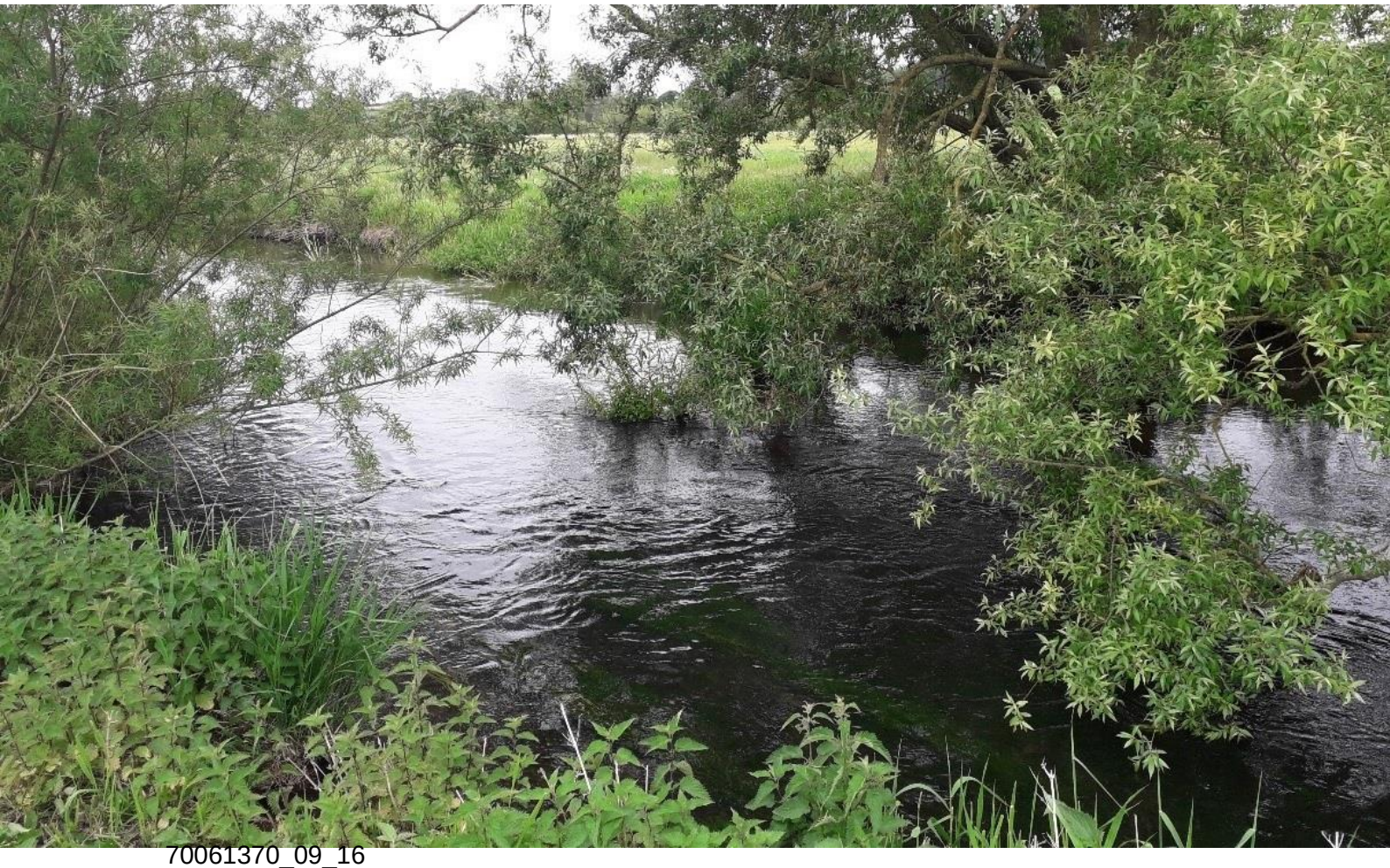
Norfolk County Council

NORWICH LINK ROAD

Aquatic Macroinvertebrate Report



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CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

1.1 PROJECT BACKGROUND

1.1.1. The Norwich Western Link Road (NWL) is a highway scheme linking the A1270 Broadland Northway from its junction with the A1067 Fakenham Road to the A47 trunk road near Honingham.

1.1.2. The NWL, hereafter referred to as the Scheme, will comprise:

- Dualling the A1067 Fakenham Road westwards from its existing junction with the A1270 to a new roundabout located approximately 400m to the north west.
- Construction of a new roundabout.
- Constructing a dual carriageway link from the new roundabout to a new junction with the A47 near Honingham.

1.1.3. As part of a separate planned scheme, Highways England proposes to realign and dual the A47 from the existing roundabout at Easton to join the existing dual carriageway section at North Tuddenham. If that scheme proceeds, it is expected that Highways England will construct the Honingham junction and the Norwich Western Link will connect to the north-eastern side of that junction.

1.1.4. The Scheme will cross the River Wensum and its flood plain by means of a viaduct. The Scheme will also cross four minor roads by means of overpass or underpass bridges. The Scheme will include ancillary works such as provision for non-motorised users, necessary realignment of the local road network and the provision of environmental mitigation measures.

1.2 ECOLOGICAL BACKGROUND

1.2.1. The requirement for aquatic macro invertebrate survey followed the identification of suitable habitats with the potential to support this species group, that may be impacted by the Scheme. These habitats were identified following the Phase 1 Habitat Survey and associated desk study (WSP UK Ltd., 2018B) and the refined survey in 2020. An updated aquatic macroinvertebrate desk study for the preferred route option is included in this report.

1.2.2. The requirement for aquatic macroinvertebrate (hereafter referred to as macroinvertebrate) surveys followed the identification of habitats within the River Wensum that may be affected by the Scheme. As part of the Scheme a viaduct structure is required to carry the NWL across the River Wensum at NGR TG 13979 15483.

1.2.3. The River Wensum's floodplain contains several ordinary watercourses (hereafter referred to as "ditches"), which are connected to the main river, that are to be crossed by the Proposed Scheme. It was therefore recommended that macroinvertebrate surveys of these watercourses should also be undertaken.

1.2.4. A culvert crossing of Foxburrow Stream, a tributary of the River Tud, is also proposed. It was therefore recommended that macroinvertebrate surveys of this watercourse be undertaken to inform impact assessment.

1.2.5. The 'Survey Area', as it is referred to hereafter, includes the locations at which aquatic macroinvertebrate samples were collected (Figure 3.1 and Figure 3.2). The Survey Area includes the location of the proposed viaduct where it crosses the River Wensum and the culvert crossing point of Foxburrow Stream.

1.3 BRIEF AND OBJECTIVES

1.3.1. WSP UK Ltd was commissioned by Norfolk County Council to complete a desk study and macroinvertebrate surveys to fulfil the following objectives:

- To determine the presence/likely absence of protected and/or notable species; and
- To present the findings of the surveys in a baseline report.

1.3.2. The findings of the desk study and surveys will be used to inform the impact assessment and proposed mitigation for macroinvertebrates, which are to be presented within the Biodiversity Chapter of the Environmental Statement for the Scheme.

2 RELEVANT LEGISLATION

2.1 LEGAL COMPLIANCE

2.1.1. Watercourses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation are an Annex I habitat and a primary reason for the designation of the River Wensum as a Special Area of Conservation (SAC) (JNCC, 2019) under The Conservation of Habitats and Species Regulations 2017 (HMSO, 2017a).

2.1.2. Such habitats designated as Sites of Community Importance (SCIs) and included in the Natura 2000 network (now referred to as National Network Sites following the UKs exit from the European Union[1]. These sites must be managed in accordance with the ecological needs of the features that characterise them.

2.1.3. The River Wensum is designated as a Site of Special Scientific Interest (SSSI), as specified under the Wildlife and Countryside Act (HMSO, 1981). The purpose of this SSSI designation is to safeguard the diversity and geographic range of habitats, species and geological and physiographic features. Public bodies have a statutory duty to take reasonable steps, consistent with the proper exercise of its functions, to further the conservation and enhancement of the special scientific interest of SSSIs.

2.1.4. The Natural Environment and Rural Communities (NERC) Act 2006 reinforces the duty upon all public authorities, including planning authorities, to have regard for the conservation of biodiversity when discharging their duties. The Act refines the definition of biodiversity conservation, stating that it includes restoring or enhancing a population or habitat. Section 41 of the NERC Act requires the Secretary of State to list habitats and species of principal importance (HPIs and SPIs) for the conservation of biodiversity in England. The habitats and species listed in accordance with Section 41 largely replicate those listed on the UK Biodiversity Action Plan (BAP) which occur in England.

2.1.5. The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater, and for all waterbodies (unless artificial or heavily modified) to achieve “good” ecological status. This is a retained EU law following the United Kingdom’s exit from the EU, in line with The Floods and Water (Amendment etc.) (EU Exit) Regulations 2019 (HMSO, 2019b).

[1] https://www.gov.uk/government/publications/changes-to-the-habitats-regulations-2017/changes-to-the-habitats-regulations-2017

2.1.6. Ecological Status is expressed in terms of five classes (High, Good, Moderate, Poor or Bad). These classes are based on specific criteria and boundaries defined against biological, physico-chemical and hydromorphological quality elements. Biological assessment uses numeric measures of communities of aquatic plants and animals, including fish. The overall Ecological Status of a water body is determined by its poorest quality element. For example, a water body's chemical and physico-chemical quality elements might be classed as 'Good' but the biological element classed as 'Moderate Status'. In this case it would be classed overall as 'Moderate Ecological Status'. To achieve the overall aim of Good surface water status, the Directive requires that surface waters be of at least Good Ecological Status and Good Chemical Status. To achieve High Status, the Directive requires that the hydromorphological Quality Elements are also in place. When considering the impact of a development or activity on a waterbody it is a regulatory requirement under the WFD to assess if it will cause or contribute to a deterioration in status or jeopardise the waterbody achieving Good status in the future.

3 METHODS

3.1 DESK STUDY

3.1.1. A desk study was undertaken in November 2020 to review relevant existing ecological baseline information available in the public domain and to obtain information held by relevant third parties. For the purpose of the desk study exercise, records were collated within various radii around the Survey Area. This approach is consistent with current good practice guidance published by the CIEEM (2017).

3.1.2. Freely downloadable datasets (available from Natural England) were consulted for information regarding the presence of statutory designated sites within 2km of the Survey Area. This search was extended to 10km for Natura 2000 sites (Special Areas of Conservation (SAC) and Special Protection Areas (SPA)) of European importance and internationally designated Ramsar sites.

3.1.3. The current Water Framework Directive (WFD) status for the relevant catchment was obtained from the Environment Agency's Catchment Data Explorer Website (Environment Agency, 2020a).

3.1.4. Macroinvertebrate survey data for the River Wensum was obtained from the Environment Agency's Ecology and Fish Data Explorer (Environment Agency, 2020b).

3.2 MACROINVERTEBRATE SURVEY

FIELD SURVEY AND PROCESSING

3.2.1. Macroinvertebrate surveys were undertaken on 27 May 2020 (spring) and repeated on 03 September 2020 (autumn).

3.2.2. Five locations for macroinvertebrate surveys were chosen based on the scheme footprint. The sampling site grid references are provided in **Table 3-1**. The sampling locations for the River Wensum and Foxburrow Stream displayed in and **Figure 3-2** respectively.

Table 3-1 – Macroinvertebrate sampling sites and National Grid References

Site	NGR
River Wensum Upstream	TG 13898 15563
River Wensum Downstream	TG 14016 15473
Foxburrow Stream	TG 10516 13346
Hall Ditch	TG 13920 15384
Ringland Ditch	TG 13716 15299

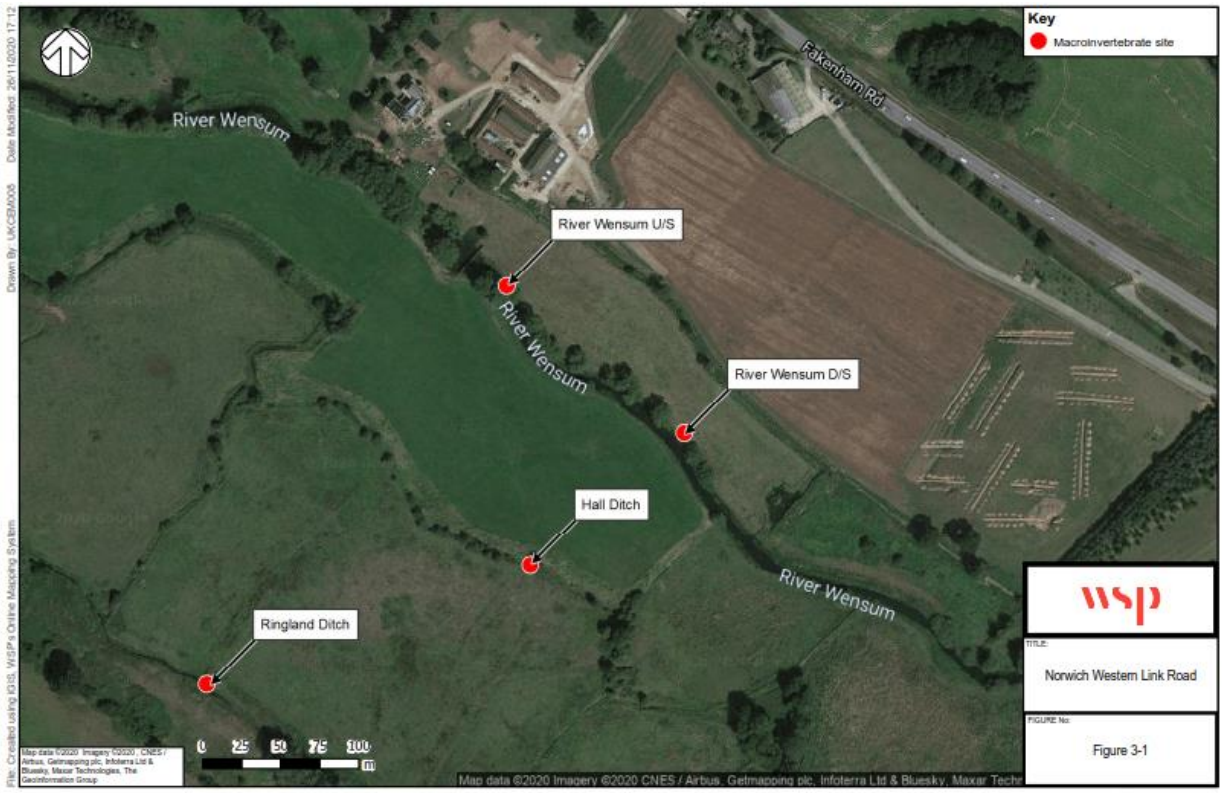

Figure 3-1 – Macroinvertebrate sampling sites on the River Wensum, Hall Ditch and Ringland Ditch

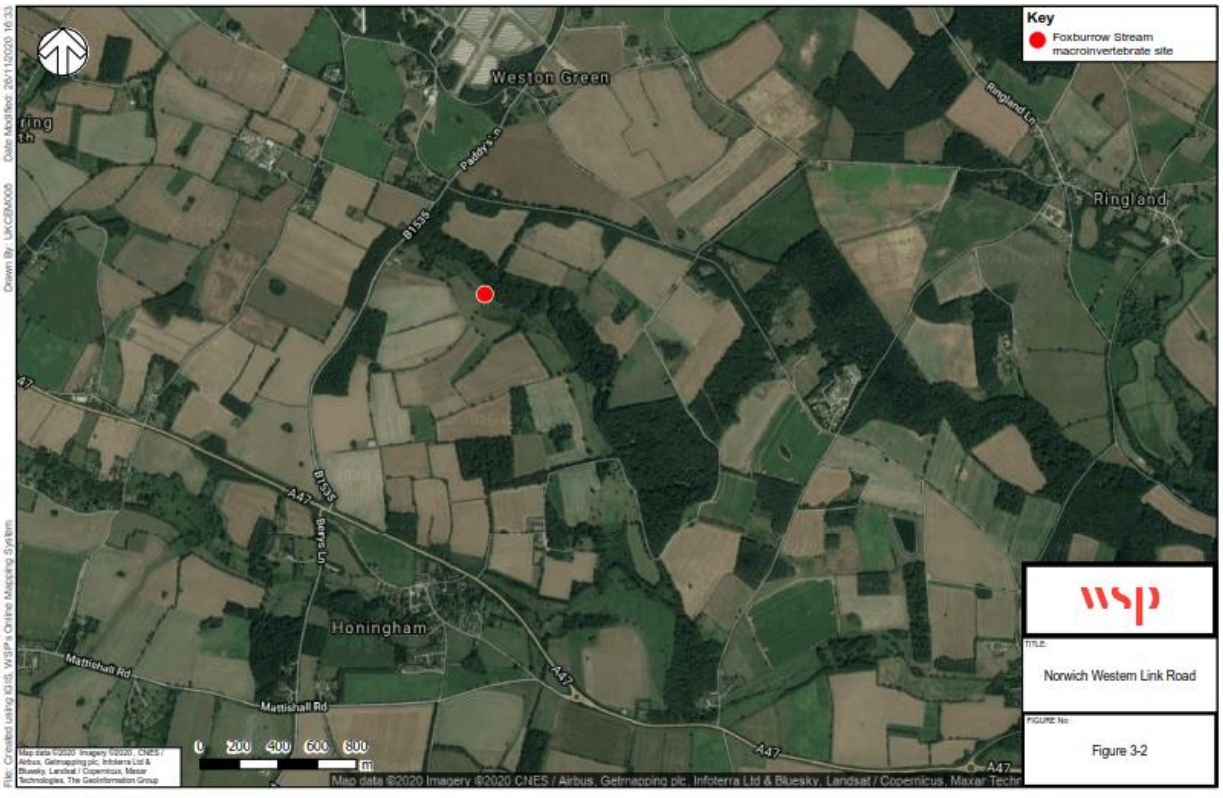

Figure 3-2 – Macroinvertebrate sampling site on Foxburrow Stream

3.2.3. Macroinvertebrate samples were collected using standard three-minute kick sampling of all in-channel habitats in proportion to their occurrence. This was carried out using a standard sampling net (1mm mesh), with a one-minute timed hand search following the Environment Agency (2017) procedure. This sampling method conforms to BS EN ISO 10870:2012 Water Quality – Guidelines for the selection of sampling methods and devices for benthic macroinvertebrates in fresh waters (British Standards Institution, 2012).

3.2.4. A standardised field sheet was completed that captures details of channel and bank physical habitat (material of banks and substrates, flow types, physical processes, bank structure), riparian land use and potential sources of anthropogenic stress.

3.2.5. Samples were placed in one-litre sample pots, preserved in Industrial Denatured Alcohol (IDA) on site and transported to the laboratory for sorting and identification to Taxonomic Level 5, in adherence with Environment Agency (2014) procedures.

BIOLOGICAL METRICS

3.2.6. The use of biological metrics allowed the assignation of ecological values to the macroinvertebrate communities observed and an assessment of pressures on those communities to be made.

River Invertebrate Classification Tool

3.2.7. The River Invertebrate Classification Tool (RICT) determines the ecological condition of a given location based on a comparison of macroinvertebrate communities observed at each study site, with macroinvertebrate communities observed at reference sites (Davy-Bowker *et al*, 2008). RICT reference sites are deemed to be as close as possible to pristine conditions and not impacted by environmental stressors such as pollution, habitat modification or flow stress. Reference sites provide an expected macroinvertebrate community score for that river type. The observed macroinvertebrate community score at a given study site is divided by the expected community score. Reference and bias adjustments are then applied to obtain the Ecological Quality Ratio (EQR). RICT can derive EQR scores for a number of biological metrics. These metrics are discussed further below.

Whalley, Hawkes, Paisley and Trigg

3.2.8. The Whalley, Hawkes, Paisley and Trigg (WHPT) metric (UKTAG, 2014) is based on the tolerance of different macroinvertebrates to organic pollution. Each macroinvertebrate family is assigned a score from -1.6 to 13, depending on their tolerance to pollution and abundance category (on a continuous scale, -1.6 is for highly abundant pollution-tolerant taxa, 13 is for highly abundant pollution-intolerant taxa) and an overall score is produced from the total. The WHPT index is widely used to determine the ecological water quality of running waters and specifically the detection of organic pollution. As such, any extrapolation of other water quality pressures should be undertaken with caution.

3.2.9. The Average Score Per Taxon (ASPT) is derived from the WHPT index. By dividing the total WHPT score by the number of scoring taxa present (NTAXA), the average score per taxon can be calculated. This metric is more easily comparable with other sites and permits an assessment of biological water quality that is less influenced by the presence of a greater proportion of low scoring taxa or sampling effort than the overall WHPT score. In both the case of WHPT score and ASPT, higher scores indicate better ecological quality.

Lotic-invertebrate Index for Flow Evaluation

3.2.10. Macroinvertebrates have specific requirements for flow conditions and can be used to determine not only predominant flow types (Extence *et al*., 1999), but also changes in flow character. The Lotic-invertebrate Index for Flow Evaluation (LIFE) metric uses abundance data to assign a flow preference score to macroinvertebrate families present in a sample and an overall score for the site can be interpreted as an abundance-weighted average score per taxon metric. The family-level LIFE score is calculated in RICT as a ratio of the observed/expected at reference sites (O/E) for the sample.

3.2.11. There are currently no WFD-related class boundaries for LIFE EQRs, but a threshold of 0.94 is used to indicate the presence of flow stressed macroinvertebrate communities (Environment Agency, 2012). A LIFE score of less than 0.94 may indicate that flow is a possible pressure acting on an ecological community at a site.

Proportion of Sediment-sensitive Invertebrates

3.2.12. The Proportion of Sediment-sensitive Invertebrates (PSI) metric aims to act as a proxy for the quantity of fine sediment at a site (Extence *et al*., 2011). Macroinvertebrate species are assigned a fine sediment sensitivity rating that ranges from highly insensitive to highly sensitive to fine sediment. The PSI score is calculated as the percentage of sensitive taxa in the sample and used to indicate how sedimented a watercourse is, from minimally sedimented/un-sedimented to heavily sedimented (**Table 3-2**).

Table 3-2 – Proportion of Sediment-sensitive Invertebrates (PSI) scores and interpretation

PSI Score	Riverbed condition
81 – 100	Minimally sedimented / un-sedimented
61 – 80	Slightly sedimented
41 – 60	Moderately sedimented
21 – 40	Sedimented
0 – 20	Heavily sedimented

3.2.13. There are currently no WFD-related class boundaries for PSI EQRs, but a threshold of 0.70 is used to indicate the presence of low stressed macroinvertebrate communities (Turley *et al*., 2016).

Community Conservation Index

3.2.14. The diversity and conservation interest of a macroinvertebrate community at each site can be represented by analysing species level data through the Community Conservation Index (CCI). The CCI incorporates elements of taxon rarity and richness to summarise the conservation value of macroinvertebrate communities (Chadd and Extence, 2004). Scores defined within Chadd and Extence (2004) are assigned to species within the sample to derive a total sample conservation score which infers a conservation value from the criteria listed in **Table 3-3**.

Table 3-3 – Community Conservation Index (CCI) scores and classification descriptions

Conservation Score	Conservation Classification	Description
0 ≤ 5	Low	Sites supporting only common species and/or a community of low taxon richness.
5 ≤ 10	Moderate	Sites supporting at least one species of restricted distribution and/or a community of moderate taxon richness.
10 ≤ 15	Fairly high	Sites supporting at least one uncommon species, or several species of restricted distribution and/or a community of high taxon richness.
15 ≤ 20	High	Sites supporting several uncommon species, at least one of which may be nationally rare and/or a community of high taxon richness.
> 20	Very high	Sites supporting several rarities, including species of national importance, or at least one extreme rarity (such as taxa included in the British RDBs) and/or a community of very high taxon richness (potentially of national significance and may merit statutory protection).

Water Framework Directive macroinvertebrate classification

3.2.15. The WFD uses the pollution sensitivity (WHPT ASPT) and macroinvertebrate richness (WHPT NTAXA) EQR scores to determine whether a watercourse meets Good Ecological Status, as required under the Directive.

3.2.16. There are five ecological status classes: Bad, Poor, Moderate, Good and High.

3.2.17. Where a macroinvertebrate community is recorded at, or above Good Ecological Status, then biological or physical pressures including flow and anthropogenic pollution are not assumed to be affecting aquatic ecology.

3.2.18. Watercourses failing to meet Good Ecological Status for macroinvertebrates may be influenced by a variety of stressors, and EQRs can be interrogated to determine the likely cause of failure to meet Good Ecological Status.

3.2.19. For WFD classification the lower scoring of these EQR scores determines the macroinvertebrate classification of a given site.

3.3 LIMITATIONS

3.3.1. Ecological survey data is typically valid for up to 18 months unless otherwise specified. The likelihood of surveys needing to be updated increases with time and is greater in circumstances where the habitat or its management has changed significantly since the surveys were undertaken. (CIEEM, 2019).

4 RESULTS

4.1 DESK STUDY

DESIGNATED NATURE CONSERVATION SITES

4.1.1. Two statutory designated nature conversation sites of interest were identified within 2km of the Survey Area:

- River Wensum SAC; and,
- River Wensum SSSI.

4.1.2. There are no additional designated sites with aquatic species as a primary reason for selection or as a qualifying feature within 2km of the Survey Area.

RIVER WENSUM SPECIAL AREA OF CONSERVATION

4.1.3. One of the primary reasons for the selection of this site as a Special Area of Conservation (SAC) is Annex I habitat consisting of '*watercourses of plain to montane levels with Ranunculion fluitantis and Callitricho-Batrachion vegetation*' (JNCC, 2019a).

4.1.4. This habitat type is characterised by the abundance of water-crowfoots *Ranunculus* spp., subgenus *Batrachium*. Floating mats of these white-flowered species are characteristic of river channels in early to mid-summer. They may modify water flow, promote fine sediment deposition, and provide shelter and food for fish and invertebrate animals (JNCC, 2019b).

RIVER WENSUM SITE OF SPECIAL SCIENTIFIC INTEREST

4.1.5. The River Wensum has been selected as a Site of Special Scientific Interest (SSSI) as an example of an enriched, calcareous lowland river. Whilst the river is of rich ecological and cultural value in its present state, the condition of the River Wensum SSSI aquatic units is currently regarded as being "Unfavourable – Recovering".

4.1.6. The Wensum has an abundant and diverse mollusc fauna which includes the nationally rare, small snail *Vertigo moulinsiana*, which is associated with aquatic vegetation at the river edge. Two other aquatic molluscs which occur, *Valvata piscinalis* and *Gyraulus albus*, have a localised distribution in England. Water beetles are well represented; *Brychnus elevatus*, of localised distribution in England, is found in deep slow-flowing sections of the river. The mayflies *Ephemerella ignita*, *Caenis luctuosa*, *Centroptilium luteolum* and *Centroptilium pennulatum* are also of local distribution. There is a species of stonefly, *Amphinemura standfussi*, more usually associated with upland rivers. The flatworm *Crenobia alpina* is of note, being a relict in southern England where it is confined to cold-water springs (Natural England, 1993).

4.2 ENVIRONMENT AGENCY MACROINVERTEBRATE SURVEY RECORDS

4.2.1. The nearest Environment Agency macroinvertebrate monitoring location on the River Wensum is located approximately 7km downstream of the River Wensum downstream site. The biological metrics derived from Environment survey data collected at this location are displayed in **Table 4-1**.

Table 4-1 – Environment Agency macroinvertebrate biological metrics from autumn (November 2018) and spring (May 2019) surveys carried out on the River Wensum at TG 15970 13710

Date	WHPT-ASPT	WHPT-NTAXA	LIFE (TL5)	PSI (TL5)	CCI (TL5)
05/11/2018	5.28	31	7.17	36.84	12.41
30/05/2019	5.21	26	6.83	29.63	9.58

4.2.2. No protected species were identified in the samples, however the non-native invasive New Zealand mud snail *Potamopyrgus antipodarum* was identified in the autumn 2018 sample.

4.2.3. The PSI scores classify the River Wensum at this site as Sedimented, while the CCI scores classify the site as Moderate to Fairly High conservation value.

4.2.4. The nearest Environment Agency monitoring location to the Foxburrow Stream macroinvertebrate sampling site is on the River Tud, approximately 8km downstream. The biological metrics are displayed in **Table 4-2.**

Table 4-2 – Environment Agency macroinvertebrate biological metrics from spring (May 2019) and autumn (November 2019) surveys carried out on the River Tud at TG 16987 11267

Date	WHPT-ASPT	WHPT-NTAXA	LIFE (TL5)	PSI (TL5)	CCI (TL5)
15/05/2019	6.13	30	7.54	55.26	12
05/11/2019	5.75	28	7.38	47.22	7.5

4.2.5. As with the River Wensum, no protected species were found in the River Tud and the New Zealand mud snail was present in both the spring and autumn samples.

4.2.6. The PSI scores classify the River Tud at this site as Moderately Sedimented and the CCI scores indicate a conservation value of Moderate to Fairly High.

WATER FRAMEWORK DIRECTIVE

4.2.7. The River Wensum within the Survey Area falls within the WFD 'Wensum Upstream (US) Norwich' waterbody (GB105034055881) (Environment Agency, 2020a). The River Wensum is designated as a WFD watercourse, whilst the connected drainage ditch network, located to the south-west of the river within the Survey Area, is classed as an ordinary watercourse.

4.2.8. The 2019 WFD ecological status of the 'Wensum Upstream (US) Norwich' waterbody was Moderate, whilst the invertebrate quality element was classified as High (Environment Agency, 2020a).

4.2.9. The hydromorphological designation of the 'Wensum Upstream (US) Norwich' waterbody is 'heavily modified', meaning it is considered to be heavily influenced by anthropogenic activity (Environment Agency, 2020a).

4.2.10. The River Tud within the Survey Area falls within the WFD 'Tud' waterbody (Environment Agency, 2020a). The River Tud is designated as a WFD watercourse.

4.2.11. The 2019 WFD ecological status of the 'Tud' waterbody was Good (Environment Agency, 2020a), with the invertebrate quality element achieving High classification.

4.2.12. The hydromorphological designation of the 'Tud' waterbody is 'heavily modified', meaning it is considered to be heavily influenced by anthropogenic activity (Environment Agency, 2020a).

4.3 MACROINVERTEBRATE SURVEY

BIOLOGICAL METRICS

4.3.1. The full macroinvertebrate taxon list is presented in **Appendix A**. Images of sampling locations are displayed in **Appendix B**.

4.3.2. The biological metrics calculated for each site based on the macroinvertebrate communities present are displayed in **Table 4-3**.

Table 4-3 – Biological metrics for the five macroinvertebrate sites in spring and autumn. (O) = Observed, (E) = Expected

Site	Season	WHPT-ASPT (TL2)	WHPT-NTAXA (TL2)	LIFE (O) (TL5)	LIFE (E) (TL5)	LIFE EQR	PSI (O) (TL5)	PSI (E) (TL5)	PSI EQR	CCI (TL5)
River Wensum Upstream	Spring	5.65	24	7.86	7.03	1.12	57.41	33.87	1.70	7.14
River Wensum Upstream	Autumn	5.58	31	7.32	6.85	1.07	48.39	29.84	1.62	11.85
River Wensum Downstream	Spring	4.55	34	6.03	7.15	0.84	13.70	37.48	0.37	12.83
River Wensum Downstream	Autumn	4.23	22	6.00	6.99	0.86	10.42	33.29	0.31	8.70
Foxburrow Stream	Spring	5.14	16	7.27	7.78	0.93	40.00	58.00	0.69	10.42
Foxburrow Stream	Autumn	5.92	14	7.63	7.74	0.99	60.71	55.00	1.10	12.22
Hall Ditch	Spring	3.56	10	5.60			0.00			10.56
Hall Ditch	Autumn	4.24	5	5.33			10.00			15.00
Ringland Ditch	Spring	4.20	20	5.71	7.73	0.74	5.77	53.95	0.11	6.75
Ringland Ditch	Autumn	4.19	12	6.25	7.64	0.89	5.56	51.84	0.11	11.88

4.3.3. The River Wensum, Foxburrow Stream, Hall Ditch and Ringland Ditch support a variety of taxa with average WHPT scores ranging from 3.56 to 5.92, indicating an overall moderate tolerance to pollution. Across all sites, 128 different taxa were identified and of these, the River Wensum sites contained the greatest diversity of WHPT scoring taxa, whilst Hall Ditch displayed the lowest diversity of WHPT scoring taxa.

4.3.4. The River Wensum Downstream, Ringland Ditch and spring Foxburrow Stream samples produced LIFE EQR values below the guideline threshold of 0.94, indicating these sites may be flow stressed.

4.3.5. The observed PSI scores showed the River Wensum Downstream, Hall Ditch and Ringland Ditch were classified as Heavily Sedimented in both the spring and autumn. The River Wensum Upstream was Moderately Sedimented in both seasons, and Foxburrow Stream was Sedimented in the spring and Moderately Sedimented in autumn. The River Wensum Downstream, Ringland Ditch and spring Foxburrow Stream samples produced PSI EQR scores below the threshold of 0.70, which is indicative of fine sediment pressure.

4.3.6. The macroinvertebrate communities identified in the samples classified most of the sites as Moderate to Fairly High conservation value with the exception of Hall Ditch, which achieved Fairly High conservation value in the spring and High conservation value in the autumn.

4.3.7. Hall Ditch was excluded from RICT analysis due to it not flowing during the spring and having very little to no flow during the autumn. RICT analysis does not apply to watercourses such as ditches with no flow.

RIVER INVERTEBRATE CLASSIFICATION TOOL

4.3.8. River Invertebrate Classification Tool analysis was performed to produce WFD status classifications for macroinvertebrates; outputs are summarised in **Table 4-4**.

Table 4-4 – RICT output for the macroinvertebrate sampling sites.

Site	Index	Spring EQR	Autumn EQR	Combined EQR	Overall classification	Confidence of class (%)
River Wensum Upstream	WHPT-ASPT	1.14	1.18	1.16	High	99.87
River Wensum Upstream	WHPT-NTAXA	0.97	1.18	1.07	High	99.87
River Wensum Downstream	WHPT-ASPT	0.89	0.87	0.88	Good	59.97

Site	Index	Spring EQR	Autumn EQR	Combined EQR	Overall classification	Confidence of class (%)
River Wensum Downstream	WHPT-NTAXA	1.33	0.83	1.08	Good	59.97
Foxburrow Stream	WHPT-ASPT	0.96	1.18	1.07	Moderate	52.96
Foxburrow Stream	WHPT-NTAXA	0.68	0.62	0.65	Moderate	52.96
Ringland Ditch	WHPT-ASPT	0.75	0.81	0.78	Moderate	78.40
Ringland Ditch	WHPT-NTAXA	0.83	0.53	0.69	Moderate	78.40

4.3.9. Foxburrow Stream and Ringland Ditch achieved Moderate status whilst the River Wensum Downstream and Upstream achieved Good and High status respectively.

4.3.10. The results indicate that the macroinvertebrate assemblages in Foxburrow Stream and Ringland Ditch are likely to be adversely affected by stressors such as pollution, flow pressures and anthropogenic activities. This is reflected in the WHPT NTAXA and WHPT ASPT EQR scores, which were below what would be expected under reference conditions.

MACROINVERTEBRATE ASSEMBLAGE AND CONSERVATION STATUS

4.3.11. The River Wensum Upstream spring sample contained large numbers of non-biting midge (Chironomidae), the blue-winged olive mayfly *Serratella ignita* and the grannom caddisfly *Brachycentrus subnubilus*. The amphipod *Gammarus pulex/fossarum* agg. was also recorded in large numbers in both seasons and dominated the autumn species assemblage.

4.3.12. The River Wensum Downstream site displayed the greatest diversity of taxa and contained more species and larger numbers of freshwater gastropod compared to the upstream site. The most abundant taxa in spring included non-biting midge, the faucet snail *Bithynia tentaculata* and the wandering snail *Radix balthica*. In autumn the sample was dominated by the faucet snail and the European stream valvata *Valvata piscinalis*.

4.3.13. Foxburrow Stream was dominated by amphipods (*Gammarus pulex/fossarum* agg. and *Gammarus pulex*), with limited numbers of other taxa (mostly Diptera).

4.3.14. Hall Ditch contained the lowest diversity of taxa with the assemblage of both seasons dominated by the water slater *Asellus aquaticus.* A single individual of the freshwater clam species *Sphaerium nucleus* was recorded in the spring sample, which is a new upstream record for the species in the Wensum catchment.

4.3.15. Ringland Ditch was dominated by freshwater clams and water slaters, with limited numbers of other taxa.

4.3.16. The invasive amphipod *Crangonyx pseudogracilis/floridanus* agg. was recorded in Hall Ditch and Ringland Ditch. A single *Physella gyrina*/*Haitia acuta*, an invasive freshwater snail, was found in the River Wensum downstream spring sample. The invasive non-native New Zealand mud snail was recorded in all samples taken from the River Wensum.

4.3.17. One species of note under Community Conservation Index scoring, the grannom caddisfly *Brachycentrus subnubilus* was identified in the samples, detailed in **Table 4-5**. A total of 560 individuals of the species were recorded in the River Wensum upstream sample, compared with 28 in autumn, and a single individual was found in the Foxburrow Stream autumn sample. The caddisfly has a conservation score of 6 and as such is Regionally Notable (uncommon in some parts of the country).

Table 4-5 – Macroinvertebrates identified with a Conservation Score of six or greater.

Latin name	Common name	Conservation Score	Status
Brachycentrus subnubilus	Grannom caddisfly	6	Regionally Notable

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Appendix A

MACROINVERTEBRATE TAXON LIST

Table A-1 – Aquatic macroinvertebrate taxon list including relevant Conservation Scores (CS) and abundance in spring (S) and autumn (A)

Order	Family	Species / taxon name	CS	River Wensum Upstream S	River Wensum Upstream A	River Wensum Downstream S	River Wensum Downstream A	Foxburrow Stream S	Foxburrow Stream A	Hall Ditch S	Hall Ditch A	Ringland Ditch S	Ringland Ditch A
AMPHIPODA	CRANGONYCTIDAE	*Crangonyx pseudogracilis/floridanus* agg.	-							23	5	36	
AMPHIPODA	GAMMARIDAE	*Gammarus fossarum*	-			2							
AMPHIPODA	GAMMARIDAE	*Gammarus pulex*	1					77	150				
AMPHIPODA	GAMMARIDAE	*Gammarus pulex/fossarum* agg.	-	252	342	1	1	60	244			6	
BIVALVIA	SPHAERIIDAE	*Pisidium* sp.	-	1		9		14	10			114	5
BIVALVIA	SPHAERIIDAE	*Pisidium subtruncatum*	1						1			30	3
BIVALVIA	SPHAERIIDAE	*Sphaerium corneum*	1	1		16	2					21	
BIVALVIA	SPHAERIIDAE	*Sphaerium nucleus*	-							1			
COLEOPTERA	DYTISCIDAE	*Agabus bipustulatus*	1					2				1	
COLEOPTERA	DYTISCIDAE	Dytiscinae	-										2
COLEOPTERA	DYTISCIDAE	Hydroporini	-			1							
COLEOPTERA	DYTISCIDAE	*Hydroporus memnonius*	4							1			
COLEOPTERA	DYTISCIDAE	*Hydroporus palustris*	1							1			
COLEOPTERA	DYTISCIDAE	*Hydroporus planus*	2							1			
COLEOPTERA	DYTISCIDAE	*Ilybius fuliginosus*	1									1	
COLEOPTERA	DYTISCIDAE	*Ilybius quadriguttatus*	5							1	1		
COLEOPTERA	DYTISCIDAE	*Ilybius* sp.	-					1					
COLEOPTERA	DYTISCIDAE	*Nebrioporus elegans*	1		2	5						1	
COLEOPTERA	ELMIDAE	*Elmis aenea*	1	10	44								
COLEOPTERA	ELMIDAE	*Limnius volckmari*	2	2	4								
COLEOPTERA	ELMIDAE	*Oulimnius* sp.	-			5							

Order	Family	Species / taxon name	CS	River Wensum Upstream S	River Wensum Upstream A	River Wensum Downstream S	River Wensum Downstream A	Foxburrow Stream S	Foxburrow Stream A	Hall Ditch S	Hall Ditch A	Ringland Ditch S	Ringland Ditch A
COLEOPTERA	ELMIDAE	*Oulimnius tuberculatus*	**2**		6	30	15						
COLEOPTERA	GYRINIDAE	*Gyrinus* sp.	**-**			3							
COLEOPTERA	GYRINIDAE	*Orectochilus villosus*	**3**		2		1						
COLEOPTERA	HALIPLIDAE	*Brychius elevatus*	**3**		2								
COLEOPTERA	HALIPLIDAE	*Haliplus obliquus*	**4**										1
COLEOPTERA	HALIPLIDAE	*Haliplus ruficollis* group.	**1**			1	1					1	1
COLEOPTERA	HALIPLIDAE	*Haliplus* sp.	**-**				1					2	5
COLEOPTERA	HYDRAENIDAE	*Hydraena riparia*	**1**		1				1				
COLEOPTERA	HYDROPHILIDAE	Hydrophilidae	**-**			2							
COLEOPTERA	SCIRTIDAE	*Elodes* sp.	**-**					3					
CYCLOPOIDA	N/A	Cyclopoida	**-**							1			
DIPTERA	CERATOPOGONIDAE	Ceratopogonidae	**-**	1		2		2	1			9	1
DIPTERA	CHIRONOMIDAE	Chironomidae	**-**	816	26	324	2	14	7	2		33	2
DIPTERA	CHIRONOMIDAE	Chironomini	**-**		14	91				1		9	7
DIPTERA	CHIRONOMIDAE	Prodiamesinae	**-**		5				6				3
DIPTERA	CHIRONOMIDAE	Tanypodinae	**-**		10	60	1	22	1			9	12
DIPTERA	CHIRONOMIDAE	Tanytarsini	**-**				1						1
DIPTERA	DIXIDAE	*Dixa* sp.	**-**						4		1		
DIPTERA	LIMONIIDAE	*Eloeophila* sp.	**-**						1				
DIPTERA	LIMONIIDAE	*Helius* sp.	**-**					2	1				
DIPTERA	PEDICIIDAE	*Dicranota* sp.	**-**		2								
DIPTERA	PTYCHOPTERIDAE	*Ptychoptera lacustris*	**-**					2	10				
DIPTERA	SCIOMYZIDAE	Sciomyzidae	**-**			1	1						
DIPTERA	SIMULIIDAE	*Simulium costatum*	**5**					4	9				

Order	Family	Species / taxon name	CS	River Wensum Upstream S	River Wensum Upstream A	River Wensum Downstream S	River Wensum Downstream A	Foxburrow Stream S	Foxburrow Stream A	Hall Ditch S	Hall Ditch A	Ringland Ditch S	Ringland Ditch A
DIPTERA	SIMULIIDAE	*Simulium lundstromi*	**4**					4					
DIPTERA	SIMULIIDAE	*Simulium* sp.	**-**			1			12				
DIPTERA	STRATIOMYIDAE	*Odontomyia* sp.	**-**		1								
DIPTERA	STRATIOMYIDAE	*Oxycera* sp.	**-**					1					
EPHEMEROPTERA	BAETIDAE	Baetidae	**-**						2				
EPHEMEROPTERA	BAETIDAE	*Baetis atlanticus/rhodani* agg.	**1**	36			1	2					
EPHEMEROPTERA	BAETIDAE	*Centroptilum luteolum*	**4**				1						
EPHEMEROPTERA	BAETIDAE	*Cloeon simile*	**2**			2	1						
EPHEMEROPTERA	CAENIDAE	*Caenis luctuosa*	**1**	2								1	
EPHEMEROPTERA	EPHEMERELLIDAE	*Serratella ignita*	**1**	248		24							
EPHEMEROPTERA	EPHEMERIDAE	*Ephemera danica*	**1**		3								
EPHEMEROPTERA	EPHEMERIDAE	*Ephemera* sp.	**-**		12								
GASTROPODA	ACROLOXIDAE	*Acroloxus lacustris*	**2**		2	5				5		1	
GASTROPODA	ANCYLIDAE	*Ancylus fluviatilis*	**1**	8									
GASTROPODA	BITHYNIIDAE	*Bithynia leachii*	**5**			31							2
GASTROPODA	BITHYNIIDAE	*Bithynia tentaculata*	**1**	4	39	546	156					30	
GASTROPODA	HYDROBIIDAE	*Potamopyrgus antipodarum*	**1**	18	24	15	2						
GASTROPODA	LYMNAEIDAE	*Galba truncatula*	**3**				1						
GASTROPODA	LYMNAEIDAE	*Lymnaea stagnalis*	**1**			2	20						
GASTROPODA	LYMNAEIDAE	*Radix balthica*	**-**	1	8	314	11					28	3
GASTROPODA	LYMNAEIDAE	*Stagnicola palustris*	**2**			3						4	
GASTROPODA	NERITIDAE	*Theodoxus fluviatilis*	**3**	35	15	1	1						
GASTROPODA	PHYSIDAE	*Physa fontinalis*	**1**				17						

Order	Family	Species / taxon name	CS	River Wensum Upstream S	River Wensum Upstream A	River Wensum Downstream S	River Wensum Downstream A	Foxburrow Stream S	Foxburrow Stream A	Hall Ditch S	Hall Ditch A	Ringland Ditch S	Ringland Ditch A
GASTROPODA	PHYSIDAE	*Physa* sp.	-			88							
GASTROPODA	PHYSIDAE	*Physella gyrina/Haitia acuta*	-			1							
GASTROPODA	PLANORBIDAE	*Anisus vortex*	1			7	14						
GASTROPODA	PLANORBIDAE	*Gyraulus albus*	1		2	15	3						
GASTROPODA	PLANORBIDAE	*Planorbarius corneus*	4			3							
GASTROPODA	PLANORBIDAE	*Planorbis carinatus*	1		1	9	1						
GASTROPODA	SUCCINEIDAE	*Succinea putris*	1				11			2			
GASTROPODA	VALVATIDAE	*Valvata cristata*	2			50	17			1			
GASTROPODA	VALVATIDAE	*Valvata piscinalis*	1	1	96	55	241					21	1
GASTROPODA	VIVIPARIDAE	*Viviparus viviparus*	3			1							
HEMIPTERA	CORIXIDAE	Corixidae	-			1							
HEMIPTERA	CORIXIDAE	*Sigara dorsalis*	1			2							
HEMIPTERA	APHELOCHEIRIDAE	*Aphelocheirus aestivalis*	5	53	58	1	4					3	
HEMIPTERA	NOTONECTIDAE	*Notonecta glauca*	1				1						
HEMIPTERA	NOTONECTIDAE	*Notonecta maculata*	5				1						
HEMIPTERA	NOTONECTIDAE	*Notonecta viridis*	5				1						
HEMIPTERA	PLEIDAE	*Plea minutissima*	4			1							
HIRUDINEA	ERPOBDELLIDAE	Erpobdella	-		1								
HIRUDINEA	ERPOBDELLIDAE	*Erpobdella octoculata*	1			3	1					5	
HIRUDINEA	ERPOBDELLIDAE	*Erpobdella* sp.	-									3	
HIRUDINEA	GLOSSIPHONIDAE	*Glossiphonia complanata*	1		5							10	
ISOPODA	ASELLIDAE	*Asellus aquaticus*	1	1	2	50	23		1	80	20	50	3
ISOPODA	ASELLIDAE	*Prosellus meridianus*	3					4					

Order	Family	Species / taxon name	CS	River Wensum Upstream S	River Wensum Upstream A	River Wensum Downstream S	River Wensum Downstream A	Foxburrow Stream S	Foxburrow Stream A	Hall Ditch S	Hall Ditch A	Ringland Ditch S	Ringland Ditch A
MEGALOPTERA	SIALIDAE	*Sialis lutaria*	**1**		2							2	3
N/A	N/A	Cyclopoida	**-**								1		
ODONATA	AESHNIDAE	*Aeshna cyanea*	**2**			2							
ODONATA	CALOPTERYGIDAE	Calopteryx	**-**	5		36							
ODONATA	CALOPTERYGIDAE	*Calopteryx* sp.	**-**		6		3						
ODONATA	CALOPTERYGIDAE	*Calopteryx splendens*	**2**	5	8	7	4						
ODONATA	COENAGRIONIIDAE	Coenagrioniidae	**-**			2	2						
OLIGOCHAETA	OLIGOCHAETA	Oligochaeta	**-**	25	6	14	1			1	1	21	7
PLECOPTERA	LEUCTRIDAE	*Leuctra geniculata*	**4**		1								
PLECOPTERA	LEUCTRIDAE	*Leuctra* sp.	**-**		1								
PLECOPTERA	LEUCTRIDAE	*Nemoura* sp.	**-**						2				
PLECOPTERA	NEMOURIDAE	*Nemurella picteti*	**2**					3					
TRICHOPTERA	BERAEIDAE	*Beraea pullata*	**4**						2				
TRICHOPTERA	BERAEIDAE	*Beraeodes minutus*	**5**										5
TRICHOPTERA	BRACHYCENTRIDAE	*Brachycentrus subnubilus*	**6**	560	28				1				
TRICHOPTERA	HYDROPSYCHIDAE	*Hydropsyche contubernalis*	**4**		12								
TRICHOPTERA	HYDROPSYCHIDAE	*Hydropsyche pellucidula*	**2**	24	22								
TRICHOPTERA	HYDROPSYCHIDAE	*Hydropsyche siltalai*	**1**	186									
TRICHOPTERA	HYDROPSYCHIDAE	*Hydropsyche* sp.	**-**		28								
TRICHOPTERA	HYDROPTILIDAE	*Hydroptila* sp.	**-**	110									
TRICHOPTERA	LEPIDOSTOMATIDAE	*Lepidostoma hirtum*	**2**	2									
TRICHOPTERA	LEPTOCERIDAE	*Athripsodes aterrimus*	**1**									4	
TRICHOPTERA	LEPTOCERIDAE	*Athripsodes* sp.	**-**	1								4	

Order	Family	Species / taxon name	CS	River Wensum Upstream S	River Wensum Upstream A	River Wensum Downstream S	River Wensum Downstream A	Foxburrow Stream S	Foxburrow Stream A	Hall Ditch S	Hall Ditch A	Ringland Ditch S	Ringland Ditch A
TRICHOPTERA	LEPTOCERIDAE	*Ceraclea albimacula*	**7**			1							
TRICHOPTERA	LEPTOCERIDAE	*Mystacides* sp.	**-**		1								
TRICHOPTERA	LIMNEPHILIDAE	*Anabolia nervosa*	**2**									1	
TRICHOPTERA	LIMNEPHILIDAE	Limnephilidae	**-**		1	2							
TRICHOPTERA	LIMNEPHILIDAE	*Limnephilus lunatus*	**1**	2		16	1	8		1		10	
TRICHOPTERA	LIMNEPHILIDAE	*Limnephilus* sp.	**-**			4						3	
TRICHOPTERA	LIMNEPHILIDAE	*Micropterna lateralis*	**2**	2									
TRICHOPTERA	POLYCENTROPODIDAE	*Plectrocnemia conspersa*	**2**					1					
TRICHOPTERA	POLYCENTROPODIDAE	*Polycentropus* sp.	**-**		6								
TRICHOPTERA	SERICOSTOMATIDAE	*Sericostoma personatum*	**1**		2	1							
TRICLADIDA	DUGESIIDAE	*Dugesia tigrina*	**3**							1			
TRICLADIDA	N/A	Tricladida	**-**							2			
TRICLADIDA	PLANARIIDAE	*Polycelis nigra/tenuis*	**1**					2					
TROMBIDIFORMES	N/A	Hydracarina	**-**			1				23		9	
Total no. of taxa			29	42	53	37	20	20	17	6	33	19	
Total abundance			2412	853	1870	566	228	466	125	29	483	67	

Appendix B

SITE PHOTOGRAPHS

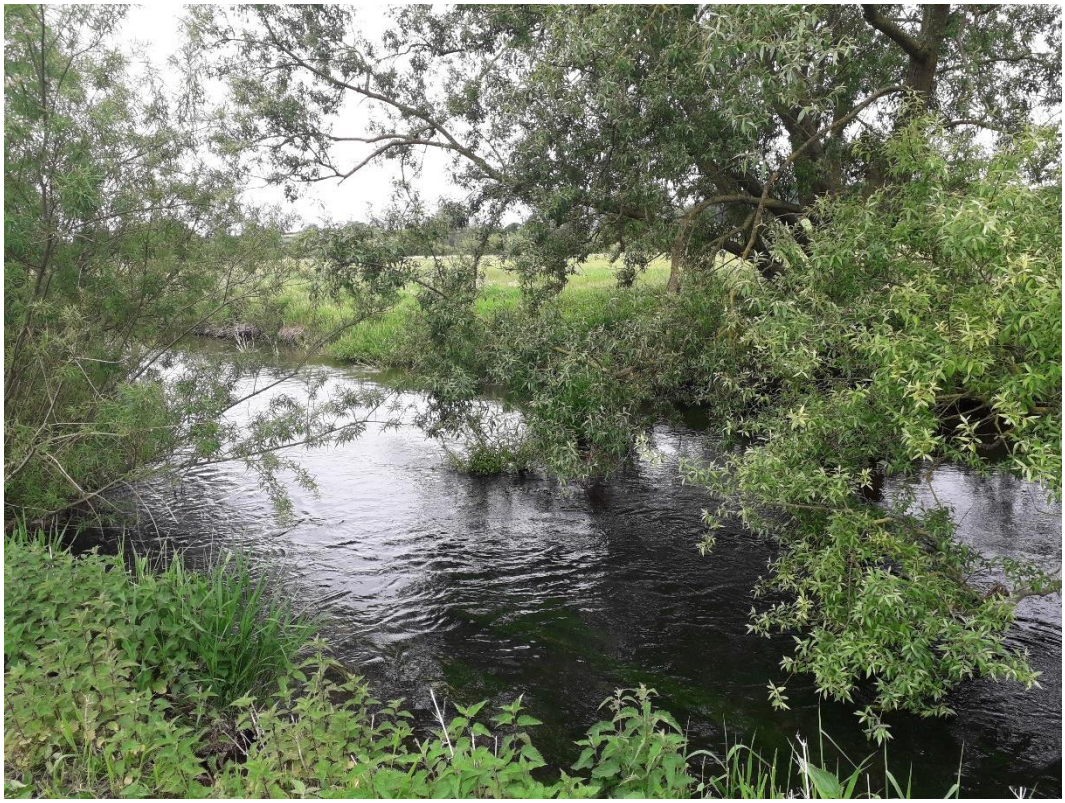

Figure B-1 - River Wensum Upstream aquatic macroinvertebrate sampling location

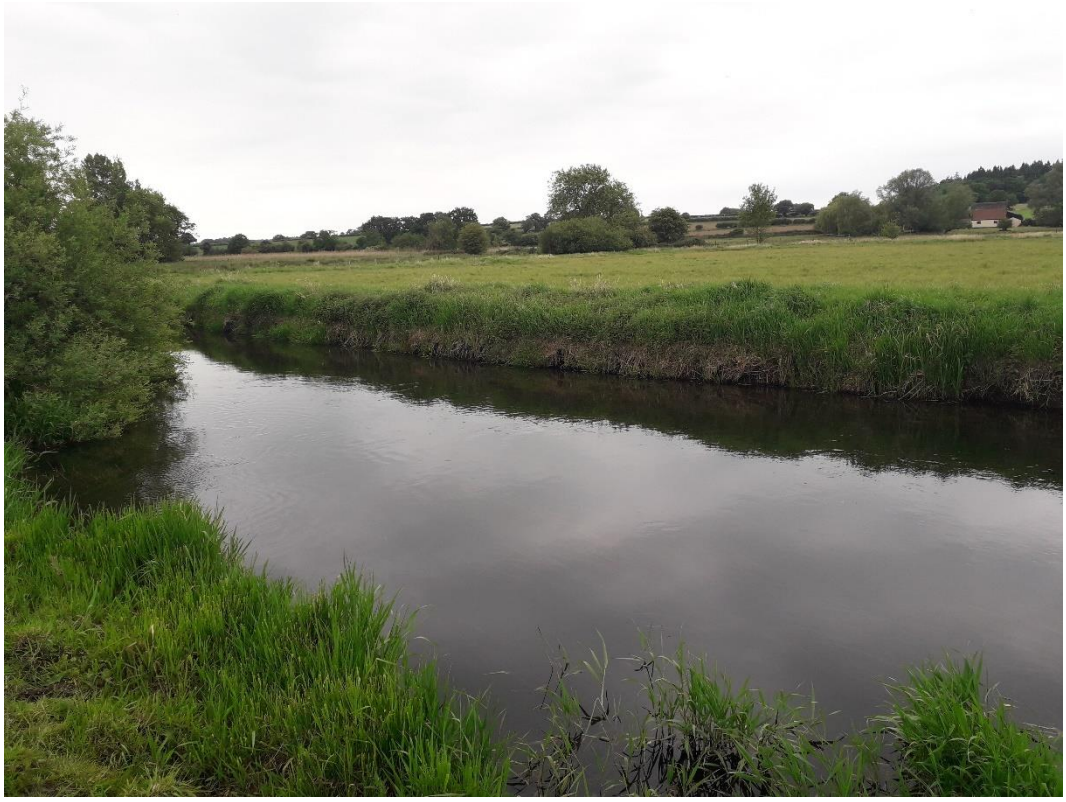

Figure B-2 - River Wensum Downstream aquatic macroinvertebrate sampling location

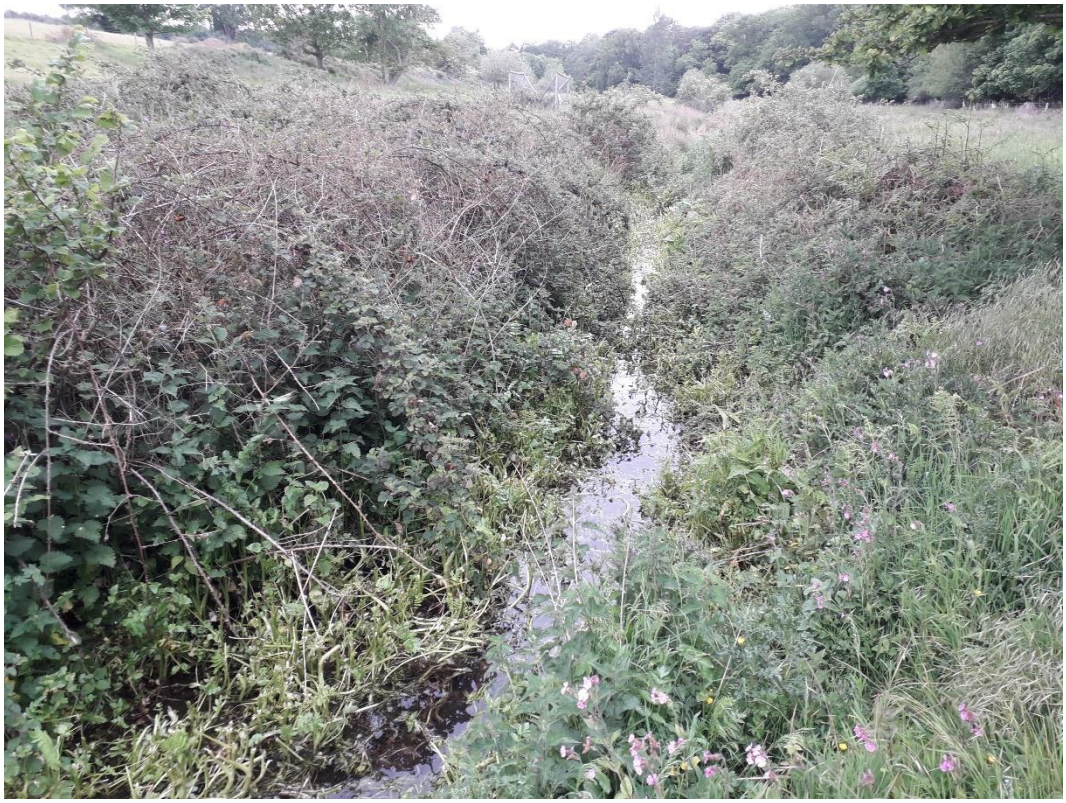

Figure B-3 – Foxburrow Stream aquatic macroinvertebrate sampling location

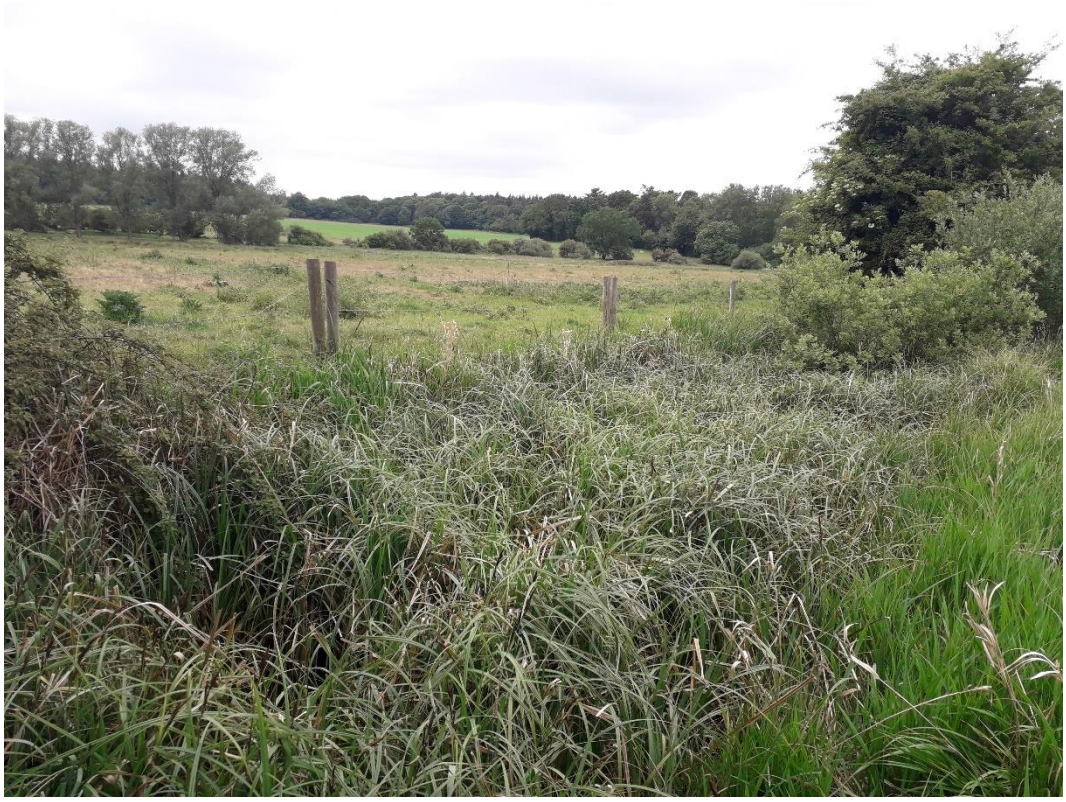

Figure B-4 – Hall Ditch aquatic macroinvertebrate sampling location

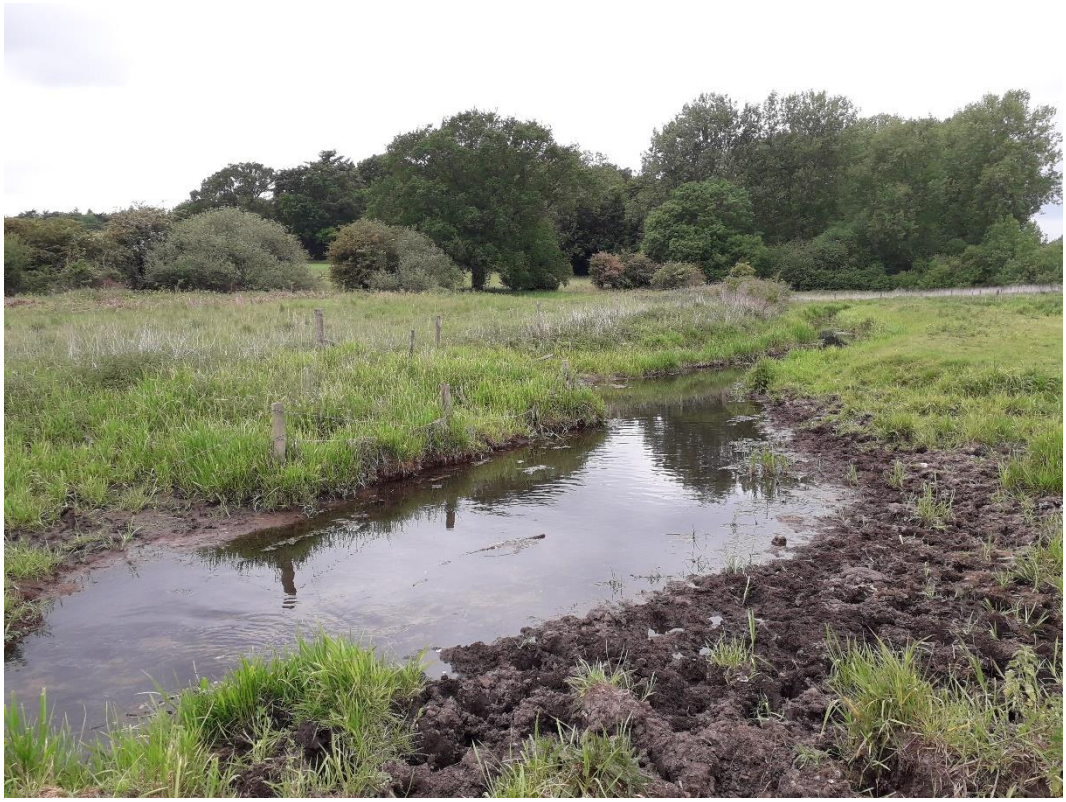

Figure B-5 – Ringland Ditch aquatic macroinvertebrate sampling location

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