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6.4 Environmental Statement
Appendix 8.22 Aquatic Invertebrate
Survey Report

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**6.4 Environmental Statement Appendix 8.22 Aquatic Invertebrate
Survey Report**

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Foreword

This report sets out the results of aquatic invertebrate field surveys undertaken in November 2019, May 2020 and September 2020. The objective of these surveys was to collect quantifiable data from the tributary of Norman's Brook as it would be realigned by the scheme. Data from the River Frome, River Churn, Horsebere Brook and Painswick stream also informs the assessment. This report should be read in conjunction with the other aquatic survey reports associated with the scheme to gain a full appreciation of the overall aquatic and semi-aquatic species assemblages, namely:

- ES Appendix 8.23 River Habitat Survey and Fish Habitat Assessment Report (2020) (Document Reference 6.4)
- ES Appendix 8.19 White-Clawed Crayfish Technical Report (2019) (Document Reference 6.4)
- ES Appendix 8.15 Great Crested Newt Survey Report (2019) (Document Reference 6.4)
- ES Appendix 8.17 Otter Technical Report (2019) (Document Reference 6.4)
- ES Appendix 8.18 Water Vole Technical Report (2019) (Document Reference 6.4)

Executive summary

This report presents the methodology and baseline survey data recorded from review of environmental records from 2000 to 2019 and field surveys conducted in 2019 to 2020 across the scheme.

Following a desk study records search, 11 species of conservation value were found within the scheme and wider river network.

Baseline invertebrate samples were taken from seven sites on three sampling occasions (Autumn 2019, Spring 2020, Autumn 2020) using industry standard kick sampling and manual hand-searching methods in line with best practice (European Committee of Standardisation, 2014).

Baseline data identified the presence of a nationally notable invertebrate species in the tributary of Norman's Brook. The invasive non-native species (INNS) signal crayfish was recorded in a tributary of the River Churn. Invertebrate community conservation value ranged from low to very high across the survey sites.

A complete assessment of potential impacts to macroinvertebrate communities has been undertaken within ES Chapter 8 Biodiversity (Document Reference 6.2), along with details of mitigation such as alternative habitat creation, and compensation measures as appropriate.

1 Introduction

1.1 Purpose of this document

1.1.1 This document is a report which details baseline data for aquatic macroinvertebrates collected from desk studies and field survey carried out in autumn 2019 and spring 2020. This report informs the Environmental Impact Assessment (EIA) and Water Framework Directive (WFD) Compliance Assessment (ES Appendix 13.2, Document Reference 6.4) of the A417 Missing Link Scheme 'the scheme'.

1.2 Scope of the report

1.2.1 This technical report outlines the survey scoping, methodology and results for aquatic macroinvertebrates for the scheme. It is beyond the scope of this report to outline an assessment of effects or detail the need for measures to avoid or mitigate effects on the ecological features discussed. These are reported in ES Chapter 8 Biodiversity (Document Reference 6.2).

2 Methodology

2.1 Overview

2.1.1 Details of the methodology used for establishing the ecological baseline for aquatic macroinvertebrates are provided below.

2.2 Survey guidance

2.2.1 The following survey guidance has been considered in the methodology design. Any deviation from this guidance is noted in section 2.4 Field survey methodology.

2.2.2 Best practice guidance for the undertaking of aquatic macroinvertebrate surveys and assessment is provided in BS EN ISO 10870:2012 (European Committee of Standardization, 2014).

2.2.3 Macroinvertebrate sampling and taxonomic analysis was undertaken in accordance the Environment Agency's standard macroinvertebrate sampling and analysis manual – BT001 (Murray-Bligh, 1999) and standard River Invertebrate Prediction and Classification System (RIVPACS) procedures (EU-STAR, 2004).

2.2.4 Macroinvertebrate sample analysis was undertaken to RIVPACS Taxonomic Level 5 (TL5), as described in the SNIFFER (Scotland and Northern Ireland Forum for Environmental Research) document 'Further Development of River Classification Tool (Davy-Bowker et al., 2010).

Desk study

2.2.5 Macroinvertebrate data was obtained via a data request from the Environment Agency (EA). Data was requested from six waterbodies which either fall within the scheme or within the wider river network. The desk study documents any notable and protected macroinvertebrates present in this EA data.

2.2.6 Data was received from the following sites:

- River Churn - source to Perrots Brook (WFD ID: GB106039029810);
- River Frome - source to Ebley Mill (WFD ID:GB109054032470);

- Horsebere Brook - source to confluence River Severn (WFD ID: GB109054032760);
- Hatherley Brook – source to River Severn (WFD ID: GB109054032801);
- Painswick Stream - source to confluence Stroudwater (WFD ID: GB109054032460); and
- Norman's Brook - source to confluence Hatherley Brook (WFD ID: GB109054032780).

2.3 Survey scoping and design

2.3.1 Prior to field surveys commencing, scoping activities were undertaken by the aquatic ecology lead for the project to identify rivers and streams within the scheme boundary as shown on ES Figure 2.1 General Arrangement (Document Reference 6.3) and the wider river network. Scoping activities included site visits, a review of desk study information, Ordinance Survey mapping, aerial imagery, available information on the scheme and consultation with various stakeholders including the EA, Natural England and Highways England.

2.3.2 In order to determine the baseline condition for macroinvertebrates, seven sites were selected based on the results of scoping. This forms the Macroinvertebrate Survey Area as shown on ES Figure 8.21 Aquatic Macroinvertebrate Monitoring Sites (Document Reference 6.3). Survey sites were selected to be representative of the rivers within the scheme boundary and wider river network and located to capture the spatial variation in habitat available within these localities.

2.3.3 The following waterbodies were identified as requiring field surveys for macroinvertebrates:

- Tributary of Norman's Brook:
 - 3 sites surveyed
- Tributary of the River Churn:
 - 2 sites surveyed
- Tributary of the River Frome:
 - 2 sites surveyed

2.3.4 Survey locations are shown on ES Figure 8.21 Aquatic Macroinvertebrate Monitoring Sites (Document Reference 6.3) and Table 2-1.

Table 2-1 Sample sites, associated waterbodies and grid references where field surveys occurred in 2019

Sample site	Waterbody	NGR
AQ1	Tributary of Norman's Brook	SO 91322 16454
AQ2	Tributary of Norman's Brook	SO 92512 15678
AQ3	Tributary of River Frome Springhead	SO 94387 13340
AQ4	Tributary of River Frome	SO 94678 12757
AQ5	Tributary of River Churn	SO 96441 15529
AQ6	Tributary of River Churn	SO 95009 16256
AQ7	Tributary of Norman's Brook Springhead	SO 92690 15698

- 2.3.5 To enable an integrated understanding of the aquatic ecology baseline, where practicable, macroinvertebrate survey sites were aligned with surface water quality monitoring locations and hydrological monitoring locations. In addition to sampling streams, springheads connected to the streams were also sampled to identify any specialist species present. Observations from River Habitat Surveys (RHS) undertaken in 2019 were also used to identify appropriate macroinvertebrate sampling sites. This information was used to identify the presence of pools, riffles, flowing water biotypes and to determine whether these biotypes were representative of the wider reach being assessed.
- 2.3.6 Due to a lack of records within the scheme boundary, EA desk study data as shown on ES Figure 8.20 Environment Agency (Desk Study) Aquatic Macroinvertebrate Monitoring Sites (Document Reference 6.3), was also included to provide further understanding of the catchments in proximity of the scheme. This includes data from two waterbodies;
- Painswick Stream; and
 - Horsebere Brook.

2.4 Field survey methodology

Field surveys

- 2.4.1 In accordance with British Standards (BS EN ISO 10870:2012) all samples comprised three minutes of kick sampling, where sediment is disturbed forcefully by foot and the released material caught in a square pond net, and a one-minute manual search. The one-minute manual search included sweeping of the water surface to capture surface-dwelling macroinvertebrates and a search of cobbles, stones and woody debris to capture species that may be attached to the submerged substrates.
- 2.4.2 Environmental data pertaining to the sampling area, banks and surrounding area were collected alongside each sample. These data included the predictor variables (watercourse width, depth, substrate composition) required for River Invertebrate Classification Tool (RICT) analysis (EU-STAR, 2004). Site photos were also taken and are available in Appendix A of this report.
- 2.4.3 Labelled sample pots were stored in a cool box (kept between 1-3°C) until preservation later that day in Industrial Methylated Spirit (IMS).

Survey period

- 2.4.4 Autumn macroinvertebrate samples were collected on 28 and 29 November 2019 as well as 22 September 2020 in accordance with the autumn macroinvertebrate sampling season (September to November).
- 2.4.5 Spring macroinvertebrate samples were collected on 19 and 20 May 2020 in accordance with the spring macroinvertebrate sampling season (March to May).

Survey conditions

- 2.4.6 All samples were collected in periods of normal flow.

2.5 Data analysis methodology

Sample analysis

- 2.5.1 Macroinvertebrate samples were analysed in the laboratory to RIVPACS Taxonomic Level 5 (TL5) (Davy-Bowker et al., 2010). For each given sample, the

taxa present and their abundance were recorded. This is predominantly to species-level with exceptions where this would either involve disproportionate effort (for example aquatic worms) or it is not possible (for example many true fly larvae). Within this framework, individuals were identified to the highest taxonomic level possible given their life stage and condition. This level of taxonomic identification enabled calculation of biological indices (described below), the detection of non-native species, and species of conservation value.

Biological indices overview

2.5.2 The resulting datasets were used to calculate the following biological indices, which were used to evaluate the condition and/or conservation value of the sampled macroinvertebrate communities:

- Whalley, Hawkes, Paisley and Trigg Average Score Per Taxon (WHPT ASPT) (WFD-UKTAG, 2014) – an index used to assess the general degradation of rivers.
- Whalley, Hawkes, Paisley and Trigg No. of Taxa (WHPT NTAXA) (WFD-UKTAG, 2014) – the number of taxa which score within the WHPT system.
- The Lotic Invertebrate Index Flow Evaluation (LIFE) index (Extence et al., 1995) – an index used to assess whether riverine macroinvertebrate communities are sensitive to low flow pressure.
- Proportion of Sediment-sensitive invertebrates (PSI) index (Extence et al., 2011) – an index used to assess whether macroinvertebrate communities are affected by deposition of fine sediment.
- Community Conservation Index (CCI) (Chadd and Extence, 2004) – used to evaluate the conservation value of freshwater macroinvertebrate communities.

Protected and notable species

2.5.3 Recorded species were cross-referenced with the following lists to identify UK taxa with a conservation designation:

- Bern Convention on the Conservation of European Wildlife and Natural Habitats (1979)
- Natural Environment and Rural Communities Act 2006 - Species of Principal Importance in England (section 41)
- The Conservation of Habitats and Species Regulations 2017
- The IUCN Red List of Threatened Species (2020)
- Wildlife and Countryside Act 1981 Schedules 1, 5 and 8 (protected birds, animals and plants)

2.5.4 Taxa were also cross referenced with species listed under the Wildlife and Countryside Act 1981 Schedule 9, Invasive Freshwater shrimps and Isopods (Freshwater Biological Association, 2012) and the Great Britain Non-native Species Secretariat website (2020) to identify macroinvertebrate invasive non-native species recorded at the survey sites.

2.5.5 The CCI system was used to indicate the conservation value of waterbodies with regards to macroinvertebrates. The system takes account of the richness of the invertebrate community and the rarity of species within it (on a scale of 1 to 9), to generate a single CCI score for the sample. This score equates to one of five conservation value categories shown in Table 2-2. CCI scores from EA monitoring sites are shown in Table B-2 in Appendix B of this report. Field results from this analysis are shown in Table 3-2.

Table 2-2 Community conservation categories

CCI Score	Conservation categories
0 – 5.0	Low conservation value
>5.0 – 10.0	Moderate conservation value
>10.0 – 15.0	Fairly high conservation value
>15.0 – 20	High conservation value
>20.0	Very high conservation value

Water Framework Directive data analysis

- 2.5.6 Following WFD-UKTAG (2014) guidance and using the River Invertebrate Classification Tool (RICT), WHPT ASPT and WHPT NTAXA values were processed to produce ecological quality ratios (EQRs) at each site, which were then used to provide indicative WFD statuses. This provides an indication of the extent to which the macroinvertebrate communities have been impacted by human activities at each site, as shown in Table 2-3.
- 2.5.7 RICT was used to provide EQR and WFD status values for 2020 through combined classification of 2020 spring and autumn data. Autumn 2019 data was classified as a single season.

Table 2-3 WFD class boundaries for macroinvertebrates

Class	WHPT NTAXA EQR	WHPT ASPT EQR	Description
High	≥0.80	≥0.97	Near natural conditions
Good	0.68 – 0.80	0.86 – 0.97	Slight change from natural conditions as a result of human activity
Moderate	0.56 – 0.68	0.72 – 0.86	Moderate change from natural conditions as a result of human activity
Poor	0.47-0.56	0.59 – 0.72	Major change from natural conditions as a result of human activity
Bad	<0.47	<0.59	Severe change from natural conditions as a result of human activity

2.6 Deviations, constraints and limitations

- 2.6.1 WFD-UKTAG (2014) guidance requires macroinvertebrate sampling to be undertaken in spring and autumn of the same year to allow a combined annual WFD classification to be generated.
- 2.6.2 Autumn 2020 sampling was carried out at five sites. Access was not available for sites AQ2 and AQ7 to undertake further surveys.
- 2.6.3 Typically, environmental record searches consider records up to ten years old, however, to find sufficient data to inform the baseline for some areas, records were considered for a longer period dating back to 2000. This is considered a limitation as more up-to-date data was not available for these areas. The age of data for these areas may mean that some results are not fully representative of current conditions within the watercourse.

3 Results

3.1 Desk study results

- 3.1.1 The EA data provided records of 11 invertebrate species of conservation value within 2km of the scheme boundary; as detailed in Appendix B of this report. One Invasive Non-Native Species (INNS) was also reported within the scheme boundary and is detailed in Table B-1, Appendix B of this report, and highlighted in red. CCI scores for each river sample has been shown in Table B-2, Appendix B of this report.
- 3.1.2 EA macroinvertebrate survey sites for the period 2000 to 2019 and their locations are shown in ES Figure 8.20 Environment Agency (Desk Study) Aquatic Macroinvertebrate Monitoring Sites (Document Reference 6.3). Site ID and Site name are shown in Table 3-1.

Table 3-1 Site names and their EA monitoring site ID

Site ID	Site name
35164	U/S Colesbourne
35765	Colesbourne (old site)
36222	North Cerney
89727	Butler's Farm, Colesbourne
48318	Stratford Park
51904	Edgeworth Mill Farm
170423	U/S Millbrook Academy
170424	Millbrook Academy
170425	Brockworth Sports Ground
159488	Halfway Bridge

3.2 Field survey results

- 3.2.1 Invertebrate samples were collected in autumn 2019 and spring 2020 at the seven sites, totalling 14 invertebrate samples. A further five samples were taken from sites AQ1, AQ3, AQ4, AQ5 and AQ6 in autumn 2020. Observed WHPT, PSI, and LIFE scores for each sample are shown in Table B-3. CCI scores for each river sample are displayed in Table 3-2.
- 3.2.2 INNS and species of conservation value recorded during baseline surveys are detailed in Table 3-3. Species of conservation value found during baseline surveys and full biological indices created from EA baselines studies are noted in Table B-4 - Appendix B of this report.
- 3.2.3 In addition to the INNS specified in Table 3-3, one non-native shrimp *Gammarus fossarum* was recorded at all baseline sites. This species is not listed under the Wildlife and Countryside Act 1981 Schedule 9 and has only recently been discovered in the United Kingdom but is now known to be widespread across the south of England (Blackman et al, 2017).

Table 3-2 CCI scores generated from baseline surveys

Waterbody	Site name	CCI autumn 2019	Conservation Value autumn 2019	CCI spring 2020	Conservation Value spring 2020	CCI autumn 2020	Conservation Value autumn 2020
Tributary of Norman's Brook	AQ1	12.73	Fairly high	6.3	Moderate	6.00	Moderate
	AQ2	20.56	Very high	20.46	Very high	N/A	N/A
	AQ7	10.38	Fairly high	10	Fairly high	N/A	N/A
Tributary of the River Frome	AQ3	3.67	Low	10.5	Fairly high	4.00	Moderate
	AQ4	8.5	Moderate	6	Moderate	10.83	Fairly high
Tributary of the River Churn	AQ5	11.11	Fairly high	7.69	Moderate	6.75	Moderate
	AQ6	17.18	High	10.45	Fairly high	10.36	Fairly high

Table 3-3 Species of conservation value and INNS recorded in baseline surveys

Site	Scientific name	Common name	Designation(s)
AQ2	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable
AQ5	<i>Pacifastacus leniusculus</i>	Signal Crayfish	Wildlife and Countryside Act, Section 9, Part 1

3.3 Water Framework Directive data analysis

3.3.1 WFD EQRs were generated through RICT using spring and autumn 2020 data. Table 3-4 displays EQR values for WHPT NTAXA and WHPT ASPT indices as combined season classifications, based on spring and autumn data. The overall WFD status for each sample based on these EQR values are also provided.

Table 3-4 Ecological Quality Ratios and Indicative Water Framework Directive Statuses

Site	2020 Classification		
	WHPT NTAXA EQR	WHPT ASPT EQR	WFD Status
AQ1*	0.60	0.88	Moderate
AQ2*	0.78	0.84	Moderate
AQ3*	0.76	0.78	Moderate
AQ4	0.54	0.89	Poor
AQ5	0.67	0.93	Moderate
AQ6*	0.72	0.83	Moderate
AQ7*	0.98	0.82	Moderate

*Sites where RICT classifications have low suitability within the model

3.3.2 The RICT model is designed to generate EQR values on rivers which are naturally permanently flowing. As some of the sites are located close to their source and may therefore not support permanent flow, RICT has indicated a low suitability for these sites to produce reliable EQR values. These sites are indicated within the table. In these instances it is advised that interpretation of the baseline quality of the macroinvertebrate community at these sites relies on raw index scores rather than EQR values.

3.4 Data analysis results

Tributary of Norman's Brook

- 3.4.1 The WFD waterbody 'Norman's Bk - source to confluence Hatherley Bk' (GB109054032780) was Classified by the EA as 'good' for the macroinvertebrate element in 2016 Cycle 2. This suggests that the macroinvertebrate communities within this waterbody may be slightly deviated from pristine quality due to human activities.
- 3.4.2 Three sites on the tributary of Norman's Brook were sampled in 2019 and 2020 (AQ1, AQ2 and AQ7). However Autumn 2020 data was not available for sites AQ2 and AQ7.
- 3.4.3 Site AQ1 produced CCI scores ranging between 6 and 12.73 across the three sampled seasons. This indicates that it supports invertebrate communities of a fairly high conservation value. The WHPT NTAXA scores ranged between 10 and 14. The WHPT ASPT scores ranged between 4.73 and 5.27. This data reflects a community of moderate diversity and good proportions of invertebrates sensitive to general degradation. No INNS or species of conservation value were found during baseline surveys.
- 3.4.4 Site AQ2 produced CCI scores of 20.56 and 20.46 in autumn 2019 and spring 2020 respectively. This indicates that it supports invertebrate communities of a very high conservation value. The WHPT NTAXA scores were calculated to be 18 and 14 in autumn and spring respectively. The WHPT ASPT scores were calculated to be 5.71 and 5.36 in autumn and spring respectively. This data reflects a community of good diversity and good proportions of invertebrate sensitive to general degradation. One species of conservation value was recorded at AQ2; the riffle beetle *Riolus subviolaceus* which is considered to be nationally notable.
- 3.4.5 Site AQ7 produced CCI scores of 10.38 and 10 in autumn 2019 and spring 2020 respectively. This indicates that it supports invertebrate communities of a fairly high conservation value. The WHPT NTAXA scores were calculated to be 16 and 13 in autumn and spring respectively. The WHPT ASPT scores were calculated to be 5.74 and 4.62 in autumn and spring respectively. This data reflects a community of moderate diversity and moderate to poor proportions of invertebrates sensitive to general degradation. No notable species or INNS were found during baseline surveys.
- 3.4.6 The EA provided data for one site on the tributary of Norman's Brook, 'Halfway bridge, ID: 159488', spanning through 2013 to 2016. CCI scores for this site varied from 3.75 to 7.92. During baseline surveys at the EA site 'Halfway Bridge, ID: 159488', no INNS or species of conservation value were recorded.

River Frome

- 3.4.7 The WFD waterbody 'Frome - source to Ebley Mill' (GB109054032470) was classified by the EA as 'high' for the macroinvertebrate element in 2016 Cycle 2. This suggests that the macroinvertebrate communities within this waterbody represent those found in near-natural conditions.
- 3.4.8 Two sites on tributaries of the River Frome were sampled, in 2019 and 2020 (Sites AQ3 and AQ4).
- 3.4.9 Site AQ3 produced CCI scores which ranged between 3.67 and 10.5. This indicates that it supports invertebrate communities of a fairly high conservation

value. The WHPT NTAXA scores ranged between 10 and 12. The WHPT ASPT scores ranged between 3.82 and 5.92. This data reflects a community of poor diversity and poor to good proportions of invertebrates sensitive to general degradation. No INNS or species of conservation value were found during baseline surveys.

- 3.4.10 Site AQ4 produced CCI scores which ranged between 6 and 10.83. This indicates that it supports invertebrate communities of fairly high conservation value. The WHPT NTAXA EQR values indicate low macroinvertebrate community diversity in overall classification for 2020 samples which were consistent with poor WFD status. The WHPT ASPT EQR values indicate good proportions of taxa sensitive to general degradation, consistent with good WFD status. No INNS or species of conservation value were found during baseline surveys.
- 3.4.11 EA invertebrate for 'Edgeworth Mill Farm, ID: 51904' spanned from 2009 to 2019. 'Edgeworth Mill Farm' had CCI scores varying between a low of 7 (classified as moderate, 2009) and a high of 19.6 (classified as high, 2017). A search of existing EA data for the River Frome identified the presence of:
- one nationally rare species - *Synagapetus dubitans*;
 - two nationally scarce and notable species - *Riolus subviolaceus*, and *Riolus cupreus*; and
 - two nationally scarce species - *Hydropsyche saxonica* and *Wormalida subnigra*
- 3.4.12 The invasive signal crayfish *Pacifastacus leniusculus* listed under the Wildlife and Countryside Act Section 9, Part 1 was also recorded at this site in 2017.

River Churn

- 3.4.13 The WFD waterbody 'Churn – source to Perrots brook' (GB106039029810) was classified by the EA as 'high' for the macroinvertebrate quality element in 2016 Cycle 2. This suggests that the macroinvertebrate communities within this waterbody are characteristic of those found in near-natural conditions.
- 3.4.14 Two sites on tributaries of the River Churn were sampled, in 2019 and 2020 (Sites AQ5 and AQ6).
- 3.4.15 Site AQ5 produced CCI scores which ranged between 6.75 and 11.11. This indicates that it supports invertebrate communities of a fairly high conservation value. The WHPT NTAXA EQR values indicate macroinvertebrate community diversity in overall classification for 2020 samples which were consistent with moderate WFD status. The WHPT ASPT EQR values indicate good proportions of taxa sensitive to general degradation, consistent with good WFD status. The invasive signal crayfish listed under the Wildlife and Countryside Act Section 9, Part 1 was recorded at this site. No notable species were recorded at this site.
- 3.4.16 Site AQ6 produced CCI scores which ranged between of 10.36 and 17.18. This indicates that it supports invertebrate communities of high conservation value. The WHPT NTAXA scores were calculated to be 13 and 18 in autumn and spring respectively. The WHPT ASPT scores were calculated to be 5.2 and 5.7 in autumn and spring respectively. This data reflects a community of moderate to good diversity and moderate to good proportions of invertebrates sensitive to general degradation. No notable species or INNS were found during baseline surveys.
- 3.4.17 Existing EA data was available for four sites on the River Churn, named 'Upstream Colesbourne, ID: 35164', 'Colesbourne (old site), ID: 35765', 'North

Cerney, ID: 36222' and 'Butlers Farm, Colesbourne, ID: 89727'. Data sets span from 2001 to 2019. CCI scores from these sites varied between 6.25 ('North Cerney, ID: 36222', 08/05/2013) to 49 ('North Cerney, ID: 36222', 04/10/2004).. Baseline surveys conducted by the EA have recorded seven invertebrate species of conservation value:

- Two NERC Act Section 41 Species of Principal Importance were recorded; *Pisidium tenuilineatum* and *Nigrobaetis niger*;
- Three nationally notable species *Riolus subviolaceus*, *Riolus cupreus* and *Sialis nigripes*; and
- Two nationally scarce species *Hydatophylax infumatus* and *Potamophylax rotundipennis*.

3.4.18 No INNS were recorded.

Horsebere Brook

3.4.19 No baseline surveys were carried out in this waterbody due to distance from scheme. EA data has been included for context.

3.4.20 The WFD waterbody 'Horsebere brook – source to confluence River Severn' (GB106039029810) was classified as 'good' for the macroinvertebrate quality element in 2016 Cycle 2. This suggests that the macroinvertebrate communities within this waterbody may be slightly deviated from pristine quality due to human activities.

3.4.21 EA data existed for three sites on Horsebere Brook; Horsebere brook named 'u/s Millbrook Academy, ID: 170423', 'Millbrook Academy, ID: 170424' and 'Brockworth Sports Ground, ID: 170425'. The WHPT NTAXA varied between 5.17 to 5.75 and the WHPT ASPT varied between 15 to 27. The highest LIFE score recorded was 8.2 ('Millbrook Academy; ID 17424') and the lowest was 7.63 ('Brockworth Sports Ground, ID: 170425'). The PSI score varied from 53.85; moderately sedimented to 72.41; slightly sedimented. CCI scores indicated species of low ('Millbrook Academy, ID 170424':3.6) and moderate ('Brockworth Sports Ground, ID: 170425' scored 5.56; 'U/s Millbrook Academy, ID: 170423' scored 7.5) conservation value.

3.4.22 No species of conservation value were recorded. No INNS were recorded.

Painswick Stream

3.4.23 No baseline surveys were carried out at this site due to distance from scheme. Existing EA data has been included for context.

3.4.24 The WFD waterbody 'Painswick stream – source to confluence Stroudwater' (GB109054032460) was included as it forms part of the Frome catchment. This waterbody was classified by the EA as 'high' for the macroinvertebrate quality element in 2016 Cycle 2. This suggests that the macroinvertebrate communities within this waterbody represent those found in near-natural conditions.

3.4.25 'Stratford park, ID: 48318' was sampled in May 2000 and found to have a WHPT NTAXA of 17 and WHPT ASPT of 5.79. In the same year, in September the site was recorded to have a WHPT NTAXA of 18 and a WHPT ASPT of 5.77. No CCI scores were recorded at this site.

3.4.26 No species of conservation value were recorded during baseline surveys. No INNS were recorded at this site.

4 Conclusion

- 4.1.1 In the desk study data search, 11 aquatic macroinvertebrate species of conservation value (Appendix B) were identified within the study area. Sites sampled in the tributaries of the River Frome in 2019 and 2020 supported macroinvertebrate communities of fairly high conservation value based on CCI scores. Sites sampled in the tributaries of the River Churn supported macroinvertebrate communities of fairly high to high conservation value based on CCI scores.
- 4.1.2 The INNS signal crayfish was recorded on the tributary of the River Churn during spring 2020 baseline surveys and on the River Frome within Environment Agency data.
- 4.1.3 The sites sampled in the tributary of Norman's Brook supported communities of fairly high to very high conservation value based on CCI scores.
- 4.1.4 Field sampling in the tributary of Norman's Brook recorded the presence of one nationally notable riffle beetle *Riolus subviolaceus*.
- 4.1.5 Based on the data available, the macroinvertebrate communities supported by the tributary of Norman's Brook and associated springheads are considered to be of very high conservation value.
- 4.1.6 Detailed impact assessment and mitigation measures are reported in ES Chapter 8 Biodiversity (Document Reference 6.2).
- 4.1.7 Mitigation measures are included in ES Appendix 2.1 EMP Annex D Landscape and Ecological Management Plan (Document Reference 6.4).

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Appendix A - Photographs

Photograph 1 Photographs taken on site during autumn 2019 field surveys



Site AQ1



Site AQ2



Site AQ3



Site AQ4



Site AQ5



Site AQ6



Site AQ7

Photograph 2 Photographs taken on site during spring 2020 field surveys



Site AQ1



Site AQ2



Site AQ3



Site AQ4



Site AQ5



Site AQ6



Site AQ7

Photograph 3 Photographs taken on site during autumn 2020 field surveys



Site AQ1



Site AQ3



Site AQ4



Site AQ5



Site AQ6

Appendix B – Tables

Table B-1 Species of conservation value with INNS highlighted in red

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
Churn	Upstream Colesbourne	SO9958413257	01-Oct-01	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
	Colesbourne (old site)	SP0052913224	27-Mar-02	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Hydatophylax infumatus</i>	Northern caddisfly	Nationally scarce
	North Cerney	SP0190807912	15-Apr-09	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			25-Nov-09	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Potamophylax rotundipennis</i>	Northern caddisfly	Nationally scarce
			25-May-10	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			20-Oct-10	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Hydatophylax infumatus</i>	Northern caddisfly	Nationally scarce
			28-Mar-11	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
26-Sep-11			<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce	

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
			26-Mar-12	<i>Potamophylax rotundipennis</i>	Northern caddisfly	Nationally scarce
			28-Sep-12	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			08-May-13	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			05-May-15	<i>Riolus cupreus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			02-Sep-15	<i>Riolus cupreus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Pisidium tenuilineatum</i>	Fine-lined pea mussel	NERC Act Section 41 Species of Principal Importance
			20-Apr-16	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			07-Oct-16	<i>Riolus cupreus</i>	Riffle beetle	Nationally notable, Nationally scarce
			24-May-18	<i>Pisidium tenuilineatum</i>	Fine-lined pea mussel	NERC Act Section 41 Species of Principal Importance

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
	Butlers Farm, Colesbourne	SO9916613287	29-Nov-02	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Sialis nigripes</i>	Lacewing	Nationally notable
				<i>Hydatophylax infumatus</i>	Northern caddisfly	Nationally scarce
			06-May-03	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			28-Nov-03	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			26-May-04	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			04-Oct-04	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			22-Apr-05	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			13-Mar-06	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			23-Nov-06	<i>Hydatophylax infumatus</i>	Northern caddisfly	Nationally scarce
			10-Apr-08	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			23-Oct-08	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Hydatophylax infumatus</i>	Northern caddisfly	Nationally scarce

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
			15-Apr-09	<i>Nigrobaetis niger</i>	Southern iron blue	NERC Act Section 41 Species of Principal Importance
			25-Nov-09	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			25-May-10	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Potamophylax rotundipennis</i>	Northern caddisfly	Nationally scarce
			20-Oct-10	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Hydatophylax infumatus</i>	Northern caddisfly	Nationally scarce
			28-Mar-11	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Sialis nigripes</i>	Lacewing	Nationally notable
			26-Mar-12	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			Frome	Edgeworth Mill Farm	SO9524706705	11-Mar-15
11-Apr-17	<i>Riolus cupreus</i>	Riffle beetle				Nationally notable, Nationally scarce
	<i>Riolus subviolaceus</i>	Riffle beetle				Nationally notable, Nationally scarce
18-Oct-17	<i>Hydropsyche saxonica</i>	Netspinning caddisfly				Nationally scarce

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
				<i>Pacifastacus leniusculus</i>	Signal crayfish	Wildlife and Countryside Act, Section 9, Part 1
			18-Oct-17	<i>Hydropsyche saxonica</i>	Netspinning caddisfly	Nationally scarce
				<i>Pacifastacus leniusculus</i>	Signal crayfish	Wildlife and Countryside Act, Section 9, Part 1
			21-May-18	<i>Riolus cupreus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			06-Nov-18	<i>Potamopyrgus antipodarum</i>	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
				<i>Sialis nigripes</i>	Lacewing	Nationally notable
				<i>Wormaldia subnigra</i>	Finger nepped caddis fly	Nationally scarce
			13-May-19	<i>Oxycera pardalina</i>	Hill soldier	Nationally notable
				<i>Pacifastacus leniusculus</i>	Signal crayfish	Wildlife and Countryside Act, Section 9, Part 1
				<i>Synagapetus dubitans</i>	Saddle-Case Makers	Nationally rare
				<i>Riolus cupreus</i>	Riffle beetle	Nationally notable, Nationally scarce

*No notable or invasive species were recorded in the tributary of Norman's Brook, Painswick Stream or Horsebere Brook

Table B-2 CCI scores generated from EA data with unevaluated records in purple

Waterbody	Site name	Date	CCI score	Conservation value
Horsebere Brook	Upstream Millbrook Academy	08/10/2013	7.5	Moderate
	Millbrook Academy	08/10/2013	3.6	Low
	Brockworth Sports Ground	08/10/2013	5.56	Moderate
Painswick	Stratford Park	16/05/2000	Unrecorded	Unevaluated
		13/09/2000	Unrecorded	Unevaluated
Churn	Upstream Colesbourne	01/10/2001	15.31	High
	Colesbourne (old site)	27/03/2002	22.81	Very high
	North Cerney	15/04/2009	12.13	Fairly high
		25/11/2009	13.5	Fairly high
		25/05/2010	12.12	Fairly high
		20/10/2010	17.5	High
		28/03/2011	11.59	Fairly high
		26/09/2011	18.52	High
		26/03/2012	17.74	High
		28/09/2012	8.91	Moderate
		08/05/2013	9.32	Moderate
		17/09/2013	6.25	Moderate
		05/05/2015	16.19	High
		02/09/2015	26.67	Very high
		20/04/2016	15.52	High
07/10/2016	20.63	Very high		
10/03/2017	11.67	Fairly high		

Waterbody	Site name	Date	CCI score	Conservation value
		18/10/2017	11.58	Fairly high
		24/05/2018	27.59	Very high
		16/11/2018	12.22	Fairly high
		21/05/2019	10.83	Fairly high
	Butlers Farm, Colesbourne	29/11/2002	15.88	High
		06/05/2003	12.32	Fairly high
		28/11/2003	11.43	Fairly high
		26/05/2004	21.46	Very high
		04/10/2004	10.28	Fairly high
		22/04/2005	10.28	Fairly high
		13/09/2005	9.69	Moderate
		13/03/2006	8.33	Moderate
		23/11/2006	9.44	Moderate
		10/04/2008	16.45	High
		23/10/2008	16	High
		15/04/2009	14.9	Fairly high
		25/11/2009	8.57	Moderate
		25/05/2010	10.91	Fairly high
		20/10/2010	14.27	Fairly high
		28/03/2011	11	Fairly high
03/10/2011	6.88	Moderate		
26/03/2012	13.42	Fairly high		
28/09/2012	7.37	Moderate		
Frome	Edgeworth Mill Farm	03/10/2001	Unrecorded	Unevaluated

Waterbody	Site name	Date	CCI score	Conservation value
		20/05/2002	Unrecorded	Unevaluated
		01/04/2003	Unrecorded	Unevaluated
		17/09/2003	Unrecorded	Unevaluated
		25/04/2006	Unrecorded	Unevaluated
		05/10/2006	Unrecorded	Unevaluated
		19/03/2009	Unrecorded	Unevaluated
		10/11/2009	7	Moderate
		25/05/2012	8.67	Moderate
		13/09/2012	10.5	Fairly high
		11/03/2015	14.29	Fairly high
		11/04/2017	19.6	High
		18/10/2017	17	High
		18/10/2017	17.68	High
		21/05/2018	16.58	High
		06/11/2018	10.83	Fairly high
		13/05/2019	19.44	High
		11/10/2019	11.36	Fairly high
Norman's Brook	Halfway Bridge	04/04/2013	3.82	Low
		13/11/2013	5.91	Moderate
		03/03/2016	3.75	Low
		06/09/2016	7.92	Moderate

Table B-3 Biological Indices Scores from 2019 and 2020

Waterbody	Site name	Year	Season	WHPT NTAXA	WHPT ASPT	LIFE Score	PSI
Tributary of Norman's Brook	AQ1	2019	autumn	13	5.26	7.55	60.00
	AQ2	2019	autumn	18	5.70	8.00	65.85
	AQ7	2019	autumn	16	5.74	8.14	72.50
Tributary of the River Frome	AQ3	2019	autumn	10	3.82	7.60	50.00
	AQ4	2019	autumn	11	5.69	8.30	81.48
Tributary of the River Churn	AQ5	2019	autumn	13	5.01	8.00	60.00
	AQ6	2019	autumn	13	5.46	8.42	79.31

Waterbody	Site name	Year	Season	WHPT NTAXA	WHPT ASPT	LIFE Score	PSI
Tributary of Norman's Brook	AQ1	2020	spring	14	5.15	7.90	68.18
	AQ2	2020	spring	14	5.36	7.87	52.78
	AQ7	2020	spring	13	4.62	7.56	43.48
Tributary of the River Frome	AQ3	2020	spring	10	5.92	7.89	66.67
	AQ4	2020	spring	17	5.95	7.67	61.29
Tributary of the River Churn	AQ5	2020	spring	14	4.90	7.85	62.50
	AQ6	2020	spring	18	5.20	7.67	39.47

Waterbody	Site name	Year	Season	WHPT NTAXA	WHPT ASPT	LIFE Score	PSI
Tributary of Norman's Brook	AQ1	2020	autumn	10	4.73	7.43	58.82
	AQ2	2020	autumn	N/A	N/A	N/A	N/A
	AQ7	2020	autumn	N/A	N/A	N/A	N/A
Tributary of the River Frome	AQ3	2020	autumn	12	4.84	8.00	68.42
	AQ4	2020	autumn	13	4.18	7.00	38.71
Tributary of the River Churn	AQ5	2020	autumn	8	5.10	7.67	42.86
	AQ6	2020	autumn	17	5.70	8.23	70.27

Table B-4 Biological indices generated from EA baselines

Waterbody	Site	NGR	Date	WHPT ASPT	WHPT NTAXA	LIFE	PSI
Churn	Upstream Colesbourne	SO9958413257	01/10/2001	5.94	33	7.63	53.57
	Colesbourne (old site)	SP0052913224	27/03/2002	6.26	33	8.03	63.49
	North Cerney	SP0190807912	15/04/2009	6.26	35	8.02	64.41
			25/11/2009	5.91	32	7.92	60.32
			25/05/2010	6.33	29	7.86	59.02
			20/10/2010	6.56	38	7.93	70.42
			28/03/2011	6.36	34	7.97	63.33
			26/09/2011	6.49	33	8	74.55
			26/03/2012	6.28	37	7.8	66.67
			28/09/2012	6.24	25	8.14	71.43
			08/05/2013	6.47	26	8	66.67
			17/09/2013	6.13	20	8.17	70.45
			05/05/2015	7.03	31	8.29	78.95
			02/09/2015	6.36	23	8.18	72.73
			20/04/2016	6.86	27	8.42	77.55
			07/10/2016	6.8	28	8.45	80
			10/03/2017	6.47	30	8.46	71.67
			18/10/2017	6.6	23	8.61	76.19
			24/05/2018	6.26	26	8.27	69.39
			16/11/2018	6.17	27	8.35	70.83
21/05/2019	6.3	18	8.41	86.67			
Butlers Farm, Colesbourne	SO9916613287	29/11/2002	5.77	28	7.62	51.06	
		06/05/2003	6.41	29	7.87	69.23	

Waterbody	Site	NGR	Date	WHPT ASPT	WHPT NTAXA	LIFE	PSI
			28/11/2003	6.37	36	8.28	73.13
			26/05/2004	6.49	37	8.28	70
			04/10/2004	6.66	24	8.27	79.55
			22/04/2005	6.68	24	8.19	76.6
			13/09/2005	5.23	18	7.19	35.71
			13/03/2006	6.72	23	8.61	86.36
			23/11/2006	6.28	25	8.12	73.91
			10/04/2008	6.64	24	8.08	62.79
			23/10/2008	5.87	36	7.63	54.1
			15/04/2009	6.59	33	7.83	62
			25/11/2009	2.6	22	7.39	46.34
			25/05/2010	5.92	26	7.48	51.11
			20/10/2010	5.85	32	7.64	53.7
			28/03/2011	5.91	26	7.26	46.15
			03/10/2011	5.18	23	6.81	34.15
			26/03/2012	5.89	29	7.3	48.84
			28/09/2012	5.42	24	7.26	48.89
Painswick Stream	Stratford Park	SO8473005590	16/05/2000	5.79	17	7.64	69.23
			13/09/2000	5.77	18	7.73	75.86
Frome	Edgeworth Mill Farm	SO9530006700	03/10/2001	6.5	30	7.4	67.35
			20/05/2002	6.37	27	8	76.79
			01/04/2003	7.39	27	7.88	81.13
			17/09/2003	6.2	31	7.19	60.38
			25/04/2006	6.62	29	7.7	74.55

Waterbody	Site	NGR	Date	WHPT ASPT	WHPT NTAXA	LIFE	PSI
			05/10/2006	6.13	22	7.75	68.57
		SO9524706705	19/03/2009	6.29	19	8.11	81.58
			10/11/2009	6.81	32	7.8	67.8
			25/05/2012	6.17	21	8.18	67.44
			13/09/2012	6.62	32	8.13	71.93
			11/03/2015	6.6	30	8.05	69.09
			11/04/2017	7.02	25	8.32	86.36
			18/10/2017	6.43	31	8	66
			18/10/2017	6.56	29	8.06	67.39
			21/05/2018	6.16	25	8.18	69.05
			06/11/2018	6.38	24	8.04	65.12
			13/05/2019	6.78	30	8.28	67.86
			11/10/2019	5.83	17	8	55.17
Horsebere Brook	Upstream Millbrook Academy	SO8994316438	08/10/2013	5.55	27	8.04	63.27
	Millbrook Academy	SO8984516492	08/10/2013	5.75	15	8.2	72.41
	Brockworth Sports Ground	SO8957816684	08/10/2013	5.17	27	7.63	53.85
Norman's Brook	Halfway Bridge	SO8777321699	04/04/2013	4.65	18	6.79	55.17
			13/11/2013	4.6	29	7	40
			03/03/2016	4.53	22	6.92	47.73
			06/09/2016	4.69	27	7.19	50