many groups of aquatic macroinvertebrates according to their scarcity and nature conservation value in England as understood at the time that the classification was developed. Species scores range from 1 to 10, with 1 being very common and 10 being Endangered. Since its initial publication, in some cases the references used in the CCI classification to define scarcity and value have been superseded by more recent assessments; AECOM was provided with updated species scores to take account of this new information (Chadd, *pers. comm*., 2018). These updated scores have been used within this assessment.

Lotic-invertebrate Index for Flow Evaluation (LIFE)

3.4.7 LIFE scores were calculated (Ref. 7-17). This is an index that links benthic macroinvertebrate data to flow regimes prevailing in UK waters. Flow scores have been allocated to various macroinvertebrates based on species/family abundance and ecological association with different flows, as detailed in Appendix C. The overall LIFE score for a Reach is calculated as the sum of the individual scores divided by the number of scoring species/families. LIFE scores increase with current velocity, scores <6.00 generally indicating sluggish or still water conditions and score >7.5 indicate fast flows. LIFE allows the mean flow preference of invertebrates colonising a reach to be determined so that effect of habitat changes such as sediment accumulation can be monitored.

[2] 'Reach' is a term for a particular section of a watercourse

Proportion of Sediment-sensitive Invertebrates (PSI)

3.4.8 Calculations were undertaken to determine the proportion of sediment sensitive macroinvertebrates present using the PSI index (Ref. 7-18). Using this approach, individual taxa of aquatic macroinvertebrate are assigned a Fine Sediment Sensitivity Rating (FSSR) ranging from A to D, as detailed in Appendix D. The PSI score for each aquatic macroinvertebrate sample was derived from individual species scores and abundances. The derived PSI score corresponds to the percentage of fine sediment-sensitive taxa present in a sample and ranges from 0 to 100, where low scores correspond to watercourses with high fine sediment cover. The PSI score therefore provides an indication of the extent to which watercourses are influenced by fine sediments, and therefore by inference the potential sensitivity of the associated aquatic macroinvertebrate community to changes in silt load and deposition.

Whalley, Hawkes, Paisley & Trigg (WHPT)

3.4.9 The aquatic macroinvertebrate data were analysed to generate the Whalley, Hawkes, Paisley & Trigg (WHPT) score Average Score Per Taxon (ASPT), and Number of scoring taxa (NTAXA) values, which provides an indication of the ecological quality in the watercourse (Ref. 7-19). This assigns numerical value to taxa according to their sensitivity to organic pollution. The average of the values for each taxon in a sample, known as ASPT is a stable and reliable index of organic pollution. Therefore, these assessments can indicate to what extent an aquatic macroinvertebrate community is exposed to organic pollution (further information is provided in Appendix E). It is important to note that these indices can vary between geological regions and habitat types. Ditches for example are unable to support many of the high-scoring taxa associated with fast flowing habitats. Therefore, the resultant metrics should be reviewed with an awareness of their potential limitations, and the Reach-specific context, as described in this report.

3.4.10 The WHPT method has been primarily designed to respond to organic pollution, however it is suitable for monitoring other types of impact and is used for assessing the WFD classification parameter “General degradation”.

River Invertebrate Classification Tool (RICT)

3.4.11 Analysis using the River Invertebrate Classification Tool version 2 (RICT) web application is only suitable for freshwater (not estuarine or marine) sites on rivers or streams that are naturally permanently flowing. As such, RICT analysis was not undertaken due the nature (i.e., not naturally permanently flowing condition) of field drain (‘ditch’) habitats comprising the survey Reaches.

3.5 Aquatic Macrophyte Surveys

3.5.1 Aquatic macrophyte (plant) surveys were undertaken on 3 November 2022 at eight survey locations (Figure 1 and Table 3.3) during autumn surveys. The recommended time period for aquatic macrophyte surveys is between 1 June and 30 September and should not be undertaken during or immediately after periods of high flow. Although macrophyte surveys were undertaken outside the optimal season, the high level of artificial modification and agricultural impact is more likely to have reduced assemblages rather than seasonal variation. Therefore, these sub-optimal surveys are not considered a limitation to the conclusions of this report, and an accurate representation of

macrophyte and INNS presence has been obtained through this and other surveys.

3.5.2 Pond aquatic macrophyte surveys were also completed, in conjunction with Pond PSYM Surveys, on 21 July 2022 at nine survey locations (Figure 1 and Table 3.5). These surveys were completed during the optimal survey season due to constraints of PSYM methodology and data requirements.

Table 3.3 Aquatic macrophyte survey locations

Water body ID	NGR	Water body comments	Date of survey
ESN1	SK 92149 90363	Watercourse was dry and terrestrial encroachment was present throughout the entire channel	03/11/22
ESN2	SK 90705 90399	Watercourse had water and flow present	03/11/22
ESN3	SK 91147 89399	Watercourse had water present with no noticeable	03/11/22
FB4	SK 93325 87707	Watercourse had water present with no noticeable	03/11/22
FB5	SK 92553 87857	Recent terrestrial encroachment of channel was recorded with pooled areas present, suggesting	03/11/22
FB7	SK 92662 86671	Watercourse had water present with no noticeable	03/11/22
FB8	SK 91500 87431	Watercourse had water present with no noticeable	03/11/22
ESN12	SK 92653 90007	Watercourse was almost entirely dry, with minor pools intermittently present	03/11/22

Aquatic Macrophyte Survey Methodology

3.5.3 The aquatic macrophyte surveys followed guidance set out in the UKTAG River Assessment Method (Macrophytes and Phytobenthos) for use with LEAFPACS2 (Ref. 7-20). The survey was accomplished by walking within the channel of each watercourse along a 100 m transect, where safely accessible. Any inaccessible areas were bypassed as necessary before re-entering the channel at the next available access point. A list of all macrophytes encountered was collated and their relative abundance was recorded using Taxon Cover Values (TCV), detailed below (Table 3.4).

Table 3.4 Taxon Cover Values (TCV) and their associated percentage cover

TCV	Percentage cover for the macrophyte species
C1	<0.1%
C2	0.1 to 1%
C3	1 to 2.5%
C4	2.5 to 5%
C5	5 to 10%
C6	10 to 25%
C7	25 to 50%
C8	50 to 75%

C9	>75%

3.5.4 Aquatic macrophyte data was processed through the River LEAFPACS2 calculator, available from WFD UKTAG[3]. Four metrics were calculated using macrophyte species and groups data:

- **River macrophyte nutrient index (RMNI)** – Macrophyte taxa are allocated a score based on their relative tolerance of nutrients. The overall observed RMNI score for a survey is the cover weighted average of the individual scores of the different taxa found.
- **Number of macrophyte taxa (NTAXA)** – The number of scoring taxa recorded in the field survey. Only true hydrophytes are included.
- **Number of functional groups (NFG)** – Hydrophytes are allocated to one of 24 "functional groups". These are groups of organisms which exploit a resource in a similar way.
- **Cover of filamentous green algae (ALG)** – The percentage cover of filamentous green algae over the whole of the surveyed section.

3.5.5 LEAFPACS2 predicts the RMNI, NTAXA and NFG scores for the surveyed Reach based on the Reach altitude, alkalinity, and slope. The predicted scores are then compared to actual scores and the output is an Ecological Quality Ratio (EQR). The EQR can be translated into a Water Framework Directive (WFD) classification (High, Good, Moderate, Poor, or Bad). Alkalinity data should be obtained from monthly analysis of samples from each over a period of at least one year, whereas here, only alkalinity was based on the average of two samples collected during the survey visits.

3.5.6 River LEAFPACS2 analysis was designed to reflect the impact of nutrient enrichment on macrophyte communities, with High status indicating there is no impact and Bad status indicating there is a severe impact. The method may also be sensitive to alterations in river flow and/or modifications to morphological conditions which may impact macrophyte communities (Ref. 7-20).

3.5.7 Aquatic macrophyte species were cross referenced against the JNCC Taxon Designations list[4] to identify if any protected and/or notable species were recorded during the surveys.

3.5.8 As for macroinvertebrate surveys, the nature of the water bodies surveyed for macrophytes is atypical for LEAFPACS methodology and data interpretation, i.e., heavily modified, or artificial agricultural drainage ditches. However, the resulting macrophyte data and indices are representative of habitat conditions and provide valuable information to inform the impact assessment, mitigation requirements, and WFD assessment.

3.6 Pond PSYM surveys

3.6.1 Pond PSYM surveys were undertaken on 21 July 2022 at eleven survey locations (Table 3.5). Pond PSYM has been developed for use in the summer

[3] https://www.wfduk.org/resources/rivers-macrophytes
[4] Available at: https://hub.jncc.gov.uk/assets/478f7160-967b-4366-acdf-8941fd33850b

survey season (June - August) and is based on assessments of both macroinvertebrate and macrophyte assemblages. Surveys were therefore undertaken during the optimal pond PSYM survey season.

3.6.2 During PSYM surveys, macrophytes surveys were undertaken at most sites, while additional macroinvertebrate samples were collected where possible. A total of forty-two water bodies were identified as potential sites for Pond PSYM surveys, however twelve were subject to detailed survey (Appendix H) due to low water levels at the time of survey and proximity to the Principal Site Boundary.

3.6.3 Access limitations prevented approach to the water body at Pond 18, due to dense scrub that proved impassable to the surveyors during pond surveys. A blue-green algal bloom was also recorded at the pond amalgamation of Ponds 23, 24 and 25, where surveyors were careful when working near the water and restricted access to one of the ponds – due to the similar characteristics of these three ponds and the species observed, this survey is therefore considered representative of all three ponds.

3.6.4 A full PSYM assessment was only completed at ponds that were suitable for a macroinvertebrate sample.

Table 3.5 Pond aquatic macrophyte and PSYM survey locations

Site reference	Grid reference	Water body description	Macrophyte survey completed	Invertebrate sample collected	PSYM completed
Pond 6	SK 90493 90684	Small water body that had recently dried in a pasture field	Y	-	-
Pond 8	SK 90901 89785	Artificial agricultural pond, with input from arable drainage	Y	-	-
Pond 9	SK 91476 89890	Recently dried	-	-	-
Pond 11	SK 91120 88656	Recently dried	Y	-	-
Pond 12	SK 91855 89903	Agricultural drainage pond, with low water level and heavy siltation	Y	-	-
Pond 15	SK 93140 89798	U-shaped moat stocked with carp	Y	Y	Y
Pond 17	SK 92176 88731	Drainage pond	Y	Y	Y
Pond 18	SK 93863 88985	Inaccessible to surveyors due to dense scrub	-	-	-
Pond 19	SK 93609 88799	Predominately dry pond	Y	-	-

Site reference	Grid reference	Water body description	Macrophyte survey completed	Invertebrate sample collected	PSYM completed
Ponds 23, 24 and 25	SK 93296 87813	3 uniform artificial reservoirs amalgamated into one survey	Y	Y	Y

'Y' Survey or sample completed at site

Pond PSYM methodology

3.6.5 The pond PSYM method (Ref. 7-21) was utilised to assess the biological quality of the twelve ponds, at ten sites, within and directly adjacent to the Principal Site Boundary. PSYM is a standard method that provides an assessment of the biological quality of ponds and small lakes up to five hectares in area in England and Wales. The method includes the collection of physical data, macroinvertebrate sampling and macrophyte recording.

3.6.6 Macroinvertebrate samples were collected using 'kick/sweep sampling' for three minutes followed by a one-minute hand search of larger substrates using a standard Freshwater Biological Association (FBA) pattern pond net (mesh size: 1 mm). The three-minute sampling time was apportioned equally between the number of mesohabitats identified in line with the pond PSYM methodology. The samples were analysed, and specimens identified to family taxonomic level in accordance with pond PSYM methodology.

3.6.7 Macrophytes were surveyed by walking or wading the entire perimeter of the dry and shallow water areas of the water body. Deeper water areas were sampled by grapnel thrown from shallow water or the bank. The aim of plant recording was to make a complete list of aquatic and marginal plants present within and on the banks of each water body, including INNS.

3.6.8 To determine conservation importance of the ponds, the data collected during the surveys was submitted to the Freshwater Habitats Trust (FHT) to be compared against a national database. This analysis provides a rating from Very Poor to Good and determines whether the water body is a 'priority pond' for conservation purposes.

4. Results

4.1 Desk Study

Water Framework Directive Status

4.1.1 Catchments are described from upstream to downstream according to EA catchment data water body order, for the water bodies associated with the Witham catchment, within the vicinity of the Scheme.

Fillingham Beck

4.1.2 Fillingham Beck[5] (WFD water body ID: GB105030062490) is monitored by the Environment Agency for the purpose of the WFD.

4.1.3 Fillingham Beck is designated as being heavily modified and is currently classified by the Environment Agency as having Moderate ecological status. The quality elements preventing the catchment from achieving Good status is primarily elevated phosphates levels and detrimental impacts to invertebrate communities. The Reasons for Not Achieving Good (RNAG) and Reasons For Deterioration (RFD) have been assessed as phosphates and detriment to invertebrates due to a combination of 'Poor nutrient management and soil management from Agriculture and rural land management' in addition to 'Continuous discharge from the Water Industry' and 'Physical modification from Land drainage from the Agriculture and rural land management' further impacting invertebrates. Within the catchment 'Chemical pollution from Polybrominated diphenyl ethers (PBDE) and Mercury compounds' was also recorded as a RNAG.

4.1.4 No update is available on the 2015 objectives although the status was to be maintained at Moderate by improving the biological quality element of invertebrate deterioration to Moderate from Poor. A further improvement of phosphates to Moderate was also an objective although both were 'Technically infeasible: No known technical solution is available'.

4.1.5 Within the catchment is the Lower Witham Protected area (NVZ S375) under the Nitrates Directive.

River Till (Witham)

4.1.6 The River Till (Witham)[6] (WFD water body ID: GB105030062500) is monitored by the Environment Agency for the purpose of the WFD.

4.1.7 The Till (Witham) is designated as heavily modified and is currently classified by the Environment Agency as having Moderate ecological status. The quality elements preventing the catchment from achieving Good status is primarily elevated phosphates. The RNAG have been assessed as elevated phosphates due to a combination of 'Poor nutrient from Agriculture and rural land management', 'Continuous sewage discharge from the Water industry' and 'Trade/industry discharge from Industry' in addition to chemical pollution from Polybrominated diphenyl ethers (PBDE) and Mercury compounds.

4.1.8 No update has been made since the 2015 catchment objectives, which were to maintain the Moderate status. The biological quality elements of

[5] https://environment.data.gov.uk/catchment-planning/Water body/GB105030062490
[6] https://environment.data.gov.uk/catchment-planning/Water body/GB105030062500

macrophytes and phytobenthos remained unassessed and the chemical quality element for Phosphates was classified as Poor, due to 'Technically infeasible: No known technical solution is available'.

4.1.9 Within the catchment is the Lower Witham Protected area (NVZ S375) under the Nitrates Directive.

Tributary of the Till

4.1.10 The Tributary of the Till[7] (WFD water body ID: GB105030062480) is monitored by the Environment Agency for the purpose of the WFD.

4.1.11 The Tributary of the Till is not designated artificial or heavily modified and is the only catchment of the Witham within the Scheme with this designation. It is currently classified by the Environment Agency as having Poor ecological status. The quality elements preventing the catchment from achieving Good status is primarily poor soil management and land drainage within the catchment. The reasons for not achieving Good status (RNAG) have been assessed as poor soil management due to a combination of 'Poor nutrient from Agriculture and rural land management', 'Continuous sewage discharge from the Water industry', and 'Trade/industry discharge from Industry' in addition to chemical pollution from Polybrominated diphenyl ethers (PBDE) and Mercury compounds.

4.1.12 The objectives of the catchment are to improve biological quality elements from Poor to Moderate by 2027, including Invertebrates in addition to Macrophytes and Phytobenthos. The main reason for not achieving this objective has been recorded as 'Disproportionately expensive: Disproportionate burdens and Unfavourable balance of costs and benefits.'

4.1.13 Within the catchment is the Lower Witham Protected area (NVZ S375) under the Nitrates Directive.

Skellingthorpe Main Drain

4.1.14 The Skellingthorpe Main Drain[8] (WFD water body ID: GB105030062390) is monitored by the Environment Agency for the purpose of the WFD.

4.1.15 The Till (Witham) is designated as heavily modified and is currently classified by the Environment Agency as having Moderate ecological status. The quality elements preventing the catchment from achieving Good status is primarily elevated phosphates. The RNAG have been assessed as elevated phosphates due to a combination of 'Poor nutrient from Agriculture and rural land management', 'Continuous sewage discharge from the Water industry' and 'Trade/industry discharge from Industry' in addition to chemical pollution from Polybrominated diphenyl ethers (PBDE) and Mercury compounds.

4.1.16 No update has been made since the 2015 catchment objectives, which were to maintain the Moderate status. The biological quality elements of macrophytes and phytobenthos remained unassessed and the chemical quality element for Phosphates was classified as Poor, due to 'Technically infeasible: No known technical solution is available'.

4.1.17 Within the catchment is the Lower Witham Protected area (NVZ S375) under the Nitrates Directive.

[7] https://environment.data.gov.uk/catchment-planning/Water body/GB105030062480
[8] https://environment.data.gov.uk/catchment-planning/Water body/GB105030062500

Marton Drain Catchment

4.1.18 The Marton Drain Catchment[9] (WFD water body ID: GB104028057840) is monitored by the Environment Agency for the purpose of the WFD.

4.1.19 The Till (Witham) is designated as heavily modified and is currently classified by the Environment Agency as having Moderate ecological status. The quality elements preventing the catchment from achieving Good status is primarily elevated phosphates. The RNAG have been assessed as elevated phosphates due to a combination of 'Poor nutrient from Agriculture and rural land management', 'Continuous sewage discharge from the Water industry' and 'Trade/industry discharge from Industry' in addition to chemical pollution from Polybrominated diphenyl ethers (PBDE) and Mercury compounds.

4.1.20 No update has been made since the 2015 catchment objectives, which were to maintain the Moderate status. The biological quality elements of macrophytes and phytobenthos remained unassessed and the chemical quality element for Phosphates was classified as Poor, due to 'Technically infeasible: No known technical solution is available'.

4.1.21 Within the catchment is the Lower Witham Protected area (NVZ S375) under the Nitrates Directive.

Trent from Carlton-on-Trent to Laughton Drain

4.1.22 The Trent from Carlton-on-Trent to Laughton Drain[10] (WFD water body ID: GB104028058480) is monitored by the Environment Agency for the purpose of the WFD.

4.1.23 The Till (Witham) is designated as heavily modified and is currently classified by the Environment Agency as having Moderate ecological status. The quality elements preventing the catchment from achieving Good status is primarily elevated phosphates. The RNAG have been assessed as elevated phosphates due to a combination of 'Poor nutrient from Agriculture and rural land management', 'Continuous sewage discharge from the Water industry' and 'Trade/industry discharge from Industry' in addition to chemical pollution from Polybrominated diphenyl ethers (PBDE) and Mercury compounds.

4.1.24 No update has been made since the 2015 catchment objectives, which were to maintain the Moderate status. The biological quality elements of macrophytes and phytobenthos remained unassessed and the chemical quality element for Phosphates was classified as Poor, due to 'Technically infeasible: No known technical solution is available'.

4.1.25 Within the catchment is the Lower Witham Protected area (NVZ S375) under the Nitrates Directive.

Seymour Drain catchment

4.1.26 Seymour Drain Catchment (trib of Trent) Water Body[11] (WFD water body ID: GB104028058340) is monitored by the Environment Agency for the purpose of the WFD.

4.1.27 Seymour Drain has been designated as heavily modified and is currently classified by the Environment Agency as having Moderate ecological status. The quality elements preventing the catchment from achieving Good status

[9] https://environment.data.gov.uk/catchment-planning/Water body/GB105030062500
[10] https://environment.data.gov.uk/catchment-planning/Water body/GB105030062500
[11] https://environment.data.gov.uk/catchment-planning/WaterBody/GB104028058340

are primarily reduced dissolved oxygen, phosphate, and detrimental impacts to invertebrates and macrophytes. The RNAG for dissolved oxygen and biological elements have been assessed as 'Diffuse source pollution from transport drainage and poor soil management', 'Continuous sewage discharge from the Water industry' and 'Physical modification of land drainage from Agriculture and rural land management'. Within the catchment 'Chemical pollution from Polybrominated diphenyl ethers (PBDE) and Mercury compounds' was also recorded as a RNAG.

4.1.28 The objectives in place are to improve the catchment to a Good classification by 2027, with low confidence due to Disproportionately expensive: Disproportionate burdens.

4.1.29 Within the catchment is the Seymour Drain Catchment (trib of River Trent) Protected area (NVZ S343) under the Nitrates Directive.

Eau from Source to Northorpe Beck

4.1.30 Eau from Source to Northorpe Beck Water Body[12] (WFD water body ID: GB104028057970) is monitored by the Environment Agency for the purpose of the WFD and is within the northern limits of the site. This is the only catchment not associated with the River Witham within the Scheme and is ultimately a tributary of the River Trent.

4.1.31 The Eau from Source to Northorpe Beck Water Body is not designated artificial or heavily modified and is currently classified by the Environment Agency as having Moderate ecological status. The quality elements preventing the catchment from achieving Good status is primarily elevated phosphates. RNAG for elevated phosphates have been assessed as a combination of 'Poor nutrient from Agriculture and rural land management' and 'Continuous discharge from the Water Industry', in addition to 'Chemical pollution from Polybrominated diphenyl ethers (PBDE) and Mercury compounds'

4.1.32 The objectives in place are to improve the catchment to a Good classification by 2027, primarily from improving the classification of Phosphates within Physico-chemical quality elements.

4.1.33 There is one Protected Area within catchment, which is the River Eau from Kirton Lindsey (Trib to R Trent) (NVZ S334) under the Nitrates Directive.

4.2 Notable Species

4.2.1 Historic records of macroinvertebrate and macrophyte species within the last ten years are available from the EA through their routine ecological monitoring programme. The EA has seven monitoring locations on the associated water bodies within the vicinity of the project. The nearest EA fish monitoring site is located 2.31km downstream on the River Till at Stow (Table 4.1).

Table 4.1 Location of EA biological monitoring sites

Water body	Site ID	NGR	Proximity to Scheme	Year last surveyed	Group monitored
Principal Site					

[12] https://environment.data.gov.uk/catchment-planning/Water body/GB104028057970

Water body	Site ID	NGR	Proximity to Scheme	Year last surveyed	Group monitored
Fillingham Beck	55132 (I) 160643 (M)	SK 93295 87702	Within Principal Site at Glentworth	2016	Invertebrates, Macrophytes
Fillingham Beck	184408	SK 94549 87947	0.1km N of Principal Site at Glentworth	2016	Invertebrates
Aisthorpe Springs	156610	SK 95694 89922	1.6km NE of Principal Site at Glentworth	2014	Invertebrates
Black Dyke	55035	SK 96000 89965	1.9km NE of Principal Site at Glentworth	2014	Invertebrates
Cable Route Corridor					
Seymour Drain	165003	SK82164 80935	Inside Cable Route Corridor Boundary at Coates	2015	Invertebrates
Seymour Drain	158857	SK81644 78723	Within Cable Route Corridor Boundary at Cottam power station	2012	Invertebrates
Seymour Drain	158854	SK81624 78695	<0.1km S of Cable Route Corridor Boundary at Cottam power station	2012	Invertebrates
Marton Drain	52709	SK83500 81240	<0.1km W of Cable Route Corridor Boundary at Marton.	2020	Macrophytes
Marton Drain	54038	SK84129 80987	<0.1km E of Cable Route Corridor Boundary at Marton	2013	Invertebrates
Padmoor Drain	160480 (I) 161709 (M)	SK87236 83541	<0.1km W of Cable Route Corridor Boundary at Willingham by Stow.	2016	Invertebrates Macrophytes
Sewer Drain	48092	SK83768 77981	0.1km SE of Cable Route Corridor Boundary at Torksey Lock	2015	Invertebrates
Seymour Drain	52591	SK81963 80374	0.4km N of Cable Route Corridor Boundary at Cottam	2015	Invertebrates
River Till	55373	SK87900 84600	0.4km SE of Cable Route Corridor Boundary at Willingham by Stow	2013	Invertebrates
Carr Drain	158852	SK82580 81417	0.4km N of Cable Route Corridor Boundary at Cottam	2012	Invertebrates

Water body	Site ID	NGR	Proximity to Scheme	Year last surveyed	Group monitored
Marton Drain	163330 (I) 163330 (M)	SK840117 9852	0.5km E of Cable Route Corridor Boundary at Brampton	2013 (I) 2016 (M)	Macrophytes
Marton Drain	163332	SK84080 79103	0.5km E of Cable Route Corridor Boundary at Torksey	2013	Invertebrates
Seymour Drain	158851	SK79988 77654	0.9km S of Cable Route Corridor Boundary at Rampton	2012	Invertebrates
Lee Beck	159090	SK79498 80866	1.7km W of Cable Route Corridor Boundary at Cottam	2012	Invertebrates
Catchwater Drain	159091	SK79372 82289	1.7km W of Cable Route Corridor Boundary at Coates	2012	Invertebrates
Squires Bridge R.Till	5857	SK 90300 82400	1.3km SE of Cable Route Corridor Boundary at Normanby by Stow	2014	Fish

Principal Site

4.2.2 At the four EA macroinvertebrate monitoring sites, a total of sixty-one taxa have been recorded between 2013 and 2016, with none identified as protected or notable. The non-native but not invasive New Zealand mud snail *Potamopyrgus antipodarum* was recorded at all sites over this period, with the non-native freshwater amphipod 'shrimp' *Crangonyx pseudogracillis/floridanus* recorded at Fillingham Beck (ID 55132) in 2016.

4.2.3 At the Fillingham Beck EA macrophyte monitoring site, three taxa were recorded in 2016. None of these were protected, notable or invasive.

Cable Route Corridor

4.2.4 A total of 159 taxa have been recorded at the 13 EA macroinvertebrate monitoring sites between 2012 and 2016, none of which are protected or notable. The non-native but not invasive New Zealand mud snail was recorded in Seymour Drain, Marton Drain, Padmoor Drain, Sewer Drain, the River Till, Lee Beck and Catchwater Drain, with the most recent sighting being in 2015. The non-native *Crangonyx pseudogracillis/floridanus* was recorded in Seymour Drain, Marton Drain, Padmoor Drain and Sewer Drain, with the most recent sighting being in 2016.

4.2.5 No EA fish surveys were conducted within the search radius for the Scheme, with the closest records located just outside the search radius, Squires Bridge on the River Till (SK 90300 82400), east of Stow. The notable and protected species European eel *Anguilla*, was found in the years 2013 and 2014 as elvers (juvenile eel). This species is afforded protection under the Eels (England and Wales) Regulations 2009, which places a requirement upon developers and abstracters to ensure continued eel passage and to prevent eel entrainment. Additional records of spined loach *Cobitis taenia* were

identified within the water body; this species is listed in Annex II of the European Commission Habitats and Species Directive and Appendix III of the Bern Convention.

4.2.6 Atlantic salmon *Salmo salar* are anecdotally known to use the River Trent as a migratory route. The closest record to Site was a capture in a seine net at Stoke Bardolph (SK 64980 41715) approximately 60km upstream of the Site in November 2021. However, to Reach this location migratory salmon must pass the Cable Route Corridor. Other migratory fish species are known to be present in the River Trent, and potentially in its tributaries: brown/sea trout *Salmo trutta*, and lamprey species Petromyzontidea, notably river lamprey *Lampetra fluviatilis*, and sea lamprey *Petromyzon marinus*, which are designated features of the Humber Estuary SAC of which the River Trent is a tributary.

4.2.7 There are no recent historic records[13] of the protected, white-clawed crayfish *Austropotamobius pallipes*, or the invasive non-native American Signal Crayfish *Pacifastacus leniusculus*, within a 2 km radius of the site, and the nearest records were at least 15 km from the Principal Site. Therefore, these species are considered absent from the site and the immediate vicinity.

4.3 Statutory Designated Sites

4.3.1 The Scheme is located within two Nitrates Vulnerable Zones (2017 designations) of the Lower Witham (NVZ S375) and the River Eau from Kirton Lindsey (Trib to R Trent) (NVZ S334) under the Nitrates Directive.

4.3.2 Although not within the Principal Site Boundary, the Site of Special Scientific Interest Lea Marsh, adjacent to the River Trent near Gainsborough, is approximately 5km away from the Cable Route Corridor at Kexby and Land parcels at Springthorpe and is therefore considered outside the zone of influence of this development.

4.4 Aquatic Habitat Walkover Surveys

4.4.1 Habitat appraisal surveys were undertaken within the spring surveying period between 25 and 27 May 2022 by two suitably experienced surveyors. All surveyed watercourses were heavily modified (straightened and adapted for land drainage) or agricultural drainage ditches. Other water body types, ponds, were also surveyed to inform whether pond PSYM survey was appropriate in the context of the Scheme.

4.4.2 Descriptions of surveyed water bodies within the Principal Site Boundary are provided below.

ESN1

4.4.3 This Reach consisted of very steep banks along an agricultural drainage ditch, covered in simple tall herb and rank vegetation on both banks (Plate 1). The bank vegetation provided low to moderate shading along the course of the channel. Water depth averaged 3 cm across a soft bed of silt substrate. The average width of the ditch was 0.25 m.

[13] Records of white-clawed crayfish are present upstream NW of the cable crossing at Cottam and NE of the start of the cable crossing, however, given the lack of more recent records it may be considered this species is likely now absent from the catchment.

4.4.4 Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were present from approximately three species, primarily fool's watercress *Helosciadium nodiflorum*, with total cover of 5%. No fish spawning habitat was found within the ditch and no notable species were present. The ditch was culverted under a farm track for access, with a secondary ditch draining into the ditch from the south. No evidence of water quality impacts was documented.

4.4.5 The Reach was situated within tilled farmland and narrow semi-improved grassland buffers around field margins, within the wider landscape.

4.4.6 The surveyed Reach contained sufficient water and aquatic habitats to warrant macroinvertebrate survey at the time of appraisal.

Plate 1. Downstream survey Reach ESN1

ESN2

4.4.7 This Reach consisted of steep banks along an agricultural drainage ditch, with simple tall herb and rank vegetation on both banks (Plate 2). The bank vegetation provided low to moderate shading along the course of the channel. Water depth within channel averaged 30 cm across a soft bed of an entirely silt substrate. The average width of the ditch was 0.25 m.

4.4.8 Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were present, including reed canary grass *Phalaris arundinacea* and terrestrial vegetation, with a total channel cover of 5%. No notable species were present, and evidence of domestic litter was documented.

4.4.9 The Reach was situated within tilled farmland and narrow semi-improved grassland buffers around field margins, within the wider landscape.

4.4.10 The surveyed Reach contained sufficient water and aquatic habitats to warrant a macroinvertebrate survey at the time of appraisal. Stickleback (*Gasterosteus* sp.) were recorded as by-catch of macroinvertebrate sampling in the ditch.

Plate 2. Downstream habitat survey Reach ESN2

ESN3

4.4.11 This Reach consisted of steep banks along an agricultural ditch, with simple tall herb and rank vegetation on both banks. This vegetation provided low to moderate shading along the course of the channel. Water depth averaged 10 cm across a soft bed of entirely silt substrate. The average width of the ditch was 0.25 m.

4.4.12 Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were present with one reed species with a total channel cover of 10%. No fish spawning habitat was found within the ditch and no notable species were present. The ditch was culverted under a farm track for access between two adjacent fields. Recent bank top mowing was recorded at the Reach along the entire left bank. No evidence of pollution was documented.

4.4.13 The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

4.4.14 The surveyed Reach contained sufficient water and aquatic habitats to warrant macroinvertebrate survey at the time of appraisal.

FB4

4.4.15 This Reach consisted of steep banks along an agricultural drainage ditch, with simple tall herb and rank vegetation on the right bank (Plate 3). Complex deciduous tree and scrub vegetation on the right bank produced moderate to heavy shading along the course of the channel. The average width of the ditch was 0.75 m with an entirely silt substrate, producing a soft bed.

4.4.16 Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were present, with a total cover up to 70% of the channel. No suitable fish spawning habitat was found during the habitat appraisal however two specimens of stickleback were caught during the macroinvertebrate sample. No notable species were present and some domestic waste pollution (binbags and other fly tipping) on the right bank was documented. The surveyed Reach was upstream of a culvert underneath a minor tarmacked track.

4.4.17 The Reach was situated within tilled farmland and narrow semi-improved grassland buffers around field margins, within the wider landscape. An artificial water body within high embankments was present to the north of the ditch, although connection to the surveyed Reach was unclear.

4.4.18 The surveyed Reach contained sufficient water and aquatic habitats to warrant macroinvertebrate survey at the time of appraisal.

Plate 3. Upstream habitat survey Reach FB4

FB5

4.4.19 This Reach consisted of steep banks along an agricultural drainage ditch, with dense simple herb and rank vegetation on both banks overhanging the channel, with occasional singular deciduous trees scattered along the right bank top (Plate 4). The bank vegetation provided moderate to heavy shading along the course of the channel. The average width of the ditch was 0.5 m with

a an entirely silt substrate producing a soft bed. A high level of detritus was present with 70% coverage of the channel, primarily from terrestrial vegetation. The slightly turbid water present in the ditch had a maximum depth of 2 cm and a low flow of approximately 10 cm/s.

4.4.20 Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the channel and terrestrial encroachment (grasses and herbs) covered 85% of the in-channel substrate. No suitable fish spawning habitat or notable species were present at the survey Reach. No evidence of pollution was documented.

4.4.21 The Reach was situated within tilled farmland and narrow semi-improved grassland buffers around field margins, comparable with characteristics of the wider landscape.

4.4.22 The surveyed Reach contained sufficient water and aquatic habitats to warrant macroinvertebrate survey at the time of appraisal.

Plate 4. Upstream habitat survey Reach FB5

FB7

4.4.23 This Reach consisted of steep banks along an agricultural ditch, with simple herb and rank vegetation on the right bank and complex hedgerow vegetation on the left bank (Plate 5). The bank vegetation provided moderate shading along the course of the channel. The average width of the ditch was 0.5 m with a predominantly silt and sand substrate producing a soft bed. Water was clear with an average depth of 6 cm, and a low flow of approximately 10 cm/s.

4.4.24 Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were present, primarily fool's watercress, covering only 5% of the ditch, with some additional terrestrial

encroachment of herbs and grasses. A minor presence of filamentous algae was recorded across 10% of the wetted ditch. During the habitat appraisal no suitable fish spawning habitat or notable species were found. A tributary ditch also drained into the watercourse approximately 10 m upstream of the survey Reach. No evidence of pollution was documented.

4.4.25 The Reach was situated within tilled farmland with narrow semi-improved grassland buffers around field margins, within the wider landscape.

4.4.26 The surveyed Reach contained sufficient water and aquatic habitats to warrant macroinvertebrate survey at the time of appraisal.

Plate 5. Downstream habitat survey Reach FB7

FB8

4.4.27 This Reach consisted of very steep banks along an agricultural drainage ditch, with complex herb, rank, scrub, and deciduous tree vegetation on both banks (Plate 6). The vegetation provided moderate shading along the course of the channel. The average width of the channel was 0.5 m with an entirely silt substrate producing a soft bed. Water present had slight turbidity, with an average depth of 5 cm and a low flow of approximately 10 cm/s.

4.4.28 Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the channel with an intermediate level of terrestrial encroachment from grasses and herbs within marginal habitats, totalling 40% cover. No suitable fish spawning habitat or notable species were present during the surveys. No evidence of pollution was documented.

4.4.29 The Reach was situated within tilled farmland with narrow semi-improved grassland buffer strips around field margins, within the wider landscape.

4.4.30 The surveyed Reach contained sufficient water and aquatic habitats to warrant macroinvertebrate survey at the time of appraisal.

Plate 6. Upstream habitat survey Reach FB8

ESN12

4.4.31 This Reach consisted of relatively steep banks along an agricultural ditch, with complex scrub, herb, and rank vegetation on the right bank (Plate 7). Complex deciduous woodland and herbs on the left bank overhung the channel and produced heavy shading along the course of the channel. The average width of the wetted channel was 1 m with a silt substrate producing a soft bed. The slightly turbid water had an average depth of 10 cm, with no obvious flow in-channel. Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the ditch with no notable terrestrial encroachment of the ditch. During the survey no notable species were present and no evidence of pollution was documented.

4.4.32 The Reach was situated within tilled farmland with narrow semi-improved grassland buffers around field margins, within the wider landscape.

4.4.33 The surveyed Reach contained sufficient water and aquatic habitats to warrant macroinvertebrate survey at the time of appraisal. One specimen of stickleback was caught during the macroinvertebrate survey.

Plate 7. Downstream habitat survey Reach ESN12

4.5 Aquatic Macroinvertebrate Survey Results

Spring and Autumn Survey Results

4.5.1 The full aquatic macroinvertebrate taxa list can be found in Appendix F. A description of the macroinvertebrate community at each site is provided below.

ESN1

4.5.2 The spring community at ESN1 was primarily comprised of snails (wandering snail *Ampullaceana balthica,* New Zealand mud snail and ramshorn *Anisus vortex*) and freshwater Oligochaeta worms totalling 66.9% and 11.8% respectively. The site had a relatively diverse beetle assemblage with Dytiscidae, *Hydroporus* sp., *Agabus bipustulatus, Agabus paludosus, Helophorus* sp., and *Anacaena globulus* present. Other taxa included two species of freshwater leech (*Glossiphonia complanata* and *Erpobdella octoculata*), pea mussels *Pisidium* sp., the water cricket *Velia caprai*, the freshwater shrimp Gammarus pulex and the cased caddisfly larvae Limnephilus lunatus. Five taxa of truefly larvae were also recorded: craneflies Tipula sp. and Limoniidae, drain fly Psychodidae, biting midge Ceratopogonidae, and the soldier fly Stratiomyidae.

4.5.3 During autumn macroinvertebrate surveys the watercourse was dry and a sample could not be taken.

ESN2

4.5.4 The spring sample was dominated by water slaters (*Asellus aquaticus* and *A. meridianus*) totalling 50.9% of specimens and a further 40.4% from non-biting midge larvae (Tanypodinae, Chironomini and Tanytarsini). Species tolerant to organic enrichment were present such as aquatic snails (*A. balthica* and *Gyraulus crista*), pea mussel Pisidium sp., freshwater Oligochaeta worms and their predatory species *Glossiphonia complanata*. A diverse beetle assemblage was present with five taxa including Haliplidae, Gyrinus sp., *A. bipustulatus*, *Dytiscus marginalis*, and Hydrophilidae. Additional taxa identified included the freshwater shrimp *Gammarus pulex/fossarum* agg., lesser water boatman *Hesperocorixa sahlbergi*, the alderfly Sialis lutaria, cased caddisfly *L. lunatus* and cranefly Tipula sp.

4.5.5 The autumn community was less diverse and was dominated by freshwater Oligochaeta worms, which totalled 95.0% of identified specimens. The pea mussel Pisidium sp, freshwater leech *G. complanata* and non-biting midges Tanypodinae and Chironomini, are also tolerant to organic enrichment and slower flows and were also present, although in low numbers. Other taxa identified included the aquatic beetle *Haliplus lineaticollis* and the craneflies *Tipula* sp. and Limoniidae.

ESN3

4.5.6 The spring community was heavily dominated by non-biting midges (Tanypodinae and Tanytarsini), and the Hydrobiidae New Zealand mud snail, comprising 47.6% and 18.2% of the identified specimens. Pea mussels *Pisidium* sp. were abundant comprising a further 16%. A relatively diverse assemblage of aquatic beetles was present with specimens of Haliplidae, *Hydroporus palustris, Helphorus brevipalpis, Helophorus grandis/aquatic,* and Hydrophilidae larvae identified. The presence of seed shrimp Ostracoda, alongside A. aquaticus and *Lymnaea stagnalis*, suggest areas of low to no

flow and organic enrichment within the ditch. Other taxa identified included aquatic snail *A. balthica* the water skater *Gerris lacustris*, water cricket Velia sp., the cased caddisfly larvae *L. lunatus*, and soldier fly Stratiomyidae.

4.5.7 A fish population was also identified in spring as specimens of three-spined stickleback Gasterosteus aculeatus were caught as by-catch.

4.5.8 The autumn community was less abundant and with similar levels of diversity. Only thirty-eight specimens were identified from the sample, with equal numbers of species tolerant to eutrophication prevalent with aquatic snails (*Galba truncatula*, *A. balthica*, and *P. antipodarum*), freshwater Oligochaeta worms and non-biting midges Orthocladiinae. Other taxa identified within the sample included the lesser water boatman *H. sahlbergi*, the greater water boatman *Notonecta glauca*, the aquatic beetle *Hydroporus planus*, cased caddisfly larvae Limnephilidae, and the craneflies *Tipula* sp. and Limoniidae.

FB4

4.5.9 Spring community was predominantly crustaceans (*Gammarus pulex*) and non-biting midges (Tanypodinae, Orthocladiinae and Tanytarsini) comprising 34.8% and 31.7% of the identified specimens respectively. The black fly larvae *Simulium* sp. accounted for 10.5% of the sample, suggesting areas of faster flow within the surveyed Reach, allowing filter feeding with their specialised fan-like mouthparts. The higher presence of freshwater leeches is also indicative of prominent levels of prey items such as Chironomidae and freshwater Oligochaeta worms. Other taxa included the flatworms *Polycelis nigra/tenuis* and Dugesia sp., the non-native aquatic snails Physidae and New Zealand mud snail, mayflies Baetis sp., and drain flies Psychodidae.

4.5.10 A fish population was identified with specimens of three-spined stickleback found as sample by-catch.

4.5.11 The autumn community was also dominated by the freshwater shrimp *G. pulex/fossarum agg*., totalling 42.2% of identified specimens. The next highest abundance taxa were Oligochaeta worms, totalling 16.2% of the sample, alongside their predatory taxa freshwater leeches, the detritivore water slaters *A. aquaticus,* and non-biting midge larvae. Remaining taxa identified included the mayflies Baetidae, specimens of the cased caddisfly family Limnephilidae, and drain fly larvae Psychodidae.

FB5

4.5.12 Within the spring sample, crustaceans (*G. pulex/fossarum* and *A. aquaticus*) dominated the sample comprising 50.7% of the identified specimens. High proportions of the organic tolerant non-biting midges (Tanypodinae, Orthocladiinae, Tanytarsini and Prodiamesinae) and the detritovore New Zealand mud snail, comprising 19.6% and 17.3% of specimens respectively. Other organic pollution-tolerant species included the aquatic snail *A. vortex*, freshwater Oligochaeta worms and the pea mussel *Pisidium* sp. Other taxa included the water cricket *Velia caprai* and a specimen of the biting midge Ceratopogonidae.

4.5.13 A fish population was also supported as unidentified fish fry were found within the sample as by-catch.

4.5.14 Autumn abundances were similar to spring. The freshwater shrimp *G. pulex/fossarum* agg. totalled 42.2% of the specimens identified, with further

totals of 16.3% and 15.9% for Oligochaeta and non-biting midges (Tanypodinae, Orthocladiinae and Tanytarsini) respectively. Three species of the freshwater leeches, *Alboglossiphonia heteroclite, Helobdella stagnalis* and *Erpobdella octoculata,* were recorded. Remaining taxa comprised the pea mussel *Pisidium* sp., the seed shrimp Ostracoda, the water slater *A. aquaticus*, the olive mayfly Baetidae, the cased caddisfly larvae Limnephilidae, and drain fly larvae Psychodidae.

FB7

4.5.15 Within the spring community, 24.7% of total specimens were identified as the New Zealand mud snail, and a further 23.3% and 16.8% as non-biting midges (Tanypodinae and Orthocladiinae) and the riffle beetle *Elmis aeanea* respectively. The high abundance of aquatic snails, with the ramshorn snails *Planorbis* and *A. vortex*, freshwater shrimp *Gammarus pulex* and non-biting midges suggest slower flows with organic enrichment throughout much of the channel. However, some areas still had faster flows with the filter feeding black fly larvae Simulium sp., and riffle beetle *E. aeanea*, with legs adapted to grasping the substrate, present at the site. Other species identified included the mayfly Baetidae, the water cricket Velia sp., species of aquatic beetle *H. lineaticollis* and A. globulus, and craneflies Tipula sp.

4.5.16 Within the autumn community, over half of the identified specimens comprised two taxa: the New Zealand mud snail at 32.0% and the freshwater shrimp (*G. pulex* and *G. pulex/fossarum* agg.) at 25.7%. The autumn beetle assemblage present was limited to two taxa of Elimidae, with *Oulimnius* sp. and *E. aenea*. Organic enrichment persisted into autumn with the presence of the tolerant taxa Oligochaeta worms, pea mussels *Pisidium* sp., the ramshorn snail *A. vortex*, the freshwater leech *G. complanata*, the water slater *P. meridianus* and the non-biting midges Orthocladiinae and Prodiamesinae. Other taxa identified included the flatworm *P. nigra/tenuis*, the olive mayfly *Baetis scambus*, hairy-eyed cranefly larvae *Dicranota sp.* and the cased caddisfly larvae Limnephilidae.

FB8

4.5.17 Spring community was dominated by non-biting midges (Tanypodinae, Orthocladiinae, Tanytarsini and Prodiamesinae) and crustaceans (*G. pulex/fossarum, A. aquaticus* and *P. meridianus*) comprising 37.9% and 35.3% of identified specimens identified. Three species of freshwater leech, *G. complanata, H. stagnalis* and *Erpobdella octoculata* were present within the sample most likely due to the high abundance of prey taxa: Chironomidae and freshwater Oligochaeta worms. Several species of aquatic beetle were present, Dytiscidae, *Helophorus obserris/flavipus, Helophorus dorsalis* and *A. globulus*. Presence of specimens of mayfly Leptophlebiidae and Simuliidae are suggestive of portions of faster flowing water conditions for oxygenation and filter feeding behaviours respectively. Other species recorded included the New Zealand mud snail, water cricket Velia sp., caddisfly *L. lunatus*, drain flies Psychodidae, biting midges Ceratopogonidae and mosquitos Culicidae.

4.5.18 The autumn community continued to be dominated by crustaceans, water slaters *A. aquaticus* and *P. meridianus* totalled 41.8% of the specimens, with a further 21.9% comprised of Oligochaeta worms. High abundance of species tolerant to enrichment and material deposition including the New Zealand mud snail, freshwater leeches (*G. complanata, H. stagnalis* and *E. octoculata*) and non-biting midges (Tanypodinae and Orthocladiinae). Areas of still and near-

stagnant water are evidenced by the presence of mosquito larvae Culicidae and the seed shrimp Ostracoda. Remaining taxa comprised the cased caddisfly larvae *Glyphotaelius pellucidus* and *Micropterna lateralis*.

ESN12

4.5.19 The spring community was dominated by water slaters (*P. meridianus* and *A. aquaticus*) and the aquatic snail *A. balthica*, totalling 26.2% and 35.1% of identified specimens respectively. An additional 23.1% of specimens comprised the non-biting midges Tanypodinae, Chironomini, Tanytarsini and Prodiamesinae. Species in the spring sample with similar habitat preferences included pea mussels Pisdium sp. and freshwater Oligochaeta worms. Other taxa included the flatworm Polycelis sp., the non-native but non-invasive freshwater amphipod 'shrimp' *Crangonyx floridanus/pseudogracilis*, the mayfly *Cloeon dipterum*, drain fly larvae Psychodidae and biting midge larvae Ceratopogonidae. The water flea Cladocera was also present within the sample which evidences areas of quiescent water for proliferation of this taxon.

4.5.20 During autumn macroinvertebrate surveys the watercourse was dry and a sample could not be taken.

4.6 Aquatic macroinvertebrate indices and WFD classification

4.6.1 Based on the criteria outlined in Paragraph 3.4.5, Community Conservation Index (CCI), Whalley, Hawkes, Paisley & Trigg (WHPT) Average Score Per Taxon (ASPT) and Number of scoring taxa (NTAXA), LIFE and PSI species values for each survey Reach are detailed in Table 4.2.

Table 4.2 Macroinvertebrate index scores for Tillbridge watercourses

Index	ESN1*	ESN2		ESN3		FB4		FB5		FB7		FB8		ESN12*
	Spring	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring
NTAXA (WHPT)	16	17	7	14	9	17	10	16	12	20	13	16	8	10
ASPT (WHPT)	4.12	3.99	3.61	3.99	4.10	3.90	3.50	4.10	3.80	4.75	4.14	4.06	2.94	2.98
CCI Score	1.09	4.09	1.00 †	1.00†	5.00 †	3.00 †	4.80 †	1.11 †	5.14 †	3.00	4.67 †	12.60	4.88 †	4.50 †
CCI Score - interpretation	Low conservation value	Low conservation value	Low conservation value †	Low conservation value †	Moderate conservation value †	Low conservation value †	Low conservation value †	Low conservation value †	Moderate conservation value †	Low conservation value	Low conservation value †	Fairly high conservation value	Low conservation value †	Low conservation value †
LIFE score (species)	6.23	5.55	6.00 ††	5.45 ††	5.86 ††	6.70	6.57 ††	5.58 ††	5.67 ††	6.75	7.27	6.25 ††	5.33 ††	5.67 ††
LIFE score (species) – interpretation	Low sensitivity to reduced flows	Low sensitivity to reduced flows	Low sensitivity to reduced flows ††	Low sensitivity to reduced flows ††	Low sensitivity to reduced flows ††	Moderate sensitivity to reduced flows	Moderate sensitivity to reduced flows ††	Low sensitivity to reduced flows ††	Low sensitivity to reduced flows ††	Moderate sensitivity to reduced flows	High sensitivity to reduced flows	Low sensitivity to reduced flows ††	Low sensitivity to reduced flows ††	Low sensitivity to reduced flows ††
PSI score (species)	7.69	3.85	25.00 ††	4.17 ††	30.77 ††	40.74	31.82 ††	4.35	13.04 ††	33.33	41.67	0.00	8.33 ††	9.52 ††
PSI score (species)	Heavily sedimented	Heavily sedimented	Sedimented ††	Heavily sedimented ††	Sedimented ††	Moderately sedimented	Sedimented ††	Heavily sedimented	Heavily sedimented ††	Sedimented	Moderately sedimented	Heavily sedimented	Heavily sedimented ††	Heavily sedimented ††

'*' Spring sample completed only due to dry watercourse during autumn surveys
'†' Lack of scoring species within sample which may have artificially inflated score
'††' Lack of scoring species within sample and family score was used for a more representative value of sample site

4.6.2 The CCI scores for spring samples ranged from 1.0 at ESN2 and ESN3 to 12.60 at FB8. All samples exhibited CCI scores of Low conservation value, with the exceptions of ESN3 in spring and FB5 in autumn which received Moderate conservation values, and Fairly high conservation value at FB8 in spring. Spring conservation values tended to be lower than the autumn scores, as would be expected, although increases from spring to autumn were noted at ESN2 and FB8.

4.6.3 All taxa identified had a conservation value that was Occasional (species which occur in up to 10 % of all samples from similar habitats) or lower. The only exception was a single specimen of the Nationally scarce aquatic beetle *Helophorus dorsalis*, with a conservation score of 7, which was identified within the spring sample at FB8. Whilst no protected species were identified within the samples, the non-native but non-invasive New Zealand mud snail was recorded at all survey Reaches except for ESN2 and ESN12. Furthermore, the non-native but non-invasive freshwater shrimp *C. pseudogracilis/floridanus* was also recorded during one season at ESN12 in spring. There are no statutory constraints due to the presence of these species.

4.6.4 Of all taxa communities, FB8 spring received the lowest recorded LIFE score of 5.333, indicating Low sensitivity to reduced flows, whilst FB7 in autumn received the highest LIFE score (7.27) indicating High sensitivity to reduced flows. All other watercourses also attained LIFE scores exhibiting Low sensitivity to reduced flows except for two watercourses. At FB4, both seasons were of Moderate sensitivity to reduced flows, while FB7 was classified as Moderate sensitivity to reduced flows with LIFE 6.75 in spring to High sensitivity to reduced flows in autumn.

4.6.5 PSI scores in spring ranged from 0.00 for FB8 to 41.67 at FB7. These scores resulted in interpretations of Heavily sedimented for all Reaches except FB4 and FB7, which differed in interpretation classes. PSI scores were generally higher in autumn compared to the relative scores in spring, indicating less fine sediment present in the Reaches. This was evident within ESN2 and ESN3 where in autumn, interpretation class improved to Sedimented from Heavily sedimented in spring. The only exception to this was FB4 which decreased in PSI score from Moderately Sedimented in spring to Sedimented in autumn. The watercourse at FB8 was the least sedimented within the project, attaining scores equivalent to Moderately sedimented (PSI 33.33) in spring, to a Sedimented aquatic environment (PSI 41.67) in autumn.

4.6.6 All watercourses attained biological water quality ASPT (WHPT) interpretation of Very Poor, Heavily polluted across both seasons of surveys. Spring ASPT (WHPT) scores ranged from 2.98 at ESN12 to 4.75 at FB7, whilst NTAXA (WHPT) scores ranged from 14 at ESN3 to 20 at FB7. During autumn, ASPT (WHPT) scores were slightly lower and ranged from 2.94 at FB8 to 4.14 at FB7. Autumn NTAXA (WHPT) scores were considerably lower than spring and ranged from 7 at ESN2 to 13 at FB7. The lower ASPT scores of autumn evidence higher water quality pressure while lower NTAXA suggests increased pressures on taxa communities from habitat modification and decreased complexity present toward the end of the year.

4.7 Aquatic macrophyte survey results

4.7.1 The full aquatic macrophyte taxa list can be found in Appendix G. A cross-reference with the JNCC Taxon Designations list confirmed that none of the macrophyte taxa identified during the surveys were protected or notable. Additionally, no INNS were recorded in surveyed watercourses/ditches (refer to pond section where INNS were recorded).

4.7.2 No INNS, notable, or protected aquatic macrophyte species were recorded during the surveys.

ESN1

4.7.3 No macrophytes were found during surveys at ESN1 as the agricultural ditch was dry with some terrestrial encroachment (Plate 8). The dry ditch was less than 1 m and was less than 0.25 cm deep. Substrate was comprised of earth with a cover of terrestrial grasses and herbs with 100% dense shading over the entire channel.

Plate 8. Macrophyte survey Reach at ESN1 looking upstream

ESN2

4.7.4 No macrophytes were present due to dense shading by hawthorn overhanging the left bank (Plate 9). The wet ditch was approximately 2 m with an average water depth of 30 cm. Substrate was comprised of silt/clay with dense layer of dead Hawthorne leaves over the substrate along the entire channel. Smothering of the substrate and dense shading had likely suppressed aquatic macrophyte growth.

Plate 9. Macrophyte survey Reach ESN2 downstream towards Yawthorpe Beck

ESN3

4.7.5 The watercourse at ESN3 had the lowest macrophyte cover of channels with macrophyte taxa present. The wet ditch was approximately 2 m with an average water depth of 20 cm (Plate 10). Channel substrate was comprised of silt/clay with 80% run habitat and some slack waters. Identified taxa included watercress *Rorippa nasturtium-aquaticum* agg., reed canary-grass *Phalaris arundinacea* and slender tufted-sedge *Carex acuta,* totalling 10% cover of the channel.

Plate 10. Macrophyte survey Reach ESN3 looking upstream

FB4

4.7.6 An intermediate cover of macrophytes was recorded at FB4 during autumn surveys (Plate 11). The wet ditch was approximately 2 m wide with an average wetted depth of 15 cm and substrate composition of slit. The run habitat was covered in dense shading across over 80% of the channel. One taxon, reed canary grass, was identified and covered 30% of the total channel despite the higher level of shading of the channel.

Plate 11. Macrophyte survey Reach FB4 looking downstream towards culvert

FB5

4.7.7 Macrophyte community was limited to one species of riparian macrophyte and likely suppressed by the broken shading across the entire left bank and a

further 80% from the right bank (Plate 12). The average width of the wetted channel was 75 cm with an average depth of 15 cm. Substrate was entirely silt/clay with run habitat across 70% of the channel and some slack waters. The identified taxon, reed canary grass, covered a total of 20% of the channel with an additional cover of 1% of the algae aggregate blanketweed *Cladophora glomerata/Rhizoclonium hieroglyphicum.*

Plate 12. Macrophyte survey Reach FB5 downstream from confluence of two ditches

FB7

4.7.8 Macrophyte community was the most diverse of all surveyed Reaches. No shading was recorded across more than 90% of both banks (Plate 13). The wetted width was 2 m and 20 cm deep on average, over a substrate of 15% pebbles gravel, 5% cobbles and the remainder silt. A run habitat was present along the entire survey area. Macrophyte taxa included fool's watercress, reed canary grass, and watercress, all totalling 50% of channel cover. The filamentous alga aggregate *C. glomerata/R. hieroglyphicum* covered an additional 0.1% cover.

Plate 13. Macrophyte survey Reach FB7 looking upstream

FB8

4.7.9 FB8 had a similarly high macrophyte cover of 50% of the total channel (Plate 14). Channel shading was limited, with less than 30% broken shading across

each bank. The silt/clay substrate was submerged by a run of water 1.5 m wide by 15 cm deep on average. Macrophyte taxa identified included fool's watercress and reed canary grass, with an additional cover of less than 0.1% by the filamentous algae aggregate *C. glomerata/R. hieroglyphicum.*

Plate 14. Macrophyte survey Reach FB8 looking downstream

ESN12

4.7.10 No macrophytes were found as the agricultural ditch was predominantly dry with occasional pools less than 2 cm deep (Plate 15). The predominantly dry ditch was less than 1 m and was less than 0.25 cm deep. Substrate was comprised of silt/clay with a dense cover of leaves from overhanging trees and some terrestrial encroachment from grasses and herbs, with 100% dense shading over the entire channel.

Plate 15. Macrophyte survey Reach ESN12 looking downstream

Aquatic Macrophyte WFD Indices

4.7.11 Based on the criteria outlined in Paragraph 3.5.4, RMNI, NTAXA, NFG and cover of filamentous green algae (ALG), observed and predicted scores for

each surveyed watercourse within the project are detailed in Table 4.3. The table also includes the overall Ecological Quality Ratio (EQR) and WFD macrophyte status for each surveyed watercourse.

Table 4.3 Tillbridge macrophyte metrics and WFD classification

Indices		ESN1	ESN2	ESN3	FB4	FB5	FB7	FB8	ESN12
River macrophyte nutrient index (RMNI)	Observed	0	0	7.64	7.52	7.93	7.99	7.86	0
	Predicted	7.15	7.37	6.69	6.79	6.58	7.20	6.84	6.51
Number of macrophyte taxa (NTAXA)	Observed	0	0	0	0	1	2	2	0
	Predicted	9.19	9.74	7.65	7.44	6.68	9.54	7.29	6.53
Number of functional groups (NFG)	Observed	0	0	0	0	1	2	2	1
	Predicted	5.84	6.14	4.96	4.84	4.40	6.03	4.75	4.31
Cover of filamentous green algae (ALG)	-	0	0	0	0	0.50	0.50	0.05	0
Overall Ecological Quality Ratio (EQR)	-	-	-	-	-	0.33	0.44	0.43	-
WFD Classification Category	-	Unclassifiable	Unclassifiable	Unclassifiable	Unclassifiable	Poor	Moderate	Moderate	Unclassifiable

4.7.12 The EQR of 0.44 and 0.43 at FB7 and FB8 respectively corresponds to a Moderate WFD status, signifying two watercourses are impacted by artificial modification to morphological conditions and/or eutrophication within the channels. A low EQR of 0.33 at FB5 indicated a Poor WFD status, suggesting the channel has been subject to higher levels of modification and eutrophication than the previous two watercourses. In contrast, the EQRs of ESN1, ESN2, ESN3, FB4 and ESN12 have no value equating to an Unclassifiable WFD status due to a lack of scoring macrophyte taxa present within the watercourses.

4.7.13 The minimum requirement for LEAFPACS2 classification is three scoring macrophyte taxa. It should therefore be noted that FB5 only had one scoring macrophyte taxa, while FB7 and FB8 had two scoring taxa, all lacking the base requirement. Alkalinity data should also be obtained from monthly analysis of samples from each over a period of at least one year, whereas the results are based on an average Alkalinity collected from two sample during both survey seasons. Therefore, macrophyte classifications presented here based on only two alkalinity measurements represent point-in-time classifications and could not be used for WFD classification. Consequently, these results should be treated with caution, although they do provide appropriate baseline conditions to inform impact assessment, WFD assessment, and mitigation.

4.8 Pond PSYM survey results

4.8.1 A full list of macroinvertebrate taxa can be found in Appendix F, and a full list of macrophyte taxa present at each pond can be found in Appendix G.

Pond 15

4.8.2 Pond 15 was approximately 3,720m^2 in area, with 40% shading and an emergent plant cover of 2%. The substrate of the pond was a clay/silt composition. This was identified as a U-shaped moat with a small

embankment, stocked with Carp (Cyprinidae) for recreational fishing. No inflow to the pond was found during the survey and no evidence of margin grazing was recorded within the vicinity of the pond.

4.8.3 The macrophyte community at Pond 15 was comprised of nine species of emergent plant: pendulous sedge *Carex pendula,* great willowherb *Epilobium hirsutum*, yellow flag *Iris pseudacorus*, hard rush *Juncus inflexus*, water pepper *Persicaria hydropiper*, common figwort *Scrophularia auriculata*, branched bur-reed *Sparganium erectum*, great reedmace Typha *latifolia* and brooklime *Veronica beccabunga.* Two species of floating-leaved plants, duckweed *Lemna minor* and yellow water lily *Nuphar lutea* were also present on the pond. No submerged taxa were recorded. The Trophic ranking score for Pond 15 was 9.08 and the taxa *N. lutea* was identified as uncommon with a rarity score of 2.

4.8.4 The community at Pond 15 was mainly comprised of pollution tolerant taxa with a preference to silted, organic rich substrates, including high abundances of the truefly larvae Chrionomidae, waterslater Asellidae, Ramshorn snails Planorbidae and freshwater Oligochaeta worms. Other taxa identified within the sample included flatworms (Dendrocoelidae and Dugesiidae), pea mussels Sphaeriidae, two predatory leech families (Glossiphoniidae and Erpobdellidae) of fly larvae and worms, mayflies Baetidae and alderfly Sialidae. Two families of true bug was also identified with the water scorpion Nepidae and a high abundance of lesser water boatman Corixidae juveniles. Also present were two families of aquatic beetle, including Haliplidae and Hydrophilidae. The non-native amphipod *Crangonyx pseudogracillis/floridanus* was present. The presence of water quality sensitive taxa the damselfly family Coenagrionidae and taxa of the cased caddisfly family Leptoceridae exhibit areas of higher quality habitat present within the pond, although much of the base was heavily sedimented.

Pond 17

4.8.5 Pond 17 was approximately 314m^2 in area, with 50% shading from overhanging vegetation and an emergent plant cover of 5%. The substrate of the pond was a clay/silt composition. This was identified as a rectangular agricultural drainage pond. No inflow to the pond was found during the survey and no margin grazing was recorded within the vicinity of the pond.

4.8.6 The macrophyte community at Pond 17 was comprised of two species of emergent plant: great willowherb and hard rush. The submerged macrophyte curled pondweed *Potamogeton crispus* and the floating leaved white water lily Nymphaea alba were also identified at the pond. The Trophic ranking score for this pond was 8.35 and had one uncommon species *N. alba* with a rarity score of 2.

4.8.7 Within the macroinvertebrate community at Pond 17, pollution tolerant and sediment dwelling species comprised high proportions of the identified specimens. The non-biting midge larvae Chironomidae, water slater Asellidae, freshwater leeches Erpobdellidae and Glossiphonidae, freshwater Oligochaeta worms and the two snail families (Hydrobiidae and Planorbidae) totalled 31.9% of identified specimens. A further 25.3% was comprised of Copepoda, water fleas Cladocera and mosquito larvae Culicidae, which evidence areas of still and possibly stagnant water in the pond allowing

proliferation of these taxa. Areas of more beneficial habitat were present within Pond 17 as exhibited by the presence of the sensitive taxa dragonfly larvae Aeshnidae and the damselfly larvae Coenagriidae. Other taxa identified from Pond 17 included the lesser water boatman Corixidae, taxa from three aquatic beetle families (Dytiscidae, Hydrophilidae and Helophoridae), mayflies Baetidae, and the caseless caddisfly family Polycentropidae. The non-native *Crangonyx pseudogracillis/floridanus* was present within the sample and no other notable or protected species were identified.

Ponds 23, 24 and 25

4.8.8 Due to their close proximity to each other and similar nature and connectivity, the following results were amalgamated under one PSYM assessment. The three ponds varied in area with Pond 23, Pond 24, and Pond 25 totalling approximately 7,800 m^2, 8300 m^2, and 5,100 m^2 respectively. Less than 1% shading was recorded from overhanging vegetation and total emergent plant cover was 15%. The substrate of the ponds was predominantly clay/silt. The three ponds were recorded as being uniform rectangular man-made (likely irrigation) reservoirs with steep artificial banks. No inflow to the ponds was found during the survey.

4.8.9 The macrophyte community at Ponds 23, 24 and 25 consisted of eleven aquatic macrophyte species. Emergent and marginal species had the highest taxon cover and were recorded as great willowherb, soft rush, hard rush, gypsywort, and water pepper, with three submergent species rigid hornwort *Ceratophyllum demersum,* stonewort *Chara* sp. and curled pondweed. The free-floating species common duckweed *Lemna minor* was also identified. The Trophic ranking score for the ponds was 9.38, with two uncommon species *C. demersum* and *Chara* sp., both with a rarity score of 2.

4.8.10 Blue green algae, New Zealand pigmyweed *Crassula helmsii,* and Nuttall's waterweed *Elodea nuttallii* were present in all three ponds. Both *C. helmsii* and *E. nuttallii* are listed in both Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) (Ref. 7-7) and the Invasive Alien Species (Enforcement and Permitting) Order 2019. Taken together, the legislation referenced makes it an offence to plant, or otherwise cause to grow (including allowing to spread), listed plant species in the wild. If transported off site, there is a duty of care with regards to the disposal of any part of the plant that may facilitate establishment in the wild and cause environmental harm (as per the Environmental Protection Act 1990 (Ref. 7-23). The legislation also makes in an offense to release, or allow to escape, listed species (or species not ordinarily resident in and is not a regular visitor to Great Britain in a wild state) into the wild.

4.8.11 A macroinvertebrate sample was taken from Pond 23 (the closest to the Principal Site Boundary), the results of which were applied to the grouping for PSYM analysis. The community at Pond 23 had a high abundance of taxa preferring quiescent conditions, with the water flea Cladocera and the seed shrimp Ostracoda totalling 59.7% of identified specimens. The remaining taxa included freshwater Oligochaeta worms, non-biting midge larvae Chrionomidae and their predatory taxa Leeches (Glossiphoniidae and Erpobdellidae), in addition to two families of freshwater snails (Lymnaeidae and Planorbidae), totalling 11.1% of the community. Present within the

macroinvertebrate community were some pollution sensitive species of damselflies Coenagriidae larvae, two families of dragonflies (Aeshnidae and Libellulidae) and the cased caddisfly family Leptoceridae. Other taxa included three families of freshwater beetle (Haliplidae, Dytiscidae and Elmidae), mayflies (Baetidae, Caenidae) and several taxa of true bugs (Notonectidae, Pleidae, Corixidae). WHPT indices were calculated for the respective water bodies (Table 4.4).

Table 4.4 Macroinvertebrate index scores for Pond PSYM sites

Site ID	Index		
	WHPT score	NTAXA (WHPT)	ASPT (WHPT)
Pond 15	59.80	19	3.15
Pond 17	63.00	16	3.94
Ponds 23, 24 and 25	77.80	20	3.89

4.8.12 The resident aquatic macroinvertebrate community across all ponds indicate Poor biological water quality, based on WHPT ASPT index. The habitat restrictions within the current water bodies are likely to have suppressed the WHPT indices due to the high degree of artificial structure and impounded nature of the ponds. Limited inflow, except from farm drainage, is also likely to lower the biological quality of these ponds through increased organic enrichment.

4.8.13 A full PYSM analysis was performed on the five ponds (Table 4.5).

Table 4.5 PSYM analysis outcomes (FHT)

Index category	Pond 15	Pond 17	Ponds 23, 24 and 25
No. of submerged + marginal plant species	9	3	10
No. of uncommon plant species	1	1	2
Trophic Ranking Score (TRS)	9.08	8.35	9.38
ASPT (BMWP)	4.3	4.3	4.9
Odonata + Megaloptera (OM) families	2	2	3
Coleoptera families	2	2	3
PSYM quality category	**Poor**	**Moderate**	**Moderate**
Priority Pond	**No**	**No**	**No**
Index of Biotic integrity (%)	**50**	**56**	**72**

4.8.14 PSYM results indicated variation between the three pond groups. Pond 15 was classified within the Poor quality category, while Pond 17 and the amalgamation of Ponds 23, 24, and 25 were of Moderate quality. None of the

ponds were Priority Ponds. The Poor to Moderate quality of all assessed ponds within the full PSYM survey is due to the high siltation, artificial banks, periodic drying, and general lack of habitat variation present.

4.8.15 Pond 17 supported the lowest number of submerged and marginal plant species with only three identified during the PSYM survey; Ponds 15 and Ponds 23/24/25 supported nine and ten macrophyte taxa respectively. Ponds 15 and 17 supported one uncommon plant species, while Ponds 23, 24 and 25 contained the two uncommon taxa *Chara* sp. and *C. demersum*. In addition to other aquatic macrophyte species identified during the surveys, these provide beneficial habitat for the resident macroinvertebrate community of the ponds.

5. Discussion and Evaluation

5.1.1 The desk study highlighted current issues facing the associated catchments that are nutrient input from agricultural, water treatment and industrial action, decreased dissolved oxygen and other priority hazardous chemical substances (established from WFD classifications). Heavy modification of watercourses for agricultural drainage was also highlighted as an issue for habitat quality for invertebrates. The Poor to Moderate ecological quality of all water bodies suggest the proposed development is unlikely to cause lasting impacts to the wider WFD catchments compared to current impacts. However, as a result there are opportunities to seek appropriate mitigation and enhancement, for example through Biodiversity Net Gain (BNG) assessment, to improve habitat and water quality to meet BNG objectives for the Scheme.

5.1.2 The desk study identified records of the protected species European eel *Anguilla anguilla*, which was found in 2013 and 2014 within the vicinity of the proposed Cable Route Corridor. This species is afforded protection under the Eels (England and Wales) Regulations 2009, which places a requirement upon developers and abstracters to ensure continued eel passage and to prevent eel entrainment. In addition, spined loach *Cobitis taenia* was present within the same water body; this species is listed on and Annex II of the European Commission Habitats and Species Directive (3) and Appendix III of the Bern Convention. It is relatively widespread in central and eastern England. There were no other notable species found within 2 km of the Principal Site.

5.1.3 The Environment Agency Data Explorer produced records in the River Trent within 60km of the Scheme of the following notable and/or protected fish species: Atlantic salmon *Salmo salar*, brown trout *Salmo trutta*, lamprey spp. Petromyzontidae, spined loach *Cobitis taenia* and bullhead *Cottus gobio*. Though these records did not fall within the drains and ditches assessed in the present report, migratory species such as salmon, sea trout, European eel, and lamprey will be present within the River Trent at the crossing point of the Cable Route Corridor, and there is potential for these and other fish species to utilise water bodies connected to the River Trent. The potential impacts to these species will be assessed in detail within the ES chapter.

5.1.4 Aquatic macroinvertebrate surveys revealed that watercourses within the three WFD catchments within the Principal Site are all subject to habitat diversity and water quality pressures throughout. Current ASPT (WHPT) scores suggest that all surveyed watercourses suffer from Very Poor, Heavily Polluted water quality with high levels of siltation. In line with these results, the aquatic macroinvertebrate community of all surveyed watercourses generally had a Low conservation value, except for a couple of survey sites. The Nationally Scarce aquatic beetle *Helophorus dorsalis* was found within the site, and although it has legislative designation, the presence of this species indicates suitable habitat conditions, and it contributes to an overall diverse assemblage of macroinvertebrates typical of slow-flowing to standing water conditions. This assemblage includes in particular water beetles and Odonata (dragonflies and damselflies).

5.1.5 The presence of the non-native but non-invasive New Zealand mud snail and freshwater amphipod 'shrimp' *Crangonyx pseudogracillis/floridanus* constituted the only notable macroinvertebrate records. As these species are widespread and not currently listed in UK legislation, there are no statutory constraints to the spread of either species. Additionally, no protected species were recorded during these surveys.

5.1.6 Redistribution of rainfall precipitation from solar panel arrays could reduce the impacts of topsoil erosion and improve plant growth below. This should be considered to reduce input of topsoil and nutrients into local watercourses, especially when land is no longer managed for arable agriculture. Increased surface runoff on larger solar sites could lead to higher rates of soil erosion, especially if interspace and site ground is bare, which warrants additional consideration as impacts to flow and sedimentation were present at all surveyed water bodies. This was demonstrated by PSI and LIFE scores reflecting heavily sedimented to sedimented conditions and generally low to moderate sensitivity to reduced flows throughout. The sole exception was the S5.1 in autumn with a community reflecting high sensitivity to reduced flows.

5.1.7 Macrophyte assemblages were highly suppressed, most likely due to high levels of shading from terrestrial herbs, scrub, and farmland hedgerows, together with regular dredging and weed cutting to support agricultural drainage. Terrestrial encroachment was present across the majority of watercourses, signifying prolonged periods of drying. Macrophyte assemblages were unclassifiable for WFD indices at most watercourses, except for FB5 which was designated as Poor, and both FB7 and FB8 as Moderate.

5.1.8 All five ponds assessed through PYSM survey were not Priority Ponds, with Pond 15 classed as having Poor biological quality and Ponds 17, 23, 24, and 25 classed as having Moderate biological quality. The resident macroinvertebrate communities were more diverse in the ponds compared to the watercourses within the project, although all taxa families were common. Intermediate shading around most surveyed ponds suppressed macrophyte assemblage growth, in combination with eutrophication likely as a result of agricultural drainage and runoff, and partial or complete intermittent drying.

5.1.9 Five species of macrophyte identified during pond macrophyte surveys was classed as uncommon by the freshwater habitat trust, slender tufted sedge *Carex acuta*, hornwort *Ceratophyllum demersum*, stonewort Chara sp., yellow water lily *Nuphar lutea*, and white water lily *Nymphaea alba*. All species are classed as Least Concern.

5.1.10 Pond macrophyte surveys identified the INNS species Nuttall's waterweed *Elodea nuttallii* and New Zealand pigmyweed *Crassula helmsii* within the study area. Both species are listed in Schedule 9 of the Wildlife and Countryside Act 1981 (as amended), and in the Invasive Alien Species (Enforcement and Permitting) Order 2019. The legislation referenced make sit an offence to plant, or otherwise cause to grow (including allowing to spread), listed plant species in the wild. If transported off site, there is a duty of care with regards to the disposal of any part of the plant that may facilitate establishment in the wild and cause environmental harm (as per the Environmental Protection Act 1990). The legislation also makes in an offense to release, or allow to escape,

listed species (or species not ordinarily resident in and is not a regular visitor to Great Britain in a wild state) into the wild.

6. Conclusions and Recommendations

6.1.1 The watercourses within the vicinity of the Principal Site Boundary and the Cable Route Corridor are subject to high levels of habitat and water quality pressures from existing industries, especially agriculture. This is exhibited within the results of the macroinvertebrate and macrophyte surveys. Current impacts on biological communities appear to be resultant of watercourse habitat and channel modification indicated by aquatic habitat walkover surveys from adjacent land use and rural management practices, also as indicated in the desk study.

6.1.2 Solar panels and any temporary or permanent infrastructure will be installed a minimum of 10 m away from the bank top of any water bodies (ponds, watercourses, or ditches) on site. This prevents any impacts of shading on these water bodies and is in accordance with Environment Agency flood risk guidance.

6.1.3 The use of best practice construction methods should be implemented during construction to avoid sediment runoff into surface waters.

6.1.4 A minimum of 10 m between watercourses to any spoil heaps created during construction should be employed and these should be either seeded or dampened to prevent runoff. The use of silt fencing is also recommended if construction is likely to result in runoff entering water bodies.

6.1.5 Due to the heavily modified nature of water bodies on the Principal Site, including their management for agricultural drainage, there are opportunities to enhance water bodies and riparian/marginal habitats, for example to support BNG objectives. For example, improving existing habitats through planting of aquatic macrophyte and riparian/marginal species, the removal of selected scrub to reduce shading, and removing existing sources of pollution, such as agricultural runoff and silt inputs. Reducing shading would increase light levels into the water bodies and subsequently improve macrophyte growth. Water quality could also be improved through planting selected macrophyte species, while also developing habitat complexity within the water bodies for aquatic species.

6.1.6 Due to the presence of European eel recorded locally in connected water bodies, there is the potential for this species to be present within the site in the network of watercourses and ditches. Therefore, any direct impacts to water bodies should give consideration for this, and other, fish species. Such impacts are likely to include open-trenching for watercourse crossings (cable connections etc.), culverting of water bodies for access or construction roads, and the extension of existing culverts to upgrade access roads. Such impacts should ensure to maintain connectivity along water bodies to allow eel passage and longitudinal connectivity for other aquatic species and may require fish rescues during construction where draw-down or over-pumping is required.

6.1.7 Best practice biosecurity measures should be implemented for works undertaken to or near water bodies, especially those where INNS are currently present, to prevent the risk of their spread in line with national and European legislation.

6.1.8 No further aquatic ecological investigations are required at this stage to inform the assessment of impacts to water bodies present within the Principal Site Boundary. The data presented within this report remain valid for a period of up to three years from the date of surveys, as per guidance on the age of ecological data, after which it may be necessary to repeat surveys.

7. References

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Ref 7-23 UK Government (1990). Environmental Protection Act 1990, c. 43. Available at: https://www.legislation.gov.uk/ukpga/1990/43/contents (accessed 17 June 2021).

Figure 1: Surveyed Water bodies

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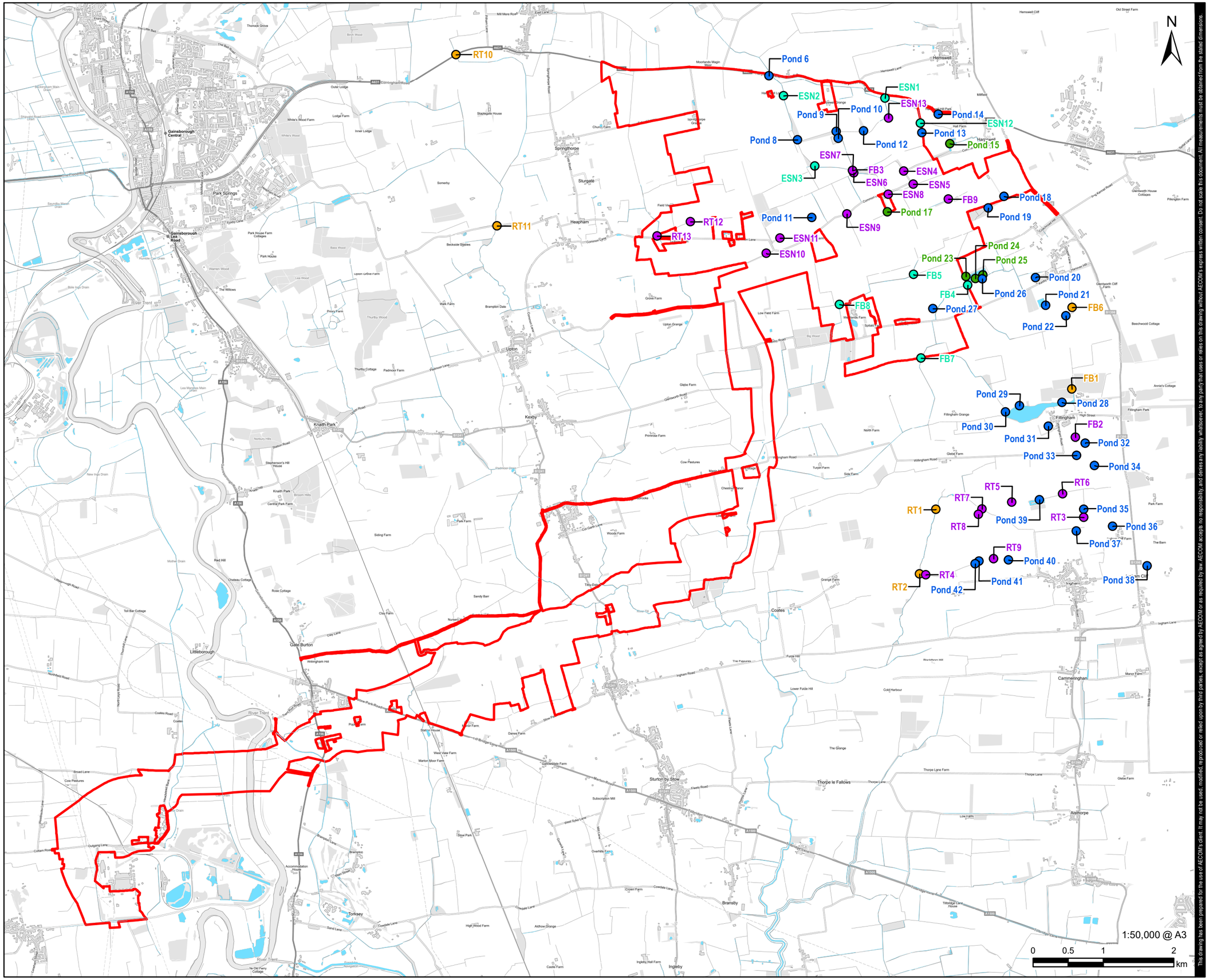

AECOM

PROJECT

Tillbridge Solar

CLIENT

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LEGEND

- Scheme Boundary
- Waterbody

Surveyed Waterbody

- Habitat Appraisals
- Habitat Appraisals and Spring Macroinvertebrate Sample
- Habitat Appraisals, Spring and Autumn Invertebrate Samples and Macrophyte Surveys

Pond

- Pond Surveyed
- Pond Surveyed and PSYM

NOTES

ISSUE PURPOSE

PEI Report

PROJECT NUMBER

60677969

FIGURE TITLE

Surveyed Waterbodies

FIGURE NUMBER

Figure 1

Appendix A Aquatic Walkover Survey

Habitat appraisal surveys were completed for the remaining watercourses although they are not included in the full set of macroinvertebrate surveys due to their suitability for further surveys and reduction in Scheme Boundary.

FB3

This Reach consisted of steep banks into an agricultural ditch, covered by simple herb and rank vegetation on the right bank and complex hedgerow vegetation on the left bank. The terrestrial vegetation provided light shading along the course of the channel. The average width of the dry channel was 0.5 m with a dominant earth substrate producing a solid bed.

Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the channel although high levels of terrestrial encroachment (grasses and herbs) were recorded along the entire length channel. Subsequently no fish spawning habitat or notable species were present. No evidence of pollution was documented.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

ESN4

This Reach consisted of very steep banks into an agricultural ditch, covered by simple herb and rank vegetation on the right bank and complex vegetation on the left bank. The present terrestrial vegetation provided heavy shading along the course of the channel. The average width of the dry channel was 1 m with a dominant earth substrate producing a solid bed.

Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the channel although high levels of terrestrial encroachment (grasses, rank vegetation and herbs) were recorded within 90% of the channel. Subsequently no fish spawning habitat or notable species were present. No evidence of pollution was documented.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

ESN5

This Reach consisted of steep banks into an agricultural ditch, covered by simple grasses, herb and rank vegetation on both banks. The vegetation provided light

shading along the course of the ditch. The average width of the dry channel was 0.75 m with a dominant earth substrate, with sporadic patches of gravel, producing a solid bed.

Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the channel with high levels of terrestrial encroachment (grasses and herbs) covered 95% of the channel. No fish spawning habitat or notable species were present in the Reach. No evidence of pollution was documented.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

ESN6

This Reach consisted of steep banks into an agricultural ditch, covered by simple grasses and herb vegetation on both banks. This vegetation provided light shading along the course of the channel. The average width of the dry channel was 0.5 m with a dominant earth substrate producing a solid bed, with patches of gravel/pebble.

Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the channel although high levels of terrestrial encroachment (grasses and *Epilobium* sp.) were recorded covering 95% of the channel. Subsequently no fish spawning habitat or notable species were present. No evidence of pollution was documented. Recent bank top vegetation cutting was recorded on the site, although no mowing of bankside vegetation was observed.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, over 2 m wide, within the wider landscape.

The surveyed Reach was dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

ESN7

This Reach consisted of steep banks into an agricultural ditch, covered by simple herb and rank vegetation on the right bank and complex hedgerow vegetation on the left bank. The terrestrial vegetation provided moderate shading along the course of the channel. The average width of the ditch was 1 m and the ditch was too deep to confirm the substrate composition. The ditch was assumed to be dry as no water was visible upstream or downstream of the survey Reach.

Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the ditch and high levels of terrestrial encroachment from grasses and herbs were recorded in 95% of the channel. No evidence of pollution was documented.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

ESN8

This Reach consisted of steep banks into an agricultural ditch, covered in simple herb and rank vegetation on the right bank and complex hedgerow vegetation on the left bank. Light shading was provided along the course of the channel by the terrestrial vegetation. The average width of the dry channel was 0.75 m with a dominant earth substrate producing a solid bed.

Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the channel although high levels of terrestrial encroachment from rank vegetation was present in up to 70% of the ditch. Subsequently no fish spawning habitat or notable species were present. No evidence of pollution was documented. Artificial modification of channel from a culvert upstream of the survey Reach was recorded.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

ESN9

This Reach consisted of steep banks into an agricultural ditch, covered by simple herb and rank vegetation on both banks. Moderate shading was present along the course of the channel from high levels of vegetation overhanging the ditch. The average width of the dry channel was 0.75 m with a dominant earth substrate producing a solid bed.

Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were present within the channel although low in coverage. *Apium* sp. was recorded along 10% of the Reach, with the terrestrial encroachment from grasses and *Epilobium* sp. within the margins. Subsequently no fish spawning habitat or notable species were present. No evidence of pollution was documented.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

ESN10

This Reach consisted of steep banks into an agricultural ditch, covered in simple herb and rank vegetation on the right bank and complex hedgerow vegetation on the left bank. The present terrestrial vegetation assemblage provided moderate shading along the course of the channel. The average width of the channel was 1 m.
Current vegetation growth did not permit access into the ditch and substrate composition could not be recorded. From the areas of channel visible through scrub growth, no flow of water could be observed, instead forming small pools. In-channel aquatic macrophytes were absent from the ditch, which was fully terrestrialised by scrub vegetation, with a high dominance of Brambles, was recorded.

Clear channel realignment and deepening was recorded from agricultural modification. No notable species were present at the survey Reach. No evidence of pollution was documented.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was inaccessible and almost dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

ESN11

This Reach consisted of steep banks into an agricultural ditch, covered by complex grasses, herb, rank and scrub vegetation on both banks. Heavy shading was present along the course of the channel. The average width of the dry channel was 1 m with a dominant earth substrate producing a solid bed.

Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the channel and high levels of terrestrial encroachment by grasses, scrub and *Epilobium* sp. were recorded in 95% of the channel. Subsequently no fish spawning habitat or notable species were present. No evidence of pollution was documented. Recent bank top vegetation cutting was recorded on the site, although no mowing of bankside vegetation was observed.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

RT12

This Reach could not be accessed at the time of appraisal due to high numbers of cattle and calves within the field adjacent to the ditch. This Reach should be considered for habitat and biological surveys within future surveys.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

RT13

This Reach consisted of steep, almost vertical, banks into an agricultural ditch, covered by simple herb and rank vegetation on the right bank and complex hedgerow vegetation on the left bank. Moderate to heavy shading was present along the course of the channel. The average width of the dry channel could not be assessed due to dense vegetation throughout the ditch and unsafe access from the banks. Some pools were observed through the terrestrial encroachment and were matted in filamentous algae.

Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes could not be accurately assessed, although due to the level of terrestrial encroachment (Grasses, herbs and scrub) and dry conditions, aquatic species are most likely absent. No notable species were present during the survey and no evidence of pollution was documented. The ditch was also culverted upstream of the survey Reach, for farm vehicle access across the ditch.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was drying up, with intermittent poor condition pools, at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

FB9

This Reach consisted of steep banks into an agricultural ditch, covered in simple herb and rank vegetation on both banks. The vegetation provided moderate shading along the course of the channel. The average width of the dry channel was 1 m with an earth substrate producing a solid bed. Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent from the channel although high levels of terrestrial encroachment from grasses and Epilobium sp. were recorded covering 80% of the channel. Subsequently no fish spawning habitat or notable species were present. No evidence of pollution was documented. Bank top vegetation also showed evidence of recent cutting.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

ESN13

This Reach consisted of steep banks into an agricultural ditch, covered in dense simple herb and rank vegetation on both banks. Terrestrial vegetation provided low to moderate shading along the course of the ditch. The average width of the dry channel was 1 m with a dominant earth substrate producing a solid bed, with minimal constituents of pebbles and gravel. Clear channel realignment and deepening was recorded from agricultural modification. In-channel aquatic macrophytes were absent and the ditch was covered entirely overgrown with terrestrial herb and rank vegetation.

No suitable fish spawning habitat was present as the ditch was dry. No notable species or evidence of pollution was documented.

The Reach was situated within tilled farmland and partial semi-improved grassland buffers around field margins, within the wider landscape.

The surveyed Reach was dry at the time of appraisal and is unlikely to change between survey seasons and will therefore not be considered for further habitat or biological surveys.

Table A1. Aquatic habitat appraisal and macroinvertebrate survey locations

Site ID	NGR	Habitat Appraisal Survey	Additional Macroinvertebrate Survey completed	Additional surveys required?
ESN1	SK 92149 90363	25/5/22	Y	Yes – Autumn macroinvertebrate
ESN2	SK 90705 90399	25/5/22	Y	Yes – Autumn macroinvertebrate
ESN3	SK 91147 89399	25/5/22	Y	Yes – Autumn macroinvertebrate
FB3	SK 91688 89337	26/5/22	Y	No – Autumn macroinvertebrate
FB4	SK 93325 87707	26/5/22	Y	Yes – Autumn macroinvertebrate
FB5	SK 92553 87857	26/5/22	Y	Yes – Autumn macroinvertebrate
FB7	SK 92662 86671	26/5/22	Y	Yes – Autumn macroinvertebrate
FB8	SK 91500 87431	26/5/22	Y	Yes – Autumn macroinvertebrate
ESN4	SK 92415 89327	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential
ESN5	SK 92550 89140	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential
ESN6	SK 91703 89303	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential
ESN7	SK 91688 89337	27/5/22	-	No – dry at time of survey with

Site ID	NGR	Habitat Appraisal Survey	Additional Macroinvertebrate Survey completed	Additional surveys required?
				conditions unlikely to change and low ecological potential
ESN8	SK 92195 88998	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential
ESN9	SK 91606 88719	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential
ESN10	SK 90461 88158	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential
ESN11	SK 90652 88375	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential
RT12	SK 89379 88607	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential
RT13	SK 88906 88404	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential
FB9	SK 93048 88928	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential
ESN12	SK 92653 90007	27/5/22	Y	Yes – Autumn macroinvertebrate
ESN13	SK 92200 90083	27/5/22	-	No – dry at time of survey with conditions unlikely to change and low ecological potential

Appendix B Community Conservation Index (CCI)

The Community Conservation Index allows a classification of the nature conservation value associated with a macroinvertebrate community. The CCI score for one sample is derived from individual Conservation Scores (CS), assigned to some species of aquatic macroinvertebrates and relating closely to the available published Red Data Books. Conservation Scores assigned to individual species vary from 1 to 10, as detailed on the Table B1 below. The derived CCI scores generally vary from 0 to > 20, as detailed in the Table B2 below. The Table B2 below provides a guide to interpreting CCI scores.

Table B1: Conservation Scores from the Community Conservation Index

Conservation Score	Relation to Red Data Books
10	RDB1 (Endangered)
9	RDB2 (Vulnerable)
8	RDB3 (Rare)
7	Notable (but not RDB status)
6	Regionally notable
5	Local
4	Occasional (species not in categories 10-5, which occur in up to 10% of all samples from similar habitats)
3	Frequent (species not in categories 10-5, which occur in up to >10-25% of all samples from similar habitats)
2	Common (species not in categories 10-5, which occur in up to >25-50% of all samples from similar habitats)
1	Very common (species not in categories 10-5, which occur in up to >50-100 % of all samples from similar habitats)

Table B2: General guide to CCI scores

CCI Score	Description	Interpretation
0 to 5.0	Reaches supporting only common species and/or community of low taxon richness	Low conservation value
> 5.0 to 10.0	Reaches supporting at least one species of restricted distribution and/or a community of moderate taxon richness	Moderate conservation value
> 10.0 to 15.0	Reaches supporting at least one uncommon species, or several species of restricted distribution and/or a community of high taxon richness	Fairly high conservation value
> 15.0 to 20.0	Reaches supporting several uncommon species, at least one of which may be nationally rare	High conservation value

CCI Score	Description	Interpretation
	and/or a community of high taxon richness	
> 20.0	Reaches supporting several rarities, including species of national importance and/or a community of very high taxon richness	Very high conservation value

Appendix C Lotic-Invertebrate Index of Flow Evaluation (LIFE)

The Lotic-Invertebrate Index for Flow Evaluation (LIFE) provides an assessment of the impact of variable flows on benthic macroinvertebrate communities. Under the assessment, individual species of aquatic macroinvertebrates are assigned to a flow group varying from I to VI, as detailed on the Table C1 below. The LIFE score for a macroinvertebrate sample is then derived (mean of individual scores) from individual species scores and abundances, as detailed on the Table C3 below. LIFE scores for a macroinvertebrate sample ranges from 1 to 12, where highest scores describe communities adapted to rapid flows.

Table C1: Flow groups used to derive LIFE scores

LIFE score Group	Description	Mean current velocity
I	Taxa primarily associated with rapid flows	Typically > 100 $cm.s^{-1}$
II	Taxa primarily associated with moderate to fast flows	Typically 20 to 100 $cm.s^{-1}$
III	Taxa primarily associated with slow or sluggish flows	Typically < 20 $cm.s^{-1}$
IV	Taxa primarily associated with (usually slow) and standing waters	
V	Taxa primarily associated with standing waters	
VI	Taxa frequently associated with drying or drought impacted sites	

Table C2: Abundance categories used to derive LIFE scores

Abundance category	Description
A	1 to 9
B	10 to 99
C	100 to 999
D	1000 to 9999
E	> 10000

Table C3: A guide to interpreting LIFE scores

Flow groups	Abundance categories			
	A	B	C	D/E
I	9	10	11	12
II	8	9	10	11
III	7	7	7	7
IV	6	5	4	3
V	5	4	3	2
VI	4	3	2	1

Appendix D Proportion of Sediment-sensitive Invertebrates (PSI)

The PSI index allows an assessment of the extent to which a water body is composed of, or covered by, fine sediments. Under this system, individual species of aquatic macroinvertebrates are assigned a Fine Sediment Sensitivity Rating (FSSR) as detailed in Table D1, and abundance rating based on LIFE scores as detailed in Table D2. The PSI score for the aquatic macroinvertebrate sample is then derived from the individual species scores and abundances, as detailed in Table D3. The PSI score corresponds to the percentage of fine sediment-sensitive taxa present in a sample and ranges from 0 to 100, with low scores corresponding to water bodies with high fine sediment cover.

Table D1: Fine Sediment Sensitivity Rating (FSSR) groups used to derive PSI scores

FSSR group	Description
A	Highly sensitive
B	Moderately insensitive
C	Moderately insensitive
D	Highly insensitive

Table D2: Abundance categories used to derive PSI scores

FSSR group	Abundance			
	1-9	**10-99**	**100-999**	**>999**
A	2	3	4	5
B	2	3	4	5
C	1	2	3	4
D	1	2	3	4

Table D3: Interpretation of PSI scores

PSI	Description
81-100	Minimally sedimented
61-80	Slightly sedimented
41-60	Moderately sedimented
21-40	Sedimented
0-20	Heavily sedimented

Appendix E Whalley, Hawkes, Paisley & Trigg (WHPT) Metric

There are approximately 4,000 species of aquatic macroinvertebrates in the British Isles. To simplify the analysis of the samples and the data we do not identify individual species but only the major types (taxa), mostly at the family taxonomic level. A key piece of information is the number of different taxa at a Reach. A fall in the number of taxa indicates ecological damage, including pollution (organic, toxic and physical pollution such as siltation, and damage to habitats or the river channel).

The WHPT scoring system is based upon the sensitivity of macroinvertebrate families to organic pollution. It replaces the Biological Monitoring Working Party (BMWP) system previously used in the UK.

The WHPT system assigns a numerical value to about 100 different taxa (known as the WHPT-scoring taxa) according to their sensitivity to organic pollution. In addition to the presence of macroinvertebrate taxa at a sampling Reach, as in the BMWP scoring system, the WHPT system also uses another type of information, this being the abundances of different scoring taxa.

Taxa abundances are classified in four categories (Class 1: 1 to 10 individuals, Class 2: 11 to 100 individuals, Class 3: 101 to 1,000 individuals, and Class 4: > 1,000 individuals). A score (Pressure Sensitivity Scores (PSs) is then assigned to each taxa, depending of the taxa sensitivity and abundances recorded.

The total WHPT score for a sample corresponds to the sum of PSs of scoring taxa recorded. The Average Score Per Taxon (ASPT) values are calculated as the Sum PSs divided by the number of scoring taxa (NTAXA). As such, three metrics are calculated:

- WHPT score
- NTAXA
- ASPT

Some animals are more susceptible to organic pollution than others, and the presence of sensitive species indicates good water quality. This fact is taken into account by the WHPT metrics.

The most useful way of summarising the biological data was found to be one that combined the number of taxa and the ASPT. The best quality is indicated by a diverse variety of taxa, especially those that are sensitive to pollution. Poorer quality is indicated by a smaller than expected number of taxa, particularly those that are sensitive to pollution. Organic pollution sometimes encourages an increased abundance of the few taxa that can tolerate it. However, maximum achievable values will vary between geological regions. For example, pristine lowland streams in East Anglia will always score lower than pristine Welsh mountain streams because they are unable to support many of the high-scoring taxa associated with fast flowing habitat. WHPT scores and ASPT for different types watercourse are dependent on the quality and diversity of habitat, natural water chemistry (associated with geology, distance from source etc.), altitude, gradient, time of year the sample was taken and other factors.

Appendix F Macroinvertebrate taxa list

Table F1. Spring macroinvertebrate taxa list

Family	Species	Conservation Score	ESN1	ESN2	ESN3	FB4	FB5	FB7	FB8	ESN12
Flatworms										
Planariidae	*Polycelis sp.*									7
Planariidae	*Polycelis nigra / tenuis*	**1**				1		12		
Dugesiidae	*Dugesia sp.*					3				
Snails										
Lymnaeidae	*Lymnaea stagnalis*	**1**			1					
Lymnaeidae	*Ampullaceana balthica*	**1**	368	8	21		1			278
Valvatidae	*Valvata piscinalis*	**1**								
Hydrobiidae	*Potamopyrgus antipodarum*	**1**	5		105	53	334	278	29	
Succineidae	*Succinea sp.*				2					
Planorbidae	*Planorbarius corneus*	**4**								
Planorbidae	*Planorbis planorbis*	**1**						1		
Planorbidae	*Anisus vortex*	**1**	3				31	11		
Planorbidae	*Gyraulus crista*	**2**		4						
Limpets and mussels										
Sphaeriidae	Sphaeriidae (juvenile / damaged)									

Sphaeriidae	*Sphaerium sp.*									
Sphaeriidae	*Pisidium sp.*		47	13	92	1	129	24		3
Worms										
Oligochaeta			75	41	2	69	5	68	125	93
Leeches										
Glossiphoniidae	*Glossiphonia complanata*	**1**	1	12	19	12	2	2	1	
Glossiphoniidae	*Helobdella stagnalis*	**1**				1			3	
Erpobdellidae	Erpobdellidae (juvenile / damaged)		1							
Erpobdellidae	*Erpobdella sp.*		1							
Erpobdellidae	*Erpobdella testacea*	**4**								
Erpobdellidae	*Erpobdella octoculata*	**1**	2			23		3	2	
Mites										
Hydracarina						1		3		1
Oribatei	*Oribatei*					1				
Crustaceans										
Ostracoda			41		22		4			
Cladocera										6
Gammaridae	*Gammarus sp.*					124				
Gammaridae	*Gammarus pulex/fossarum agg.*	**1**		7			602	20	216	
Gammaridae	*Gammarus pulex*	**1**	1			170		184		
Crangonyctidae	*Crangonyx floridanus/pseudogracilis*									7
Asellidae	*Asellus aquaticus*	**1**		732	5		376		1	13
Asellidae	*Proasellus meridianus*	**3**		44					146	194

Mayflies										
Baetidae	Baetidae (juvenile / damaged)					5		10		
Baetidae	*Baetis sp.*					1				
Baetidae	*Cloeon dipterum*	**1**								4
Leptophlebiidae	Leptophlebiidae (juvenile / damaged)								1	
True bugs										
Gerridae	*Gerris lacustris*	**1**			1					
Veliidae	*Velia* sp.		17		2	8	3	6	9	
Veliidae	*Velia caprai*	**2**	1				11			
Corixidae	*Hesperocorixa sahlbergi*	**2**		1						
Beetles										
Haliplidae	Haliplidae (larvae / damaged)			7	4					
Haliplidae	*Haliplus lineaticollis*	**1**						1		
Gyrinidae	*Gyrinus sp.*			1						
Dytiscidae	Dytiscidae (larvae / damaged)		1	6			5		2	
Dytiscidae	*Hydroporus sp.*		6							
Dytiscidae	*Hydroporus palustris*	**1**			1					
Dytiscidae	*Agabus bipustulatus*	**1**	1	1						
Dytiscidae	*Agabus paludosus*	**1**	3							
Dytiscidae	*Dytiscus marginalis*	**1**		1						
Hydrophilidae	Hydrophilidae (larvae / damaged)			5	1					
Hydrophilidae	*Helophorus* sp.		3		10		1		1	
Hydrophilidae	*Helophorus brevipalpis*	**1**			7					
Hydrophilidae	*Helophorus dorsalis*	**7**							1	

Hydrophilidae	*Anacaena globulus*	**1**	3				3	4	1	
Hydrophilidae	*Anacaena limbata*	**1**				1				
Hydraenidae	*Hydraena sp.*						3			
Elmidae	*Elmis aenea*	**1**						189		
Elmidae	*Oulimnius sp.*							1		
Elmidae	*Oulimnius tuberculatus*	**1**						2		
Alderflies										
Sialidae	*Sialis lutaria*	**1**		2						
Caddisflies										
Glossosomatidae	Glossosomatidae (juvenile / damaged)							1		
Hydropsychidae	*Hydropsyche angustipennis*	**1**						2		
Limnephilidae	Limnephilidae (juvenile / damaged)		2						12	
Limnephilidae	*Limnephilus sp.*		1							
Limnephilidae	*Limnephilus lunatus*	**1**	12	19	5	2	51	16	82	
Trueflies										
Chironomidae	Chironomidae (damaged / pupea)				2	12	1			
Chironomidae	Tanypodinae			27	77	64	79	3	63	18
Chironomidae	Orthocladiinae					41	69	263	45	
Chironomidae	Chironomini			566						123
Chironomidae	Tanytarsini			22	195	151	207		261	40
Chironomidae	Prodiamesinae						22		21	2
Tipulidae	*Tipula sp.*		4	2				1		
Pediciidae	*Dicranota* sp.					1		13		

Limoniidae	Limoniidae	1			1					
Simuliidae	Simuliidae (damaged / juvenile)							2		
Simuliidae	*Simulium* sp.				89		8			
Psychodidae		9			11	1	1	1	1	
Ceratopogonidae		25	3		1	1		3	1	
Stratiomyidae	Stratiomyidae	1		2						
Culicidae	Culicidae							1		
Additional Taxa										
	Fish fry			1	1	2				
	Stickleback (*Gasterosteus* sp.)		13	2						

Table F2. Autumn macroinvertebrate taxa list

Family	Species	Conservation Score	ESN2	ESN3	FB4	FB5	FB7	FB8
Flatworms								
Planariidae	*Polycelis nigra / tenuis*	**1**					5	
Snails								
Lymnaeidae	*Galba truncatula*	**3**		2				
Lymnaeidae	*Ampullaceana balthica*	**1**		3		4		
Hydrobiidae	*Potamopyrgus antipodarum*	**1**		4		19	175	23
Planorbidae	*Anisus vortex*	**1**					2	
Planorbidae	*Anisus leucostoma*	**4**				4		
Limpets and mussels								
Sphaeriidae	*Pisidium* sp.		4		39	10	33	
Worms								
Oligochaeta			398	2	88	77	83	108
Leeches								
Glossiphoniidae	*Alboglossiphonia heteroclita*	**4**			13			
Glossiphoniidae	*Glossiphonia complanata*	**1**	1				6	1
Glossiphoniidae	*Helobdella stagnalis*	**1**			2			2
Erpobdellidae	*Erpobdella octoculata*	**1**			41	1		1
Mites								
Oribatei	Oribatei			2				
Crustaceans								

Family	Species	Conservation Score	ESN2	ESN3	FB4	FB5	FB7	FB8
Ostracoda					1			12
Gammaridae	*Gammarus pulex/fossarum agg.*	**1**			228		2	
Gammaridae	*Gammarus pulex*	**1**					135	
Asellidae	Asellidae					9		
Asellidae	*Asellus aquaticus*	**1**			2	9		2
Asellidae	*Proasellus meridianus*	**3**				72	3	128
Mayflies								
Baetidae	Baetidae (juvenile / damaged)				14			
Baetidae	*Baetis* sp.						1	
Baetidae	*Baetis scambus*	**4**					2	
True bugs								
Corixidae	*Hesperocorixa sahlbergi*	**2**		1				
Notonectidae	*Notonecta glauca*	**1**		2				
Beetles								
Haliplidae	*Haliplus lineatocollis*	**1**	4					
Dytiscidae	*Hydroporus planus*	**2**		2				
Hydrophilidae	*Helophorus brevipalpis*	**1**				1		
Elmidae	*Elmis aenea*	**1**					75	
Elmidae	*Oulimnius sp.*						1	
Caddisflies								
Limnephilidae	Limnephilidae (juvenile / damaged)		1	4	2	9	8	3

Family	Species	Conservation Score	ESN2	ESN3	FB4	FB5	FB7	FB8
Limnephilidae	*Glyphotaelius pellucidus*	**3**						4
Limnephilidae	*Micropterna lateralis*	**2**						1
Trueflies								
Chironomidae	Chironomidae (damaged / pupae)		1		1			
Chironomidae	Tanypodinae		1		28			9
Chironomidae	Orthocladiinae			4	12	90	6	16
Chironomidae	Chironomini		2					
Chironomidae	Tanytarsini				46			
Chironomidae	Prodiamesinae						1	
Tipulidae	*Tipula sp.*			11		5		
Pediciidae	*Dicranota sp.*						9	
Limoniidae	Limoniidae		1	1		2		
Psychodidae					23	1		
Culicidae	Culicidae							1
Additional Taxa								
	Tricladida							4

Table F3 Pond macroinvertebrate taxa list

Family	Conservation Score	Pond 15	Pond 17	Pond 23, 24 and 25
Flatworms				
Dendrocoelidae		3		
Dugesiidae		23		
Snails				
Lymnaeidae	**1**			16
Hydrobiidae			12	
Planorbidae		220	26	19
Mussels				
Sphaeriidae		110		
Worms				
Oligochaeta		90	26	13
Leeches				
Glossiphoniidae		115	19	24
Erpobdellidae		12	22	21
Mites				
Hydracarina			19	21
Crustaceans				
Ostracoda		91		78
Copepoda			12	
Cladocera		8	124	921
Crangonyctidae		447	1	
Asellidae		296	2	
Mayflies				
Baetidae		4	184	172
Caenidae				1
Damselflies				
Coenagrionidae		2	13	38
Dragonflies				
Aeshnidae			3	1
Libellulidae				5
True bugs				
Nepidae		1		
Pleidae	**4**			24
Corixidae		110	8	131
Notonectidae				1

Beetles			
Haliplidae	1		16
Dytiscidae		1	3
Hydrophilidae	1	2	
Elmidae			1
Alderflies			
Sialidae	1		
Caddisflies			
Polycentropodidae		1	
Leptoceridae	1		72
Truefly larvae			
Chironomidae	482	67	93
Ceratopogonidae	1		1
Culicidae		2	1
Additional Taxa			
Fish fry		2	

Appendix G Macrophyte taxa list

Table G1. Macrophyte taxa list for watercourses

Common Name	Scientific name	ESN 1	ESN 2	ESN 3	FB4	FB5	FB7	FB8	ESN 12
Algae									
Blanketweed	*Cladophora glomerata / Rhizoclonium hieroglyphicum*	-	-	-	-	2	2	1	-
Vascular plants									
Fool's Watercress	*Apium nodiflorum*	-	-	-	-	-	3	2	-
Slender Tufted-sedge	*Carex acuta*	-	-	2	-	-	-	-	-
Reed Canary-grass	*Phalaris arundinacea*	-	-	2	7	6	7	7	-
Watercress	*Rorippa nasturtium-aquaticum* agg.	-	-	2	-	2	-	-	-

'Y' Presence of macrophyte taxa identified

Table G2. Macrophyte taxa list for ponds

	Taxa	Rarity score	Pond 6	Pond 8	Pond 9	Pond 11	Pond 12	Pond 15	Pond 17	Pond 18	Pond 19	Pond 20	Ponds 23, 24 and 25
Fool's Watercress	*Apium nodiflorum*	1	Y	-	-	-	-	-	-	-	-	-	-
Sedge	*Carex* sp.	1	Y	-	-	-	-	-	-	-	-	-	-
Slender Tufted-sedge	*Carex acuta*	2	Y	-	-	-	-	-	-	-	-	-	-
Pendular Sedge	*Carex pendula*	1	-	-	-	-	-	Y	-	-	-	-	-
Rigid Hornwort	*Ceratophyllum demersum*	2	-	-	-	-	-	-	-	-	-	-	Y
Stonewort	*Chara* sp.	2	-	-	-	-	-	-	-	-	-	-	Y
Willowherb	*Epilobium* sp.		-	-	-	-	-	-	-	-	-	Y	-
Great Willowherb	*Epilobium hirsutum*	1	Y	-	-	Y	-	Y	Y	-	-	-	Y
Yellow Flag Iris	*Iris pseudacorus*	1	-	-	Y	-	-	Y	-	-	-	-	-
Soft Rush	*Juncus effusus*	1	Y	-	-	-	Y	-	-	-	Y	Y	Y
Hard Rush	*Juncus inflexus*	1	Y	-	Y	-	Y	Y	Y	-	-	-	Y
Pygmy Rush	*Juncus pygmaeus*	32	-	-	-	-	Y	-	-	-	-	-	-
Common Duckweed	*Lemna minor*	1	Y	-	-	-		Y		-	Y	-	Y
Gypsywort	*Lycopus europaeus*	1	-	-	-	-	-	-	-	-	-	-	Y
Yellow Water-lily	*Nuphar lutea*	2	-	-	-	-	-	Y	-	-	-	-	-
White Water-lily	*Nymphaea alba*	2	-	-	-	-	-	-	Y	Y	-	-	-

	Taxa	Rarity score	Pond 6	Pond 8	Pond 9	Pond 11	Pond 12	Pond 15	Pond 17	Pond 18	Pond 19	Pond 20	Ponds 23, 24 and 25
Water-pepper	*Persicaria hydropiper*	1	-	-	-	-	-	Y	-	-	-	-	Y
Reed Canary-grass	*Phalaris arundinacea*	1	-	-	Y	-	-	-	-	-	-	-	-
Curled Pondweed	*Potamogeton crispus*	1	-	-	-	-	-	-	Y	-	-	-	Y
Water Figwort	*Scrophularia auriculata*	1	-	-	-	-	-	Y	-	-	-	-	-
Woody Nightshade	*Solanum dulcamara*	1	Y	-	-	-	-	-	-	-	Y	Y	-
Branched Bur-reed	*Sparganium erectum*	1	Y	-	-	-	-	Y	-	-	-	-	-
Bulrush	*Typha latifolia*	1	-	-	-	Y	-	Y	-	-	-	-	-
INNS													
New Zealand Pigmyweed	***Crassula helmsii***	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**Y**
Nuttall's Waterweed	***Elodea nuttallii***	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**Y**

'Y' Taxa present within pond

Table G3. Taxon cover values (TCV)

TCV	Percentage cover for the macrophyte species
C1	<0.1%
C2	0.1 to 1%
C3	1 to 2.5%
C4	2.5 to 5%
C5	5 to 10%
C6	10 to 25%
C7	25 to 50%
C8	50 to 75%
C9	>75%

Table G4. Water Framework Directive boundary values for macrophytes in rivers

Ecological Quality Ratio (EQR)	WFD Ecological Status for Macrophytes
≥ 0.80	High
≥ 0.60	Good
≥ 0.40	Moderate
≥ 0.20	Poor
< 0.20	Bad

Appendix H Pond surveys and PSYM

Pond surveys were completed for the remaining ponds although a full PSYM survey was not completed due to the reduction in Principal Site Boundary.

Pond 6

Pond 6 was approximately 379m^2 in area, with 2% shading and an emergent plant cover of 100%. The substrate of the pond was predominantly clay/silt with a composition up to 66%. No inflow to the pond was found during the survey. No margin grazing was recorded within the vicinity of the pond.

The macrophyte community at Pond 6 was comprised of nine species of emergent plant: *Apium nodiflorum*, *Carex acuta, Carex* sp., *Epilobium hirsutum, Juncus effusus, Juncus inflexus, Solanum dulcamara, Typha latifolia* and *Veronica beccabunga*. One species of floating leaved plant duckweed *Lemna minor* was also present on the pond. No submerged macrophytes were identified during the survey although traces of filamentous algae was recorded as covering the dried substrate of the pond. The Trophic ranking score was 9.50 with one uncommon species *C. acuta*.

This water body had also recently dried and prevented an invertebrate sample from being collected.

Pond 8

Pond 8 was approximately 731m^2 in area, with 50% shading and an emergent plant cover of 100%. The substrate of the pond was predominantly composed of clay/silt with a minor composition of pebble/gravel less than to 32%. It was a man-made pond with surrounding embankment and an inflow to the pond from an agricultural drainage pipe. No margin grazing was recorded within the vicinity of the pond.

The macrophyte community at Pond 8 was comprised of three species of emergent plant: *Iris pseudacorus*, *J. inflexus* and *Phalaris arundinacea*. One species of floating leaved plant duckweed *Lemna minor* was also present on the pond. Filamentous algae was recorded as covering some of the pond's base. No floating or submerged macrophytes were recorded within the site. The Trophic ranking score was 8.50 with no uncommon species.

A blue-green algal bloom within the pond prevented an invertebrate sample from being collected.

Pond 9

Pond 9 was approximately 755m^2 in area, with 60% shading and no emergent plant cover. The substrate of the pond was predominantly clay/silt with a composition up to 66%. An inflow to the pond was found during the survey. No margin grazing was recorded within the vicinity of the pond.

No Macrophyte community was recorded at Pond 9, with only bare open ground and clear long-term drying with fissures in soil. Algae was also identified within the dried pond margins.

This water body had also recently dried and prevented an invertebrate sample from being collected.

Pond 11

Pond 11 was approximately 49m^2 in area, with 60% shading and an emergent plant cover of 80%. The substrate of the pond was predominantly clay/silt with a composition up to 66%. The pond consisted of steep, high banks leading into the recently dried base. No inflow to the pond was found during the survey. No margin grazing was recorded within the vicinity of the pond.

The macrophyte community at Pond 6 was comprised of two species of emergent plant: *E. hirsutum* and *T. latifolia*. No floating or submerged macrophytes were found during macrophyte surveys and a Trophic ranking score of 8.50 was determined for Pond 11.

This water body had also recently dried and prevented an invertebrate sample from being collected.

Pond 12

Pond 12 was approximately 318m^2 in area, with 20% shading and an emergent plant cover of 100%. The substrate of the pond was a clay/silt composition. This was identified as an agricultural drainage pond with heavy siltation. Algae and Redshank *Persicara* sp. was present within the margins. An inflow to the pond was found during the survey. No margin grazing was recorded within the vicinity of the pond.

The macrophyte community at Pond 12 was comprised of two species of emergent plant: hard rush *J. inflexus* and pygmy rush *Juncus pygmaeus*. One species of floating leaved plant duckweed *L. minor* was also present on the pond. No floating for submerged. No Trophic ranking score could be attained for the pond due to a lack of species identified. The rush J. pygmaeus was identified as uncommon with a rarity score of 32.

Access limitations at this water body prevented an invertebrate sample from being collected.

Pond 18

Pond 18 was approximately 521m^2 in area, with 70% shading and an emergent plant cover of 10%. The substrate of the pond was composed of clay/silt. This pond consisted of steep overgrown banks into a shallow silted water body. An inflow to the pond was found during the survey. No margin grazing was recorded within the vicinity of the pond.

The macrophyte community at Pond 18 was comprised of one species of floating plant: *Nymphaea alba*. No emergent or submerged taxa were found during surveys.

Access limitations at this water body prevented an invertebrate sample from being collected.

Pond 19

Pond 19 was approximately 469m^2 in area, with 80% shading and no emergent plant cover. The substrate of the pond was predominantly clay/silt with a composition up to

66%. No inflow to the pond was found during the survey. No margin grazing was recorded within the vicinity of the pond.

The macrophyte community at Pond 19 was comprised of two species of emergent plant: *J. effusus* and *S. dulcamara*. One species of floating leaved plant duckweed *L. minor* was also present on the pond. No submerged taxa were recorded and a Trophic ranking score of 9.50 was determined for the pond.

This water body was mostly dried, with a dense layer of *L. minor* and prevented an invertebrate sample from being collected.

Pond 20

Pond 20 was approximately 379m^2 in area, with 100% shading (within woodland of willow and ash) and an emergent plant cover of 100%. The substrate of the pond was clay/silt. The pond comprised of a very low water level which was stagnant and contained large amounts of wood debris. No inflow to the pond was found during the survey.

Low water level, stagnant and large quantity of woody debris. No macrophytes within pond

The macrophyte community at Pond 20 was comprised of three species of emergent plant: *Epilobium sp., J. effusus* and *S. dulcamara*. No submerged or floating taxa were recorded at Pond 20 with no macrophyte taxa within the pond. Pond 20 had a Trophic ranking score of 10.00.

An invertebrate sample was not collected as pond unlikely to be impacted by Scheme and water level very low.

Table H1. Pond surveys and PSYM

Pond ID	Survey NGR	Comments on pond state	Pond PSYM undertaken	Macrophyte survey undertaken	Macroinvertebrate sample collected
Pond 1	-	No access permitted at time of survey	-	-	-
Pond 2	-	No access permitted at time of survey	-	-	-
Pond 3	-	No access permitted at time of survey	-	-	-
Pond 4	-	No access permitted at time of survey	-	-	-
Pond 5	-	No access permitted at time of survey	-	-	-
Pond 6	SK9049690681	Not fully dry, small volume of water	21/07/22	21/07/22 Macrophytes present	-
Pond 7	-	No access permitted at time of survey	-	-	-
Pond 8	SK 90905 89770	-	21/07/22	21/07/22 Macrophytes present	-
Pond 9	SK 91453 89889	Not fully dry, small volume of water	21/07/22	21/07/22 Macrophytes present	-
Pond 10	SK 91485 89793	Not a true pond, agricultural reservoir	-	-	-
Pond 11	SK 91106 88666	Not fully dry, small volume of water	21/07/22	21/07/22 Macrophytes present	-
Pond 12	SK91842 89897	Wet	21/07/22	21/07/22 Macrophytes present	-

Pond ID	Survey NGR	Comments on pond state	Pond PSYM undertaken	Macrophyte survey undertaken	Macroinvertebrate sample collected
Pond 13	SK 92672 89873	Recently dried with signs of damps substrate, unable to survey	-	-	-
Pond 14	SK92906 90135	Completely dry at time of surveys	-	-	-
Pond 15	SK93073 89715	Wet	21/07/22	21/07/22 Macrophytes present	21/07/22
Pond 16	-	No access permitted	-	-	-
Pond 17	SK92181 88746	Wet	21/07/22	21/07/22 Macrophytes present	21/07/22
Pond 18	SK93841 88967	Wet	21/07/22	21/07/22 Macrophytes present	-
Pond 19	SK 93615 88802	Not fully dry, small volume of water	21/07/22	21/07/22 Macrophytes present	-
Pond 23	SK93301 87828	Wet	21/07/22 – three ponds combined due to proximity to one another	21/07/22 Macrophytes present at all	21/07/22 Combined sample
Pond 24	SK93437 87799	Wet			
Pond 25	SK93540 87852	Wet			
Pond 26	SK93533 87795	Completely dry at time of surveys	-	-	-
Pond 27	SK92828 87372	Inaccessible - steep slopes/ dense vegetation, water present	-	-	-